Photo Sharing for Intergenerational Connections

ME310 Design Documentation

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1 Executive Summary

Digital technology forms the basis for most remote communication today. As we gain more freedom in being able to communicate across distances and time zones, we also move a large proportion of our communication online. We use mobile phones, email, social networking, teleconferencing and video chatting regularly. However, not all people are comfortable with the use of technology. At particular disadvantage are seniors, especially those in developing countries, who did not encounter any digital technology in their youth and find learning to use modern devices extremely difficult. Our switch to digital communication has created a barrier between people living in the digital realm and those living in the physical one. Add to this the divergent interests of different generations, and migration to and between cities that tears families apart and the fast paced city lifestyle that more of the world is moving into, and we have a dire need of technology that can keep family members connected.

Our mission is to bridge the gap between the Digital Foreigners (seniors), and their tech-savvy relatives, the Digital Natives (the youth), by creating a connection experience that takes into account the generation gap, physical separation, and lack of time for communication. We aim to provide an engaging and pleasurable experience for both generations by tailoring their end of the system to their needs.

Sponsored by Microsoft Research Asia, the Stanford and USTC teams have worked for 30 weeks on researching the needs of the user, brainstorming for solutions, prototyping and testing multiple solutions before settling on a promising concept and building a device that can solve these problems.

After extensive research, interviews, and discussions, we compiled a long list of issues about technology that concern the elderly, and areas where there are opportunities for enhancement or creation. Some of the solutions that we prototyped include simplified variations on video chatting and interactive surfaces, methods to save a 'family legacy' alongside video interactions, and remote tactile communication.

We found that photo sharing is an area where the disconnect is particularly bad. While the youth have smartphones and digital cameras at their disposal and take thousands of photos each year, only a minute fraction of these ever make it to their grandparents. We have Facebook, Instagram and a whole host of other online services we can use to share photos with our friends and, to some extent, our parents. Seniors who do not use technology are left completely out of the loop. In fact, the few seniors who do use computers do it mostly to download and view photos sent to them as attachments to emails.

Seniors tend to have physical albums with a lot of pictures taken over the years. They cherish these albums and enjoy looking through them. A photo means more to their generation than to the youth, since the era of cheap digital photos is not very old. A successful connection of these two worlds offers promise as a means to improve communication between generations, by giving an easy way for the younger generation to send photos to seniors in order to keep them in the loop. This can not only offer the
direct benefit of being able to look at what their family is doing, but also act as a catalyst for further interactions over the phone or in person. The challenge here is to create a system that is accessible to the elderly while offering the convenience and the connectivity of digital technology to the younger generation.

Present attempts to enter this problem space (Digital Photo Sharing), like digital photo frames, have not been very successful due to multiple reasons, the primary one being the lack of control seniors have over what photos are being displayed - the difficulty of navigation through photos. Our solution is the Family Album, a photo sharing device, which consists of a projector and a camera fixed above a blank paged-photo album. The camera is used to detect a page number/code on the page, and the projector displays the corresponding image on the page. It is important to hide the technology so as not to appear daunting to seniors, so we merged the electronics with an elegant lamp that can fit in any senior’s home.

Photos are can be added to the album either by sending an email with the photos attached, or by using the Family Album Windows Phone app. The photo will be automatically downloaded and the user will be alerted of new photos via a notification on the contents page. In addition to adding photos, the app allows you to change photo captions, create albums and rearrange and delete photos. To combat the problem of multiple relatives sending photos and the larger number of photos than pages on the album, we have multiple virtual albums that can be cycled through using a pull chain switch.

We tested our device with seniors in multiple senior centers near Palo Alto. The feedback was overwhelmingly positive, with users appreciating the ease of use and the intuitive interface. No one needed an explanation of how to use the device - everyone
knows how to flip through an album. Some users found it magical, with one user believing that we were using ‘magic paper’ that would show the photo only under the light of the lamp. Users also told us the importance of having large and clear pictures, and there were mixed comments about the need to have a portable album, one that could be pulled closer to the eye to see the picture better.

We presented a simple yet successful design of the Family Album. Future work to enhance it relate to making the system faster and more reliable. We have received suggestions about converting the Family Album into a platform that programmers can develop further applications for, to develop functionality like showing short video clips, displaying families’ social networking feeds in clipboard format on the Album, and allowing audio feedback to pictures. We believe it is important to ensure that features do not grow to a point where the device starts becoming confusing to the elderly user.
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Glossary

**Physical User** also Physical - A Person who does not use modern technology - May be too old, too young, too poor, uneducated or illiterate, or disabled

**Digital Users** Person in a developed region who is comfortable using modern technology.

**Digital Natives** Young people who grew up exposed to digital devices and the internet, and are very comfortable with using them.

**Digital Immigrants** A middle aged person who grew up without exposure to the internet and digital devices. He uses computers and smartphones more for work than for fun.

**Physical User** An elderly person who does not use modern technology and modern interfaces.

**Physical Interface** Interface where the interaction involves more than just audio, video and touching a screen.

**Benchmarking** A process of researching and observing to understand the state of the art for a given field or topic.

**Physical World** Tools and media which are mainly based on physical interaction and came before computers and the Internet.

**Printing Service** Specifically means print our all the photos into real photos and put them into a real album. Then the entire album is delivered.

**Video Loop** When a projected video image is recorded by camera, project the new image in new place and be recorded by another camera. This content then is projected back to the original place and overlap with the original projected video image. This video stream then becomes a loop.

**Video Stream Resonance** Because of transmission delay, projector and camera scanning frequency, these factors can easily produce some resonance and makes the video stream have some kinds of fluctuations periodically.

**Video Stream Echo** Since the two cameras and two projectors contract a loop, because of the time delay, if you change something under the camera, since the projected overlapping image is from other side and won’t disappear immediately; the removed object still exists and will echo for sometime. This phenomenon is video stream echo.

**Hiding Technology** To hide all the components that are related with technology, such as computer, camera, circuits and projector, so as to make it comfortable for physical user to use.

**Asymmetric Interface** A pair of device (usually for communication) and each one has a different interface that is designed for a different specific user group (seniors and young people).
2 Context

2.1 Need Statement

The family is an important part of human society, and our connection to our family contributes greatly to our happiness. However, with the development of modern technology and changes in society, this precious connection is being eroded. In particular, communication between different generations has taken a toll. Geographical separation, busy life and technology gap are the main causes of this divide.

The family window is designed for seniors who are not comfortable with technology, especially in a developing nation like China. In China, as more people migrate for work, families no longer live in the same city. This group of people includes:

(a) Students that study away from their hometown (usually true for students in top-ranking undergraduate and graduate schools in China.)

(b) Couples where the husband and wife come from different cities

(c) People who leave their hometown to work in cities (like Shanghai, Beijing) for better job opportunities.

The pace of life has become faster, especially in big cities where people are too busy to spend time with family. For families that are geographically separated, most of them are students and job hunters, hence are more likely to have busy lives.

In the last twenty years, there has been a rapid change in the availability of digital technology in the developing world. Though high-tech devices such as the computer, the iPad and the smartphone are very common among young people, they are new and unfamiliar to seniors, different from anything they used when they were young. Many of them don’t have the motivation to learn to use a computer or a smartphone, and feel uncomfortable with high-tech devices. It is very easy to find a senior that can afford high-tech devices but does not even use a mobile phone, instead preferring to continue to live in their old ways.

This change has brought great cultural changes between generations that further exacerbate the problem. Many parents realize that their children are missing the close connections with their grandparents that they themselves had in their youth.

In the US, the aging of the baby boomers creates a market of seniors who, while not completely out of touch with digital technology, find it tiresome to keep abreast with the changes in technology.

All these factors undermine the connection in families, especially between seniors and
the youth. The reality is, many teenagers and adults in China live far away from their parents and grandparents and have busy lives, but they just can’t find a good channel for family communication that seniors can accept. This problem begs to be addressed.

We found that photo sharing is an area where the disconnect is particularly bad. While the youth have smartphones and digital cameras at their disposal and take thousands of photos each year, only a minute fraction of these ever make it to their grandparents. We have Facebook, Instagram and a whole host of other online services we can use to share photos with our friends and, to some extent, our parents. Seniors who do not use technology are left completely out of the loop. In fact, the few seniors who do use computers do it mostly to download and view photos sent to them as attachments to emails. Seniors tend to have physical albums with a lot of pictures taken over the years. They cherish these albums and enjoy looking through them. A photo means more to their generation than to the youth, since the era of cheap digital photos is not very old. A successful connection of these two worlds offers promise as a means to improve communication between generations, by giving an easy way for the younger generation to send photos to seniors in order to keep them in the loop. This would not only offer the direct benefit of being able to look at what their family is doing, but also act as a catalyst for further interactions over the phone or in person.

2.2 Problem Statement

Our team is designing a device that will help to strengthen the connection between different family members especially between old and young generations. This device should:

(a) Fully exploit technology to allow better connections rather than just facilitating communication.
(b) Have a simple interface that is easy for seniors to learn to use.
(c) Hide the technology to make it less intimidating to seniors; to have them categorize it as an everyday item of use rather than as a device that you need special training to use.
(d) Have a convenient interface for young people to use.

This design is for a user group that satisfies the following criteria:

(a) Seniors, especially in developing countries, who are uncomfortable with computers, tablets and smartphones
(b) Live away from their children/grandchildren
(c) Grandchildren use digital technology extensively to take and share pictures.
(d) Can afford such a device.

This is a large section of the middle and upper middle class in developing countries, and smaller but not insignificant section in the developed world as well.
2.3 Corporate Partner: Microsoft Research Asia

In 1991, Microsoft Corp. became one of the first software companies to create its own computer science research organization. Microsoft Research has developed into a unique entity among corporate research facilities, balancing an open academic model with an effective process for transferring its research to product development teams. Today, the world-renowned scientists of Microsoft Research make up one of the largest, and most highly respected, software research organizations in the world—one that will help define and redefine the computing experience for millions of people for decades to come. From the beginning, fostering rapid and smooth technology transfer through deep relationships with Microsoft product groups has been a priority for Microsoft Research. Soon after its creation, Microsoft Research established a dedicated technology transfer team to help bridge the long-range research and near-term product development functions within Microsoft. The technology transfer program managers focus on building strong, collaborative partnerships between researchers and product teams to help fulfill a shared vision: seeing their innovative work reflected in improved software products for Microsoft customers. The benefits of this successful partnership can be seen throughout virtually every product Microsoft has delivered from Microsoft Windows 95 and Bing to the 2010 Microsoft Office system and Kinect for Xbox 360. Technologies developed within Microsoft Research are also licensed externally through the company’s intellectual property (IP) licensing program.

Established in 1998 and located in Beijing, China, Microsoft Research Asia is Microsoft’s fundamental research arm in the Asia Pacific region. It conducts curiosity-driven research in areas such as natural user interfaces, next-generation multimedia, data-intensive computing and search, and online ads. By attracting the best talent from Asia and the world, Microsoft Research Asia has grown into a world-class research location with more than 250 researchers and developers.
2.4 The Design Team

Sara Jaafar
Status: Masters Student in Mechanical Engineering
Contact: sarajaf@stanford.edu
Interests: Product Design and Methodology
I graduated from the American University of Beirut, Lebanon. I am interested in understanding the design process to be able to apply it in my future profession. I have worked for two years in the Procurement Department in an Oil and Gas company but decided to continue my graduate studies to seek an environment with innovation and creativity. I joined the design team for the Microsoft project in Winter 2013. I enjoyed the experience and will always value my time in ME 310.

Mishel Johns
Status: Mechanical Engineering Graduate Student
Contact: mishel@stanford.edu
Skills: MATLAB; Web design; CAD in Autodesk Inventor and Pro-Engineer
Microcontroller programming (AtMega), Raspberry Pi
Computing: Programming in C, C++, Python
I’m from Trivandrum, a city in southern India, and I’m here fresh after completing my Bachelor’s in Mechanical Engineering from the Indian Institute of Technology (IIT) in Madras. I’m interested in robotics, mechatronics, and design in general. I also enjoy traveling and travel photography, trying out different kinds of food, and thinking about the future of the human race.

Shiquan Wang
Status: Mechanical Engineering Graduate Student
Contact: shiquan@stanford.edu
Skills: MATLAB, Simulink, Mathematica, Ansys, SolidWorks, AutoCAD, Proteus, C, Labview
I was born in China, living in the southern part near sea. Graduated from Zhejiang University in major of mechatronics and in minor of ACEE. I am extremely interested in robotics and devoted half of my undergraduate years on related study, projects and research. I love music, playing instruments include piano, guitar and drum. Also like sport such
as basketball and Ping-Pong. Sometimes, I seem to be outgoing but sometimes I just feel that I am not that kind of person.

Li Xuesen, Tony  
Status: Mechanical Engineering Graduate Student  
Contact: xuesen@stanford.edu  
Skills: design, mechatronics, welding, prototyping  
Computing: SolidWorks, Matlab, basic C programming  
Born in China, I have always yearned to explore more about the world beyond this mass land. My undergraduate study in the Hong Kong Polytechnic University has provided me with solid theoretical knowledge, practical skills and an international outlook. It has also greatly inspired on making something real that we can see and touch.

Yingwei Li  
Status: Electrical Information Engineering Undergraduate Student  
Contact: lostoy.li@gmail.com  
I was born in China and major in Theoretical and Applied Mechanics. I enjoy the process of making my idea come into reality, so attending the ME310 class and the whole designing process is a precious opportunity for me. I also have great interests in music and swimming.
2.4. The Design Team

Yikang Liu  
Status: Electrical Engineering Undergraduate Student  
Contact: yikangl@mail.ustc.edu.cn

I was born in Hubei, a province located in middle of China. Although my major is electrical engineering, I am gifted with interests in nearly everything in the world. I desire to understand why the world functions as the way it does and feel satisfied no matter what field I step into and explore. Among the fields I have stepped into except my major, I love music and mechanics most. I am fascinated by playing keyboard, singing and making artificial gadget in leisure time.

June Zhang  
Status: Electrical Information Engineering Undergraduate  
Contact: junezjx@gmail.com

Getting to know radio direction finding in middle school made me get to be interested in electrical engineering. I love my major and enjoy learning more related to it. Fond of radio direction finding, going fishing, cooking and trying out delicacies. Love Stitch and Snoopy.
2.4. The Design Team

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Computing: Solid Works, Matlab, basic C programming, Forth

I was born in China and major in Theoretical and Applied Mechanics. I enjoy the process of converting an idea into reality, so attending the ME310 class and the whole design process is a precious opportunity for me. I am also greatly interested in music and enjoy swimming.

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2.4. The Design Team

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3 Design Requirements

Introduction

The aim of the Family Album is to strengthen communication between family members. Through extensive literary search, interviews and testing, we gathered the most important user needs and translated them to design requirements. These are listed as functional requirements, functional constraints and physical requirements in Tables 6.1, ??, and 3.2 respectively. Functional requirements, physical requirements and business requirements are discussed in this section. These requirements are set according to benchmarking, functional analysis and users’ feedback. They served as the target when we designed the Family Album and as the standard when we tested this device. Functional requirements are the criteria that can ensure the system implements the desired functionality; Physical requirements describe the physical properties of the device such as the album size, lamp height and the property of paper; Business requirements describe the requirements for the Family Album to be commercialized.

3.1 Functional Requirements and Constraints

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Metrics</th>
<th>Rationale</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>The photo should be clear enough for seniors to see</td>
<td>Resolution &gt; 72 ppi (older mac screens) Projector brightness &gt; 100 lumens</td>
<td>Essential for photo display to not appear pixelated</td>
<td>Pico Projector with resolution:1024x768, Brightness: 300 lumens</td>
</tr>
</tbody>
</table>
| The transition between photos should be smooth | New photo should appear at most 0.5s after the user puts down the new page, no flicker. | Avoid breaking the physical album metaphor; long delay ruins user experience | • Response time < 100ms  
• Strip down Linux to only essential components, Block loading unnecessary kernel modules  
• Overclock RPi  
• Change from Python to C++  
• QR code detection to color detection |
### 3.1. Functional Requirements and Constraints

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Details</th>
<th>Criterion Met</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detection of page</td>
<td>Motion of pages within normal limits (without damaging the page) does not affect the detection</td>
<td>Not only for system stability, but can also make the photo transition more natural</td>
<td>Redundancy of the color pattern for page number detection, Larger pattern</td>
</tr>
<tr>
<td>Impossible for user to block the light by head</td>
<td>The lamp should cover less than 25% of the area in the space above the album</td>
<td>Prevent occasionally blocking the light when approaching to the album to look more clearly</td>
<td>The lamp covers &lt;10% area directly above the album. With the projector located near the center of the lamp support, the projecting angle is around 15deg from the vertical. The album has been moved further away from the lamp</td>
</tr>
<tr>
<td>Sufficient Brightness</td>
<td>Image should remain clear under lamplight or sunlight from outside the window</td>
<td>Increase the usability and flexibility</td>
<td>Pico Projector with Brightness: 300 lumens</td>
</tr>
<tr>
<td>Easy Installation</td>
<td>Only one cable and connector allowed. Just like other conventional household appliances</td>
<td>Easy for seniors to use and make it looks familiar</td>
<td>Single cable. A Wi-Fi adapter can be set up somewhere else unobtrusively.</td>
</tr>
<tr>
<td>Change Album</td>
<td>Albums should be changeable so that the number of viewable photos is expanded and albums can be dedicated to people/events</td>
<td>So as to satisfy users needs on different albums.</td>
<td>Users can pull the string besides the lamp to change to another album</td>
</tr>
<tr>
<td>Good durability</td>
<td>The device should be able to work continuously for at least one year on average</td>
<td>Needs to last to provide value to the user.</td>
<td>Robust Program and electrical wiring, Stable, difficult to knock over, Most of the technology is hidden in a casing, Album pages difficult to tear, can be wiped with a cloth</td>
</tr>
</tbody>
</table>

Table 3.1: Functional Requirements
3.1. Functional Requirements and Constraints

Figure 3.1: Demonstrating the effect of ppi
3.2 Opportunities

- **Simple:**
  - Electronic system only includes a camera, a pico projector and an onboard computer.
  - Has good potential for price reduction
  - The numerous open source libraries and the basic setup of our design makes it possible to incorporate more features based on image processing and flexible projection without increase the cost

- **Familiar to Seniors:**
  - All the functions are strictly built on a real album. Seniors do not need to learn anything new to use our design
  - Does not appear to be technology-intensive.

- **Unique:**
  - No product in the market that can allow young generations to show photos remotely to seniors who cannot or do not want to use or learn how to use a computer, tablet or smart phone
  - The electronic photo frame is the only similar product in the market but because of the inconvenient navigation system and monotonous rendering way, our design can better satisfy senior users

- **New Way of Communication:**
  - It is a new way of communication between two generations: bringing digital record from the young generations’ lives and rendering it as a tangible, physical album into the older generations’ lives.
  - Might have interactive features that are new ways of facilitating more interactions between two generations based on remote information feed and control using computer and smart phone for young side, reading and writing on album for senior’s side

3.3 Assumptions

We are setting the following assumptions for our target user:

- Each Senior user has at least one child/grandchild that he/she cares for and is living far away.
- An internet connection can be easily set up and left on at the senior’s house.
- The senior has never used a computer, iPad or smartphone before or feels it is troublesome to use these devices.
3.3. Assumptions

- The senior users do not have any physical disabilities that prevent them from using our album.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Metrics</th>
<th>Rationale</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>The projected photo should be in proper position and size</td>
<td>In the middle of the page and cover 60% of the entire page area</td>
<td>Makes it look natural, and big enough to see</td>
<td>In the middle of the page and covers around 60% of the entire page area, depending on the aspect ratio</td>
</tr>
<tr>
<td>The album should look traditional and be familiar to seniors</td>
<td>&gt;90% seniors can recognize it is a photo album with one glance</td>
<td>Makes it familiar and comfortable for seniors to use</td>
<td>A modified album with a dark color.</td>
</tr>
<tr>
<td>Stability</td>
<td>With 10N force exerted on the album to lift it won’t cause the lamp to topple over</td>
<td>To keep the device balanced in case seniors might try to pick up the album</td>
<td>Good connection between the lamp base and the album with two types of fixture. Large base.</td>
</tr>
<tr>
<td>Paper material should be carefully selected</td>
<td>Rough enough to prevent glare or reflection; Strong enough to prevent warping, folding or curling of the page</td>
<td>Important for user experience and product durability</td>
<td>The papers are without glare or reflection. Corners of the paper are reinforced by metal corners to prevent it from being warped.</td>
</tr>
<tr>
<td>The pages should be easy for flipping</td>
<td>The edge of the pages should be closed to edge of the covers, the distance should &lt;0.5cm</td>
<td>Pages hidden deep inside the covers are difficult to reach</td>
<td>Corners of the paper are reinforced by metal corners to make flipping easier</td>
</tr>
<tr>
<td>The lamp should be high enough above the album</td>
<td>The distance between lamp cap bottom edge and album should &gt;50cm</td>
<td>Make it looks more natural and comfortable for use</td>
<td>The distance between lamp cap bottom edge and album is 50 cm.</td>
</tr>
<tr>
<td>Size should be small enough</td>
<td>Within 40cm<em>40cm</em>80cm</td>
<td>Easy to find a corner at home to accommodate it</td>
<td>Total box size: 50cm<em>50cm</em>100cm</td>
</tr>
</tbody>
</table>

Table 3.2: Physical Requirements
3.4 Business Requirements

3.4.1 Basic Business Model

Three types of sale can be derived from our product, which are:

- Hardware sale
- App sale and advertisement service
- Photo printing service

Our product is designed for seniors, and aims to make them feel more connected to their children/grandchildren and less lonely. However, our product is mainly intended to be sold to young people as a gift for their elders. The seniors can use it independently without any trouble.

On the young people’s side, different apps and software can be developed, providing multiple ways for them to upload photos, feed information or even remotely control the album with little effort.

Since some seniors want to print the photos, we might also provide an automatic printing service:

- Centralized printing spot for reducing cost. Sending printed album via shipment.
- Automatic notification of whether or not the album is filled out with photos and sending email to young user side to inquire whether printing service is needed.
- Once a printing request is received, the real photo album is printed out, packaged professionally, shipped and delivered by couriers.
- Package and album appearance can be highly customized by the younger users.

3.4.2 Requirements

To establish the business model described above, all the requirements as below need to be well satisfied:

- Though it is younger users that are buying this product, the price still needs to be low enough. Seniors might persuade their children/grandchildren not to buy it if it is too expensive and feel uncomfortable to use it due to its high cost.
- Once the device has been unpacked and configured by young side users or couriers, it does not need any operation or maintenance that is out of senior’s capability. Most of the accidental problem should be able to be addressed by remote control from the younger user or automatically detected and solved by our after-sale service.
- The user’s privacy should be strictly protected in our printing service.
4 Design Development

Our task is to 'design and prototype an interactive artifact, to connect people living in the
digital media realm and people who rely on traditional physical forms of media'. The plan
we followed was to first figure out what problems and needs exist. We listed out what
we use digital technology for, what 'physical people' use instead of digital technology
to perform these tasks, and why they prefer to use those methods. We visited senior
centers and talked to the elderly to learn more about our target user’s life and needs. We
looked at the technology we can use to build our device - both present technology built
for use by the elderly, and the cutting edge of technology that might give us a completely
new approach to bringing digital technology to the elderly. We also studies Microsoft
Corporation and its infrastructure and plans to see what sort of ideas could fit in. We
then brainstormed to come up with useful ideas. The difficult part was deciding which
one of those dozens of ideas deserved our further exploration. We picked three different
areas to prototype on during the first quarter, before following feedback on one of them
to settle on communication. Our design evolved from our peripheral vision display to the
family window/channel idea, and finally the family album.

4.1 Brainstorming

4.1.1 User Personas

We started with thinking about who the digital and physical users were - we created user
personas, the 'typical' users we are developing the product for. By having a clear idea of a
specific person, we hope to understand the needs of the user better. The digital native - A
young person in a large city in China, he is comfortable using modern technology. He grew
up with the internet, and has been using it since childhood for reference, communication
and for fun. He has a smartphone and a laptop computer, and is planning to buy a tablet
soon. He is a frequent, and perhaps obsessive, user of social networking services, and sends
and receives tens of emails daily. He primarily communicates with his friends by chat,
either from his computer or from his smartphone. He also spends time on the phone with
his girlfriend, and also uses text messaging a lot. He shares his life via status messages
and photo uploads on RenRen (Chinese Facebook), and reads the news on his smartphone
on his commute to work. The digital immigrant - A middle aged person, father of the
digital native, he uses computers and smartphones, but is not very comfortable with them.
He uses the computer for work, and sends email. He has an account he once created on
a social networking service, but he does not use it all, as he finds it uninteresting and
none of his friends use it. He uses a smartphone since all his colleagues use one, but he
hardly uses if for anything other than the basic phone call functions and to check his
email. He calls his son a few times a week and discusses the sorry state of the team they
are supporting. He also talks to his mother once a week on the phone, and tells her about
his family and enquires after her health. The physical user - An elderly person who does
not use modern technology and modern interfaces. She communicates with her family
4.1 Brainstorming

Figure 4.1: The digital native

and with her friends using the telephone. She sometimes sends letters or postcards to her grandchildren on their birthdays, and they visit her regularly. She grew up in a world where the family lived together with grandparents and grandkids in the same home, and she is sad that this is no longer happening. She is fine with using a TV set or a radio, as long as the controls are not too complicated. However, she cannot for the life of her figure out how to change the settings on her TV or navigate the menus. She reads her newspaper regularly, and also the occasional magazine. She thinks the things her grandson can do with technology are magical - but finds it too confusing for her own use. She calls her grandson every few weeks and asks him about his health, his education and whether he is getting good food to eat. She has heard of Facebook from some news item, but does not know what it is. She stays with her husband in the house they’ve lived in for the past 45 years.

4.1.2 Extreme User

We also looked for an ‘extreme user’ for our device - the limits of the user-space we are designing the device for. If our device can work for the users at the extremes, it can work for all users. The extreme user is an elderly family member who lives in a Senior Center. He does not talk often with his family, who live across the country, and when he does, he does not enjoy the conversation very much. Due to arthritis, his joints are weak, and he cannot stand very often or walk very far. He rarely leaves the senior center. He does not use a phone, as his fingers are not nimble enough to press the numbers, and he thinks it’s
a useless device anyway - if someone wants to talk to him, they could come and meet him. He uses a magnifying glass to read the newspaper occasionally to learn enough political news to sustain his next discussion with his neighbour, and spends a lot of time in his reclining chair looking out over the garden.

4.1.3 What ails technology adoption?

We then looked at why the physicals continue to rely on older technology despite digital technology being so commonplace. The biggest problems we identified were the cost of buying and maintaining devices, the steep learning curve involved in using most of them, non-intuitive user interfaces and the fact that these devices use a small subset of our senses (audio, video on a screen, no physical feedback) to communicate with us. Most devices are not accessible to many people - the elderly might have issues like weak hearing or eyesight, tremors, fatigue while using a device for longer periods of time, lack of dexterity, memory issues, and lack of previous experience with similar devices; the visually disabled, the hearing impaired and the physically disabled have their own set of problems. Illiteracy is also a major obstacle to using most devices. Many times, it is the embarrassment of not being able to use a device properly on the first use prevents people from attempting to use a
new device. Others do not use technology for fear of losing cherished traditions, because of an aversion to change, or even perhaps due to a bias against technology in general. Other worries about technology include the distractions it poses, and security and privacy issues. A recurring phrase we encountered while discussing about communication technology was that using the device for communication was "not intimate".

- Digital technology is expensive.
- Steep learning curve, non-intuitive interfaces.
- Problems associated with old age - weak hearing or eyesight, lack of previous experience with devices, tremors, fatigue while using a device for longer periods of time, lack of dexterity, memory issues.
- Fewer senses involved in interaction - Only audio/video for transfer of information from the device to user. There is not enough physical feedback from the device. For example, shopping is better in person because you can see, touch and feel the object you’re buying.
- Lack of education.
- Not accessible due to disability - visual, hearing, physical or other.
- Not accessible due to location - rural areas, areas with no telecom infrastructure.
• People are too busy to spend time learning a new system.

• Fear of judgment - "Will people laugh at me because I’m too slow at learning to use this device", "Will I accidentally modify some important setting, or damage this expensive device?"

• Health problems - sitting in front of the computer for a long time, headache on staring at the screen.

• Worry about wasting time/getting distracted by technology - games, movies, music, chat with friends.

• Bias against technology - "technology is evil, causing global warming, harming nature, causing cancer..."

• People do not like change; they are accustomed to traditional ways of doing things.

• Traditional alternatives to technology represent a way of life that people don’t want to lose.

• Lack of security - stories about internet fraud, online banking, viruses, security issues, privacy worries.

• Setting up the system, charging, syncing devices, connecting wires etc. is troublesome.
• Bad/boring/irritating people on the internet; inappropriate content on the internet.

4.1.4 Alternatives to Technology

We tried to enumerate what the digitals use technology for, and came up with a long list. We also tried to see what alternatives physicals have for these technologies, and why they might prefer these alternatives. By this exercise we hope to identify potential areas where technology might be able to make an impact in the life of physicals. We use technology to communicate, share details of our life, keep updated about what is happening in our friend circles, and to maintain contacts and find new contacts. We also use it to get information, as a reference, for education, and to create content and store the information and content we create. Technology is involved in most of our recreational activities today, whether it is serious gaming on the Xbox or PS3, or just whiling away time playing Fruit Ninja on the iPad. Technology also makes our life simple in other areas like shopping, navigation and in organizing our life. Physical people, on the other hand, keep in touch using the phone, or by sending letters and postcards. They network and exchange business cards at meetings. They write their to-do lists in a notebook and use a library for reference. Indoor recreation usually involves watching TV. The content they create, written on paper, cannot be widely distributed to many consumers. They are comfortable using older technology like the television, the (non-smart) phone or the radio.
<table>
<thead>
<tr>
<th>What do ‘digital people’ use tech for</th>
<th>What alternatives do ‘physical people’ use?</th>
<th>Why would they prefer these alternatives (if not listed in the previous section)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Getting the news conveniently</td>
<td>Newspapers</td>
<td>Large size of paper, can take around with you and read, works in sunlight, they are used to the texture of paper,</td>
</tr>
<tr>
<td>Communication, collaboration</td>
<td>Face to face talk, phone call, letters</td>
<td>Letter - shows that you’re willing to take more effort in communicating with the person, personalized with his handwriting etc.</td>
</tr>
<tr>
<td>• more ‘intimate’</td>
<td></td>
<td>• no signal delay, noise</td>
</tr>
<tr>
<td>• physical interaction with a shared environment (I can draw you a chair)</td>
<td></td>
<td>• video chat resolution not good enough, audio clarity not good enough</td>
</tr>
<tr>
<td>Networking</td>
<td>Face to face meeting, clubs, parties, conferences, visiting cards</td>
<td>1) ‘intimacy’  2) shows willingness to go somewhere to meet the person  3) privacy, security</td>
</tr>
<tr>
<td>Shopping (online)</td>
<td>Shopping at stores</td>
<td>You can see/touch/smell what you’re buying.</td>
</tr>
<tr>
<td>Keep records: data, photos, videos (memories)</td>
<td>Paper, notes, framed photos</td>
<td>Conversion of existing records to digital formal is difficult</td>
</tr>
<tr>
<td>Recreation: games, movies, eBooks</td>
<td>Movies at the theatre, on TV, board games, playing outside books</td>
<td>1) ‘Intimacy’ due to interaction  2) distractions on the device  3) email from boss  4) the device reminds you of work  5) health issues  6) ‘atmosphere’ of watching a movie in the theatre with others</td>
</tr>
</tbody>
</table>

Table 4.1: Technology use by digitals; Physical alternatives and their advantages (Part 1)
### What do 'digital people' use tech for?

<table>
<thead>
<tr>
<th>What alternatives do 'physical people' use?</th>
<th>Why would they prefer these alternatives (if not listed in the previous section)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher in class, blackboards, textbooks</td>
<td>1) Some things, like interacting with other people, cannot be taught online; 2) practicals/labs - flexibility of the blackboard as a display medium; 3) motivation when comparing yourself to classmates</td>
</tr>
<tr>
<td>personal organizer, notepad, to-do list, address book</td>
<td>No equivalent of post-it notes: we can put lists, notes in diff physical locations, pass on the list to someone</td>
</tr>
<tr>
<td>Dictionary, encyclopedia Britannica, library</td>
<td>Information overload, too many distractions on the internet, sense of accomplishment when you complete a physical book</td>
</tr>
<tr>
<td>Maps, asking people for directions</td>
<td>No signal in the location, no maps for the location</td>
</tr>
<tr>
<td>Actual travel</td>
<td>Virtual visit is 'not really being there', thrill, excitement, risk, exclusivity of having been to a place</td>
</tr>
</tbody>
</table>

| Misc. - Art, Content creation, online gambling, | |

**Table 4.2: Technology use by digitals; Physical alternatives and their advantages (Part2)**

Then, we tried to list the needs of a typical senior citizen. We started with a typical day in the life of an elder (Fig 4.52).
4.1. Brainstorming

Figure 4.5: Elder’s Daily Life Curve
4.1. Brainstorming

From what we learned about the daily life of the elderly based on the results of the needfinding, we developed our vision in the possible needs of the elderly and for each needs in Fig 4.53 we came up with the general solution showed in Fig 4.54. In the process of brainstorming we realized that although there are many digital devices available for the elders, they still do not use them. In spite of the needs of communication with their families or other people, the elderly are resistant to the new social communication tool in digital world. The most important reason may not lie in the infeasibility. Instead, the biggest problem that keeps them away from the digital world may be that they feel that connecting with others using digital technology is unnatural. For the elderly, the communication only based on displayed text, pictures and videos might be unable to please them. Their most intense need might be a solution that can make them that feel...
that they are close to their families, that they can communicate with just like they do in traditional physical ways. Thus, if we look further at the traditional ways of connection between the elders and their families, we can find more inspiration for our solution. For example, many elders in China will enjoy the process of cooking for the families, according to which we came up with the idea of a kitchen management system. We will list all such ideas in a later section.
4.1. Brainstorming

Figure 4.8: Brainstorming needs and solutions
4.2 User Benchmarking and Needfinding

We are building a device to connect multiple generations in a family, and hence we need to study the needs of these different kinds of users. However, since there is no lack of technology developed for the younger generation, we realized that the more serious need for connection came from the elderly. Also, it was a lot easier for us to understand the needs of the younger generation that we were a part of, that those of our grandparents. We thus focused most of our needfinding effort in getting to know the life of the elderly.

We started our user benchmarking with data from our own families - after all, we were all international students staying away from home, and good examples of the kind of user we were building the device for. We talked to our families, and discussed in depth about our communication methods and practices, what topics we talked about when we called home, our parents' and grandparents' use of technology and what kind of devices they would be comfortable with using. We also talked to David L Jaffe from the ME Design Group. He has a lot of experience in designing assistive devices for the elderly, and was kind enough to share his thoughts on our project prompt. Talking with him gave us a quick insight into designing devices for the elderly. He also pointed us to a lot of interesting existing technology we could explore.

4.2.1 Family Communication Survey

We then collected data using an online survey, which was publicized within the ME310 group and friends of our age group from China and India. Some of the more interesting results of the survey are presented here: Fig 8.9 shows the differences in communication duration when talking to parents and grandparents. 45% of the respondents report their talking session with their parents last less than 10min while 76% of the respondents report their talking session with their grandparents last the same duration. This indicates most people spend less time talking to their grandparents than their parents. From Fig 4.10, one surprising result was that most people were fine with the present frequency of communication with their parents. However Most of the respondents report communicating with their parents once and they think this is the ideal frequency. On the other hand, most respondents communicate with their grandparents less than once a month. , most wished they could talk to their grandparents more often than they do. According to Fig
4.2. User Benchmarking and Needfinding

Figure 4.10: One surprising result was that most people were fine with the present frequency of communication with their parents. However, most wished they could talk to their grandparents more often than they do.

Figure 4.11: As expected, communication with different generations involved using different tools.

4.11, communication with different generations involved using different tools as expected. The communication with parents involves tools from a wider range. Besides phone call, there are text message, audio chatting and video chatting etc. In contrast, people seldom use these methods to communicate with their grandparents. Phone call is still the most important and most outstanding tool. Fig 4.12 shows that the conversation topics also depended a lot on who they were talking to. The survey indicates most people have fewer topics to talk with their grandparents than to their parents. The topics with grandparents are generally confined within events from your daily life and events at home. Most people do not communicate with their family while being engaged in another activity at the same time according to Fig 4.13.
Figure 4.12: The conversation topics also depended a lot on who they were talking to.

Figure 4.13: Most people do not communicate with their family while being engaged in another activity at the same time.
4.2. User Benchmarking and Needfinding

4.2.2 Interview in a Nursing House (Shouxing Garden Apartment)

The USTC subteam visited the Shouxing Garden Apartment for the elderly in Hefei to learn more about the elderly user we were designing our device for.

4.2.2.1 Interview Strategy

It is essential for us to know more about the elderly’s life before we find ways for them to connect with the digital world; we needed to find a place where we could meet more old people. Luckily, we found a nursing house near our university and did a 2-hour interview there. To build intimacy between the interviewer and the elderly, we conducted the interview as a volunteer worker at the nursing house, and chatted about domestic trivia and helped with household chores (Fig 4.14). We wanted to explore the communication and record-keeping needs of the elderly. So we designed questions describing a specific scenario to induce the elderly to tell a story of their life. Questions we designed for the interview:

For the elderly

- How do you connect with your families? How often? Using what tools?
- Do you suffer from memory loss? How do you remember the phone numbers, birthdays, and other things like when or whether to have the medicines? How do you solve these memory problems? Do you use the calendar, notes, or devices?
- Do you other problems in vision, hearing or body?
- Do you have any electronic devices like laptop, phone, Ipad, E-book readers? How do you use them, and what do you use them for?

Figure 4.14: Interview with the Elders
• Do you read newspapers or watch the TV? Does your presbyopia bother you when you read? Do you want a device to help you read? (Computer, E-books)
• Do you like to keep photos and how do you keep them?

For the nurse

• What are the most common problems the elders suffer from? Vision, hearing, body frailness, memory loss?
• How often do the elders connect to their families and how?
• Do they often have the difficulty remembering things? How do you help them?

In order to get knowledge of how the elderly use digital devices, we brought two iPads and prepared games and album applications for the seniors. We intended to watch them using those devices to know what difficulties they might encounter. During the interview, the four students were divided into two subgroups. Each group had one person for recording while the other one did the interview. We had a voice recorder and two smart phones with us to record the sound and video for further reference.

4.2.2.2 Interview Results

We collected all the audio and video records after we came back from our interview and analyzed the contents (see details in Appendix 1). In general, we found out that the device we design should ameliorate the inconvenience caused by their health problems, such as poor memory and lack of body flexibility. Since we have not experienced such inconvenience ourselves, it is challenging to come up with special functions and interactive
approaches that can be used in our device to help the elderly. Besides, our device could be designed not for a person, but for a group of old people at a senior center. For instance, we found that the seniors there share mobile phones. As for the test of iPad games (fruit ninja) (Fig 4.16), we had 7 old people tested and found interesting results. The game involves slashing images of fruits falling down the screen and avoiding pictures of bombs with lit fuses. To play the game, most of the seniors used 3-4 fingers to slide on the iPad screen instead of 1-2 fingers as the way we used iPad. And this triggered the function to switch to another application. When this happened, the old players were confused what to do next. The elderly were not accustomed to gesture controls. They tended to press harshly on the screen as if they were pressing a button. Nearly all of them cut the bomb in the game even though we told them not to. Some of the old people wouldn’t try the game. So we first played the game together and taught the rules of the game while we played. (Fig 4.16) It seemed that they enjoyed it more when this interactive teaching process took place. We discussed the findings above and concluded some useful guidelines or ideas from them:

- The instruction and interface should be as easy as possible. More instructions would only drive the old users away.
- We might think of including buttons on the device for the elderly. They seem to be more comfortable with buttons.
- To smooth the learning curve of new technology for the elderly, we are considering making a device that will simulate their grandsons’ presence who will teach them in a natural manner.

Figure 4.16: iPad game: Fruit Ninja
4.2. User Benchmarking and Needfinding

4.2.3 Interview on People Around

4.2.3.1 Questions for the Elderly

After visiting the Shouxing Garden Apartment for the Aged, we found that old people live there are not a very common group. The elders live there have less education level than the average, which leads to the result that most of them have little connection with digital world. So we decided to do more survey among the elders. We hope to find their needs in everyday life and know more about their connection with digital worlds. In our needfinding process, we discovered that the children and grandchildren may also know much about the elders, their parents or grandparents. During our investigation, the young people who care about their older family members may find it easier to list their problems and needs. Since we don’t have much chance to communicate with the elders in our daily life, and it is accessible for us to get the information from the younger generation, we decided to investigate our classmates about their grandparents’ situation. We prepared some questions and the results are showed in Appendix A.

4.2.3.2 Lessons Learned

During the survey we found that many old people have eye problems like presbyopia, so large screens and large letters may be more comfortable for them. Most old people involved in our survey don’t live with their children, and in person communication is the most common communication method for them. All the old people in our survey don’t use the computer. Nearly half of them have their own mobile phones but these phones are only used for making phone calls. Cooking, watching the Beijing Opera and hand-crafts are common interests of the elderly. From the survey we conclude that large screen and letters may be welcomed by the elderly. Though none of the old people in our survey have
4.2. User Benchmarking and Needfinding

tried video chatting, they prefer face-to-face communication to other ways. So perhaps when they get accustomed to video talk, they would like it. Many old people like listening or singing Beijing Opera, but they don’t have chances to try the true opera suits on and play it on the stage. Also, doing craft work like knitting is popular among old people. We can think about some interesting devices in these directions. What’s more, we realize that most old people are eager to do something for their children and grandchildren. They hope to be useful and important to their family even as they grow older. So devices that can allow old people to remain relevant are likely to be welcomed.

4.2.4 Interviews at Senior Centers near Stanford

The Stanford subteam visited the La Comida dining room, which is part of the Avenidas positive aging center where seniors come to have lunch and talk every weekday afternoon, and the Cubberley community center where seniors, predominantly of Chinese origin, meet every Wednesday for lunch and to play board games.

4.2.4.1 Interview Strategy

Our aim was to have one on one interviews with seniors at all the senior centers we visited. We wanted to get to know them and learn more about their family, how far away they lived, how often they would communicate, who they like to communicate with etc. We asked them how often they would visit, what communication methods they used, and what activities they usually engage in when visiting family. We also asked them about who it was that initiated communication, and whether they were satisfied with the frequency and duration of communication. We also tried to learn about what devices they were familiar with, and what problems they had using technology.

4.2.5 Lessons Learned

Hardly any of the seniors we met stayed with their children, but most visited or were visited by them regularly. They were all conscious of the fact that their children were very busy (perhaps because we were in silicon valley), and tried their best not to disturb them - they preferred to keep communication limited to weekends and holidays, and said they would prefer to send messages rather than use real-time communication methods like the phone if they could. Most visits by family are for talking over meals, especially dinners. They let us know, however, that recreating the experience of living in the same house with a device was not really welcomed. They do not really want to talk to their children every day. They were particularly interested in talking to their grandchildren though. Most of them used the phone to communicate with their family, hardly anyone used video chat because it was too complicated. We identified a definite need for a device that would make video chatting as simple as a phone call. The price of any device built for seniors would be a major issue for them. A surprisingly large number of seniors in Silicon Valley use email, iPads etc, so we had to search a while to find users who met our target profile - a Chinese senior with little experience with technology. Those who do use computers use it mostly for receiving emails from family and friends, especially with photos as attachments. The ones who did not found it extremely difficult to understand what was happening when we tried to introduce a device to them, even the supposedly intuitive system on the iPad.
4.2.6 Insights

From the interviews we got insights on different aspects, which are showed as below:

**Communication**

- In many cases, the desire for communication and interaction is not symmetrical. One side (usually the parents) may desire more frequent and longer communication than the other side does. Opening up easy access to the other side at any time may be undesirable for some people.

- An important problem in communication (like using Skype) is knowing when the other party is available.

- An important element missing in remote communication is a common environment that both sides can interact with at the same time. The ability to move a chair for your grandma to sit down would make an interaction a lot more intimate.

- Audio quality and latency is very important for a good conversation.

**Cultural Heritage**

- Cultural heritage is passed on primarily by verbal interactions between grandparents and children, like storytelling etc.

**Designing Devices for the elderly**

- Old people cannot be simply put into one category, each person’s needs and disabilities (if any) are different.

- Devices are less confusing to elders if they have only one function associated with them - a Television is just used to see channels, a phone is just to make calls, a switch turns on a light.

- Abstraction is confusing - “Why should I click on ‘Start’ to shut down my computer?” - Concept of nested menus is not intuitive. “No dead ends, no logical leaps,” - as soon as users aren’t sure what to do next and hit “a dead end where it’s not obvious where they’re supposed to go, you’ve lost them.” [14]

- Devices can be disguised as familiar ones to make people feel more comfortable - E.g. A Skype device which looks like a TV, with a dial to flip contacts; Social networking feed disguised as a newspaper

- Most elders would prefer to use devices that do not make it obvious to others that they have some difficulties or impairments.

- A community computing device might make more sense in rural regions, rather than a personal device. This device sits in a common location, and people can come and use it once a week or so. This is safer; we have more leeway in using expensive technology. This might be the best way to reach people in third world countries.
We spent most of the first quarter looking at needs in communication between generations in a family. What we realized was that the gap was partly due to the forms of digital communication that young people use being inaccessible or unattractive to older users. This gap is especially large for those who live far away from their family and don’t have the chance to meet in person regularly.

4.3 Business Benchmarking

Microsoft Research Asia is the Asian center of the research wing of Microsoft Corporation, and develops products for Microsoft Corporation. The device we develop must integrate well into Microsoft’s sales and distribution system, infrastructure and company ethos if it is to be implemented. "Microsoft Corporation, incorporated on September 22, 1993, is engaged in developing, licensing and supporting a range of software products and services. The Company also designs and sells hardware, and delivers online advertising to the customers. The Company operates in five segments: Windows & Windows Live Division (Windows Division), Server and Tools, Online Services Division (OSD), Microsoft Business Division (MBD), and Entertainment and Devices Division (EDD). The Company’s products include operating systems for personal computers (PCs), servers, phones, and other intelligent devices; server applications for distributed computing environments; productivity applications; business solution applications; desktop and server management tools; software development tools; video games, and online advertising. It also designs and sells hardware, including the Xbox 360 gaming and entertainment console, Kinect for Xbox 360, Xbox 360 accessories, and Microsoft PC hardware products” Source: Reuters[10]. Of interest to our project is Microsoft’s acquisition of Skype in 2011. Skype is a major player in video communication, and our product, if it involves communication, will need to fit into the ecosystem of Skype, MSN Messenger and Windows Live Messenger. In 2012, Microsoft Corporation had a revenue of US$73.72 billion, and assets of US$121.2 billion. It employs about 94,000 people around the world. Skype Technologies earns money from paid Skype subscription, which allows you to make calls to phones. The revenue before being acquired by Microsoft was over US$700 million. In entertainment and devices segment, Microsoft competes with Sony, Apple, Google, Nintendo, and RIM. In the online space, Microsoft competes with Google and several other online service providers. Microsoft sells its products in multiple platforms - operating system sales with hardware vendors, retail sales and in the case of enterprise customers, through sales to IT departments of companies. They also have a retail presence through its gaming devices, games and PC input devices. Online services like Windows Live and Skype are promoted online.

4.4 Technology Benchmarking

4.4.1 Benchmarking existing devices that can help connecting families

We also spent a lot of time benchmarking existing technology, and we found a few very interesting ideas:

- 'Storybook coach' [11] - software for grandparents to create a storybook for their grandkids about their life, experiences etc. (The project appears to have been
merged into www.heritagemakers.com)

- The Microsoft research Sensecam [5] is a device which is clipped onto a person and takes pictures intermittently. It takes pictures more often when you’re moving. This can be a way for old people to have automatically pictures of their life to select from and show to their families.

- A prototype that Dave Jaffe once tested - A book of memories device for an Alzheimer’s patient. Photos from his past were compiled into a slideshow along with a recording of him speaking about the photo, and made into a DVD that he could occasionally watch and show people.

- The Memory glass foundation has an iPad app for seniors to look through their photos [4].

- An old project called community memory in Berkeley [13] involved a printer which worked with a bulletin board system to spread details about local happenings to the crowd.
4.4.1.1 Devices for elders

Fujitsu RakuRaku phone for the elderly [2] - Fujitsu has modified an Android smartphone to help the elderly use it better. Modifications include ignoring accidental touches, bigger buttons, voice commands, and touch to select and press to activate. The Clarity Pal phone for the elderly has huge buttons and a simple interface, and also an easily accessible emergency button that can be used to call for help. The Presto email to print machine sets up an email address for users who don’t use computers, and emails sent to that address will be printed out by the device.

4.4.1.2 Devices for children

We also researched about building devices for other members of the ‘physical’ population. The One Laptop Per Child (OLPC) project has a set of interesting devices built for children in developing nations. Some interesting concepts from their research include a ‘narrative’ interface - a device which talks to children (and uses storytelling) to in order to teach them. A spinoff from the same project is the SUGAR on a Stick OS for children, with a user-friendly interface, and mechanisms for collaboration, reflection, and exploration. Sugar is a platform that enables children to learn and process according to their own pace. It provides a user-friendly and stable interface which is suitable for children. The platform provides mechanisms for collaboration, reflection, and exploration. Sugar is open-source software based on Fedora. In our trial, we used VMware to run Sugar, thanks to its hardware independence and easy switch between VM and physical computer. As shown in Fig 4.20, Sugar provides hundreds of functions, called Sugar Activities, including: Abacus, Analyze, Colors, Image Viewer, FileShare, Chat, Physics, Speak, etc. Simply by
4.4. Technology Benchmarking

![Images of applications](image)

Figure 4.20: Examples of activities on Sugar

clicking on the icon, uses can launch the application, and the system can record users’ progress in studying.

### 4.4.1.3 Devices for visually disabled users

Technology that connects visually disabled users was also explored - we looked at smartphone apps like screen reader which read out all the text on screen, and Georgie, a smartphone system which allows you to ‘managing contacts, using speech input to send text messages and tag previous routes or hazards (like potholes or low hanging branches) using navigation apps.’

### 4.4.1.4 Devices for rural populations in third world countries

Voice-based social media for rural developing regions (The Voice4all project) [1] Television and radio are an effective means of information dissemination in rural areas. However, a platform to discuss, debate, and relate personal experience, information is terribly needed. And this product solves this problem to a certain degree: by dialing a phone number and navigating through simple audio prompts, farmers can record, browse, and respond to agricultural questions and answers. Display agricultural information, Q&A forum, announcements board, and radio archive.

### 4.4.2 Benchmarking new technology

The touch interface in the iPhone was a game changer in intuitive interfaces, before which the touch screen was limited to a few devices meant for tech savvy users. We explored a lot of cutting edge interface technology, looking for potential technologies that could be the next iPhone and transform the user experience for people inexperienced with technology.
4.4. Technology Benchmarking

We looked at devices that convert between the physical and digital worlds. Products that could scan any document kept on a table, projects like ‘sixth sense’ which project a digital layer onto physical objects, devices like tablets and digital whiteboards which digitize writing. Microsoft’s omnitouch project allows you to project a layer onto any surface and convert it into a touch screen. We interacted with Prof. Scott Klemmer of the Human-Computer Interfaces group in the CS department at Stanford, because we were interested in some of the projects that their lab had worked on - the papertoolkit project which involved digitizing work as it was being written on paper, projecting digital work onto paper, and using that for computer interactions \[7\]; the gigaprints project \[3\] which involved displaying data using extremely high quality prints on paper, utilizing the cost-effectiveness and the resolution of paper prints; voice4all, a social networking project run through mobile phones and audio alone; and Papier-Mache, which integrates digital information with physical objects \[8\]. However, we found that no student who had worked on any of the projects we were interested in were still working in the lab. We wanted to try these projects from the source that was used 5-6 years ago, but Prof Klemmer recommended that we start from scratch to build a prototype, as the technology used in the (5 year old) projects is now outdated, and it would probably not be worth the effort of learning what was happening and customizing it to work on the hardware we have available. Prof Klemmer also pointed out to us some devices/companies/researchers that might be interesting, like the digitizer pens from livescribe, HP’s Presto printer without any buttons which prints out and send email. We also talked about how a touch screen was a more intuitive interface than a keyboard and a screen, and about what made
interfaces intuitive to different user groups. We also found to be of interest Telepresence robots used in certain corporate environments, gloves that allow input using hand motions as signals (gesture control) and many applications of Microsoft’s Kinect system to allow more ‘physical’ interactions with computers.

### 4.4.2.1 Sony HMZ-T1 Head Mounted Display

This is Sony’s first generation head mounted display and simulates a 150” 3D screen 12 feet away from the wearer. We wanted to test how immersive such a display could be. However, we were disappointed with the device - it was heavier than we expected, and it wasn’t really very easy to feel like you were in the world that was being shown in the display, probably because the screen took up just a small part of the eye’s field of view. This device was designed for consuming content that was created for display on a large screen, not for immersing the viewer in another world. We shifted our focus to other products like the Oculus Rift.

### 4.4.2.2 Luidia eBeam Whiteboard

This device digitizes what we write on a whiteboard, using an IR sensor to detect the position of the pen. It turned out to be quicker and more responsive and accurate than we had expected. It would have been better with some handwriting recognition and conversion of a chart drawn on the board into digital format. We also think that adding a projector with it to allow data to move in the opposite direction (from the computer to the board) would be a great idea.

![Figure 4.22: Writing and erasing on the whiteboard.](image)

### 4.4.2.3 Magictouch resistive touchscreen

This is a transparent touch input device that fits in front of your screen. It has a stylus to be used with it. However, this is rather old technology, and its performance is rather poor compared to the screen of an iPad or an iPhone - It wasn’t very sensitive to soft touches and quick movements, and there was a noticeable lag. We don’t know if this is
true of all touchscreen add-ons available today. The company (Keytec Inc.) still produces similar devices, with the OPTIR Touch coming in sizes up to 140”... and their product videos seem to show much better responsiveness.

![Resistive Touch Screen Testing](image_url)

**Figure 4.23: Resistive Touch Screen Testing**

### 4.4.2.4 Wacom Tablet

This tablet is a both a display screen as well as a touch input device. Using this with a laptop is similar to using a tablet PC. Lessons Learnt: The Windows 7 interface is not designed for use with a touchscreen! It would be better if there were larger buttons to press, and some sort of feedback when you touch. Considering we’re using a stylus, it would be very easy to incorporate vibration feedback.

### 4.4.2.5 Noteledge

NoteLedge is a robust note-taking application that combines handwriting, typing, audio and video recording all in one package. It allows you to share ideas anytime and anywhere.

![Noteledge](image_url)

**Figure 4.24: Noteledge**
4.4.2.6 Family story

Family Story is a smartphone app which is developed by Samsung. You can use this app to share photos, memos and events with your group members. Its main feature is that it’s a private social media for the family which enhance the connection between family members.

![Family story](image)

Figure 4.25: Family story

4.4.2.7 Sensecam

Microsoft’s SenseCam is a lifelogging camera with fisheye lens and sensors such as accelerometers, heat sensing and audio., Sensecam is used for the MyLifeBits project, a lifetime storage database.
4.4. Technology Benchmarking

4.4.2.8 Friday

It’s a background app run on android devices to record the information of the device which can be used for analytics for your life. It collects statistic data of your sms, calls, emails, photos and the physical location of the user. It’s quite similar to webcam—they both collect large amount of data and extract useful information from them.

4.4.2.9 Evernote

Evernote is a suite of software and services designed for notetaking and archiving. It provides a web page version and versions which can run on mobile platform.

4.4.3 Interfaces without text

We also tried visiting websites and using phone apps in a language we didn’t understand (4.29), to see whether the device was usable - while Mishel attempted to use the iPad and the iPhone in Mandarin, and to use a few Chinese websites, Shiquan and Tony tried to navigate around sites in Hindi and Malayalam. By this exercise, we hoped to learn how a person who cannot read either due to a visual handicap or due to illiteracy would feel while using a device. For a person unacquainted with tech, the technical meanings
of common words like submit, ok, cancel etc. may not be obvious. Lessons Learnt: We use our knowledge of existing user interfaces significantly when we interact with a device. Even though I didn’t know what the text said, I could figure out what I was supposed to do to interact with the text because of my experience with similar devices in languages I understand. Websites too follow certain standard formats across languages, and hence navigation was not as much a problem as we expected. However, such knowledge would not be available to an illiterate person using the device. Icons were helpful in trying to divine the meaning of the buttons, but we realized, after talking to Prof Scott Klemmer, that it is very difficult to make ‘universal’ icons that convey the same meaning to everyone.
4.4. Technology Benchmarking

4.4.4 Benchmarking Communication technology

We needed to explore existing methods of communication, and find out what worked and didn’t work with our target users.

4.4.4.1 Mobile phones

While the mobile phone is a ubiquitous device with our generation, very few seniors use it, though they seem to have no problems with landphones. The limitations we identified were:

- Menu System - The system of scrolling through a menu and selecting the option you want is not very intuitive. Even if seniors did not want to access any function that needs a menu to get to, it is easy to accidentally press the menu button and reach an interface they are uncomfortable with.

- Having to set the phone to recharge every day is an unfamiliar concept, and many grandparents either leave it on the charger all the time or forget to charge it.

- Most mobile phones were built to be small, and that made it difficult to use. Often the volume of the speaker was not loud enough.

4.4.4.2 Answering machines

While many seniors appreciated being able to leave messages when someone wasn’t at home, many had trouble accessing their own messages because the navigation system is not simple.

4.4.4.3 Skype (Video Chat)

Most seniors use the phone regularly, but hardly anyone uses video chat because they find it too complicated. Skype, for instance, requires you to first accept a contact request. Now, you will need to have to computer up and running when someone decides to call you. Deciding when to be online together with the other person is challenging and might need to be discussed over the phone. Even if skype is set to load with windows on startup, the user needs to be experienced enough to move the mouse to the accept button when they receive a call. Clicking anywhere else might launch something that is very confusing to seniors. Placing a call requires browsing to the user and clicking on ‘call’. Other possible problems include the connection from the computer to the speakers/microphone and the internet connection stability.

4.4.4.4 Talking photo album

We bought and benchmarked a photo album that one could use to store a few seconds of audio for each photo. The idea was interesting, but poorly implemented. For one, we needed to press two buttons at the same time to record the audio. The pages were stiff and had to be held open by hand while viewing. The slots for inserting photos were on the bottom side, so if the photos were smooth enough, holding it upright cold allow photos to slip out.
4.4.4.5 Digital photo frames

We tested out a few digital photo frames we had lying around. We had heard bad reviews of the concept of the digital photo frame from our teaching team, and we found that to be true. For one, the senior users had no control over what photo would be displayed to them when it is kept on the desk, it usually cycles through all the photos put in the memory card. Navigating to a photo involved pressing the direction keys multiple times till you got to the photo you wanted. There was no identifying photo number that you
could use to remember where that photo was. Also, you had to remember to keep the
device plugged in, and the wires were a nuisance.

4.5 Idea Exploration / Brainstorming

In this section, we will describe the ideas we considered, and ultimately rejected before sett-
tling on our critical function and experience prototypes. After our extensive benchmarking
and exploration of existing technology, we had a lot of high-tech ideas and possible sol-
lutions to the problem. Listing these out formed the first part of our idea exploration
process. However, we realized that we needed to look at the problem more from the pers-
spective of the needs of the user rather than from a technology perspective. We then had
another round of brainstorming, on the premise - if you could make a magic device to meet
the user’s need, what would it be? This was done because we felt that our overemphasis on
technology was perhaps constraining our imagination. We came up with a bunch of ideas,
and then thought about how close to our 'magic' scenario we could bring technology.

![Diagram](image.png)

**Figure 4.32: Ideas we explored but did not pursue**

4.5.1 Communication Toy

The idea is to build a toy that can interact with the person while also performing the
function of a communication device. The toy acts as a proxy for the person being spoken to; perhaps it can convey the emotions of the person through some display or motion. Having an object as a stand-in for a person can improve the feeling that the other person is really present there. It would also be possible for the user to carry the toy around with him and just place it down when it is to be used for communication. An alternative approach would be to have a mobile toy that can move inside the house and follow you around. This would be especially useful if the communicant can control the toy to see what’s happening in different parts of the house. An interesting critical function to test would be to try to integrate communication technology into an existing toy, like a Pleo robot. Another interesting question to test would be how much the communicator associates the toy with the communicant. Would the motion of the toy be interpreted as the emotions of the communicant without being explicitly told so? How important is it that the toy should
remain at eye level? Do people feel comfortable talking to someone who is on the ground? How important is the device being able to move around the house?

### 4.5.2 Immersive Display

The idea is that if we can build a device that is truly immersive, if it can make the user forget she is using a device, and also give her complete freedom in interaction so she can do anything she would in the real world, then that could work for any age group - there is no new interface to learn to use, nothing that she doesn’t already do in the real world. The problem is, however, that ‘complete’ immersion is not possible using today’s technology. Our best shots at an immersive display would be a head mounted display or a dome that you sit in. A suit worn by the user could potentially transmit touch information, but by then the device has become too cumbersome. In our discussion, we came up with a lot of complexities in building such a device. We benchmarked Sony’s HMZ-T1 head mounted display, and researched other options available, like the Oculus rift [6]. A possible CFP would be to buy a head mounted display, get a 360 degree view image, and show it on the head mounted display - it is realistic? Perform a Wizard of Oz test - when the user moves their head, you move the image so that it seems like they are turning their head to see something. Do they feel dizzy, uncomfortable? Another related idea we discussed was to have a helmet with camera on one side, head mounted display on the other side, so that grandma can see what I’m seeing. It could also be asynchronous - it could track your position, and you can click pictures and add audio comments at each position, and your grandma can browse through the path you took and see pictures and listen to audio clips at each point you recorded - have a virtual tour of the place you visited.
4.5. Idea Exploration / Brainstorming

Figure 4.34: Testing Sony’s head-mounted display

Figure 4.35: Immersive communication idea development

4.5.3 Magic Table

This is a table which converts between digital and physical information display. We can place documents, photos etc. on the table, and they get automatically scanned. Also, someone using the table somewhere else can look at the photos along with you while you’re digitizing it, as the photo is now displayed on his table. This idea can be used with multiple use scenarios - from having a common surface to write on while communicating, to playing games like tic tac toe or poker, to using the table to digitize an old (physical,
printed out) photo album. CEP: Create a sample design for the table, implement some functions using Wizard of Oz techniques, test it on people. CFP: Fix the projector and a camera on a beam above a table, then calculate the position of a hand or pen on the table using an eBeam sensor. Using the combination to scan in and display photos.

4.5.4 A 'DigiPhysical' Mailbox

It converts between physical mail and email. Meant for people who are uncomfortable with using email on a computer, the device provides an email id to the user, and all mail sent to the email id gets printed out for the user to read. To reply, he just needs to write his reply on a sheet of paper, with the recipient email address at the top, and drop it into the device. The device then scans and mails the document to the right person. This function could be tested with a printer-cum-scanner device that is set up with a computer. We can write scripts to query a mail server for new email, and take a printout whenever email is received. We can also have a sensor that detects when paper is placed in the scanner, and automatically scans the data. An OCR software then recognizes the email id written at the top of the sheet.

4.5.5 Portrait Presence - A device that talks to you like a real person.

The simplest possible interface for a person without any experience with computers would be to have a person speak to them and ask them what they want done. If we could have a computer that speaks to them like a person would, and understand perfectly what they are telling it (way better than Siri does), that would be very attractive to many users. However, such a product is not within the scope of our abilities and present technology. We also considered introducing personality quirks or character faults in the talking interface to make it more likeable. One idea we had in this regard was something like a moving photo frame from the 'Harry Potter' movie series - photos that move and have a personality. There is a photo of my family at my grandparents’ place, it moves, talks like it is us, comments on the weather etc., without any action on our part. It also reminds grandma to have her medicines, warns her to wear warm clothes as the weather is going to be cold. Grandma’s messages are relayed to us through a similar photo of her that we have at home, and we can leave messages for her. However, the technical implementation of such an idea would involve a combination of chatbot technology, artificial intelligence, realistic voice synthesis, language processing and more.

4.5.6 Tele-Manipulator - Actual physical interaction with objects

We realized that an important part of in-person interaction is the ability to interact with a shared environment. Would it be possible for us to introduce this into remote communication? One way to do it would be to create a virtual world and immerse both sides in it, as explored in an earlier idea. Is it possible to actually move physical objects on the other side of the communication, perhaps by using a robot, or some sort of tactile sensor? The ideal scenario is - You have a knife with you, and if you show it to your grandma, she can pick it up, feel the edge, and even cut herself if she’s not careful. You found a weird shaped tomato at the grocers today, and you can show it to your mother, and she can hold it.
4.5.7 A shared whiteboard or refrigerator front

A wall that both sides can write on, and leave messages on. Other ideas: a large screen with easy interaction with mobile devices (flick to move notes between the screen and the device) and easy interaction with physical artifacts (stick a post-it note to the screen and it gets scanned in) can also be extended to do this. On the grandma’s side, it would mostly be physical interaction and on the family side, it is likely to be more complicated and flexible. We could have a kid mode and an elderly mode, along with a normal mode, depending on whom the window is meant for.

4.5.8 Multitasking while communicating

Another issue separating digital and physical users is the lack of time. Presently, we have small slots of concentrated communication with our family, so we have to dedicate all our time in that slot off communication. We might run out of topics during this time, and in general, the quality of interaction is not the same as just being around your parents at home. Most communication at home happens not when you sit down to talk with someone, but over dinner, or over a videogame, or over the newspaper in the morning. Can we introduce this element to daily activities? A more natural communication might be established, if interaction could be maintained over longer durations, but where the interaction is not the primary use of time - for instance, watching a movie or a sports event together, while being separated spatially. If we could integrate interaction into some daily activity - perhaps watch TV together so they could comment on the action, cheer for the team etc... or shop online together (allowing the younger side to help the technologically challenged side). Of course, the activities in question depend on the kind of user. Eg. Grandparents & grandkids - storytelling; adults & adults - TV shows, movies, board games, video games; children & children - video games, education; grandparents & grandparents - gardening, knitting, reminiscing. Often, it is not just communication that is a problem which separates physical and digital residents, it is also the lack of access the physicals have to the kind of activities the digitals spend a lot of time on. We can try to address this by allowing the digital side to control a lot of the display - pick up newspaper articles for the other side to read, post on their behalf, and show them pictures from Facebook? This device could be asymmetric - the tech savvy side can have social media integration - recommendation of shows from friends, what they are watching/listening to right now, posting on Facebook when you’ve got a highscore etc. Question: How do we synchronize activities of these two physically separate users? How do we let them know the other side is available? How do we maintain interaction over a movie, newspaper etc? CEP: Leave an audio/video connection on between your home and your parents’ home for a few days. See when interaction occurs, and how well it works. CEP: Set up xbox live with a family & grandparent who stay far away from you; watch a movie together. Does it add to/subtract from the experience? CFP: Set up a camera behind you while you are reading the newspaper, and use it to detect the page you are on and informs the other side so you are reading in sync and commenting on the same articles. CEP: Set up TeamViewer (Software to control one computer from another) and Skype so you can control your my grandmother’s computer for her, open articles for her, show her the shopping website window. Is it too tiresome for the person who is controlling the device?
Can your grandmother follow what is happening on the screen? CEP: Test by leaving a video chat on while both sides are engaged in the same activity, and see if any synergy occurs. This idea was the seed for the peripheral vision prototype we will describe in the next section.

4.5.9 Video Conference Optimizer - Optimizing bandwidth usage during video conferencing

The bandwidth is the single biggest impediment to good video conferencing. If you can’t hear/see the other side properly, there is a barrier; it doesn’t let you feel like they’re really next to you. Often, a phone call is more intimate than a Skype call because of the lack of a lag in the communication. The requirement of bandwidth is not uniform throughout the duration of the conversation. Certain parts of a conversation are more important than others, it is more important that the other side see and hear what I am doing or what I am showing at certain moments. We could thus prioritize bandwidth (at the cost of realtime interaction), by having low quality video most of the time and in parallel sending the high quality video (of just the most important moments) to be shown once it’s completely downloaded. Question: Is it possible to predict what parts of a conversation need more bandwidth and prioritize data transfer, perhaps in partnership with the ISP? If bandwidth cannot be modified, would introducing asynchronous transfer of higher resolution video/audio be a solution - and can this be made to feel natural? CEP: How good is the experience of having to wait for high-res video? If you see low res video and the person you are talking to is recording high res video which will come to you in some time, do you get impatient? What methods can be used to make this more comfortable? Test with a Mock-up CFP: Have multiple instances of video conferences running on one computer, one person on each instance, each person sets a priority value changing with time. Distribute bandwidth according to priority, and do not allow anyone to hog the bandwidth.

4.5.10 A reminder bracelet for elders

A watch or bracelet that speaks to the elderly user, reminding them about their medication, warning them about weather conditions, and advising them - "maybe you should wear a coat, because it’s going to get cold soon" - in the voice of their children. CEP: Record some common sentences used while looking after the elderly, then use a microphone and manually play the suitable sentence in corresponding situations and find out how the user feels. Is the voice of a loved one important?

4.5.11 Connected houses

What if two houses were electronically connected to indicate the presence of the people in the other house? For instance, a carpet with lights and force sensors that would light up to show the footprints of the people walking about in the other house? Transmitting sounds in the kitchen, dining room etc. Privacy concerns would be an issue.
4.5.12 Storytelling simulator and recorder - Creating a demand for old people’s stories

People like to listen to stories, even if it doesn’t relate to them - it is human nature. Old people like to tell stories. It also helps in controlling memory loss, gives some relief to families of those suffering from Alzheimers. "Storytelling can remind seniors of fun times, old friends, and amusing events in their lives. Most importantly it gets them thinking, listening and contributing again.” [9] However, more often than not, the elderly do not have an audience for their stories. The internet might be a good source of an audience. How do we connect the two? Will it be useful if old people can tell stories and people can listen to them online, share, comment, post responses etc. - a storytelling version of YouTube? Perhaps old people could talk about their life experiences, funny incidences, how did they meet their spouse, their childhood in a world very different from ours, or give advice about cooking, advice about keeping the house organized, advice about family life etc. We could design a device that records stories from old people and uploads it for people to hear. But how do we encourage people to tell stories? How do we make it feel more natural to be talking to a device? Some ideas we considered includes

<table>
<thead>
<tr>
<th>Idea</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-book mark</td>
<td>Help the reader to take and share the notes.</td>
</tr>
<tr>
<td>Family map</td>
<td>Show the statuses and activities of the family members.</td>
</tr>
<tr>
<td>BOX</td>
<td>Deliver the useful information for the elders. Has a projector.</td>
</tr>
<tr>
<td>Kitchen manage system</td>
<td>Recognize the food materials and find a recipe for the user.</td>
</tr>
<tr>
<td>Aeolian Bells</td>
<td>Transfer the motion, the sounds and the smell in different rooms.</td>
</tr>
<tr>
<td>3D Table</td>
<td>Transfer the 3D information and can be controlled both in physical and digital way.</td>
</tr>
<tr>
<td>Interactive map</td>
<td>Interact with children’s motion and some toys.</td>
</tr>
<tr>
<td>Life recorder</td>
<td>Pop out the status on SNS and record the story about it.</td>
</tr>
</tbody>
</table>

Table 4.3: *Even more ideas we looked at*

using soundscapes to revive memories (sounds are often associated with memories, and a ‘soundscape’ can actually make you feel like you are in a particular environment and can provoke memories), reminding people to tell stories when they visit someplace they
have been before, etc. Another idea would be to allow the user to just make up their own stories, like the "Time Slips Story Telling Project", which inspires seniors and others with dementia to focus on telling stories through imagination rather than relying on memories and facts [12]. We also looked at a bunch of other ideas, from a device that collects photos from people and shows it to their parents, to a device that converts a Television set into a teleconference device. Perhaps we could build a device that is designed to teach older people how to use modern technology? A device that helps old people with gardening, or tai-chi, or chess? A device that allows asynchronous audio communication, like an audio version of notes put up on the refrigerator? We also asked ourselves whether it was possible to transmit the breath of the person you are talking to, can you feel the air blowing on your face? Is communication really the single most important problem the seniors face? Or are they quite satisfied with just a phone, and have bigger problems with seeing photos and updates from their kids? We also discussed possible uses of technology - transparent screens to give an overlay on what you see, membranes which convert glass into a transparent screen, possible uses of a kinect + projector + camera combination in allowing interaction of physical and digital objects. We tried to think what would be the ideal solution if we had MAGIC powers - Here’s the scenario: At 6pm in the evening, I want to talk to my grandparents and show them photos etc... I think of that and I am magically transported back to my grandma’s house. I am really there, so I can move things, I can help my grandma cook, eat the delicious food she makes, sit with her and watch TV etc. All the photos that were on my smartphone and I wanted to show here
Critical Function and Critical Experience Prototypes (CFP/CEP)

A Critical Function Prototype aims to test/demonstrate one particularly important function in the device we are considering. The Critical Experience Prototype, on the other hand, seeks to produce and test a user experience that is essential to the product. These exercises are part of exploring the bounds of the problem space and the solution space, and should answer some basic questions we have. They are not prototypes of the final design or a proof of concept, the aim is to help us learn something that merely researching from other sources or benchmarking existing technologies would not help us with.

4.6.1 Tactile Messaging CFP

**Background:** A recurring phrase we encountered while discussing about communication technology was that using the device for communication was ‘not intimate’. What possible interactions between the users could add more intimacy to the communication? One important aspect of being next to a person is the ability to touch, and crucial to the feeling of touching a person is the warmth and softness of skin. Can we recreate and communicate this tactile experience? **Question:** Can touch, temperature and motion communication through a tabletop or portable device make remote communication more intimate? **Description:** The prototype involves a sensor module - an arduino with a temperature sensor, pressure-sensitive resistor and an accelerometer, connected to an actuator module - an arduino with a vibrating motor and a Peltier junction. The sensors
measure the pressure of touch, the temperature of the hand gripping the device, and the movement of the device. This is then communicated to the actuator module, which warms up the surface and vibrates accordingly. **Further Questions:**

- Does such interaction work best in synchronous or asynchronous communication?
- What should the device look like if it is to represent the presence of another person?
- What does it take to make the user associate the device with the person they are communicating with?
- How do we attract attention to the device when the other side wants to initiate communication? Will it just be a novelty that will wear off, or will it add value in the long term?

**Findings:** The shape and surface material of the device is very important. However, while some users imagined a smooth and hard surface like a pebble, others preferred softer and
more pliable skin-like material. Some users noted that communicating touching is more useful in certain situations, like in a romantic couple. Most testers agreed that the addition of temperature was useful. Other feedback included advice to use this along with audio or video chat and to use other input and output methods - for instance, the pulse of the person can be transmitted to the other side, and the device pulses; the device can be squeezed and the other side also compresses. There were also suggestions that we could modify the shape of the device to indicate the mood of the person on the other side. Portability of the device was critical to many users. In general, different users had very different ideas about how the device could be used - for instance, one suggestion was that it could be used to communicate by shaking the device in some pattern. **What’s next:** We plan to test asynchronous communication using the device - leaving an audio message along with tactile information. Motions other than vibration - what if the device can expand or pulse according to how the other side is squeezed? Can the motion of the device give visual cues (like a deflated object to indicate the other person is tired)?

### 4.6.2 Social Networking Aggregator CEP

#### 4.6.2.1 Social Networking Aggregator CFP

**Background:** We share interesting bits of information daily in social networking websites, but this information is not accessible to older members of our family, and it is an added effort to repeat all the same information when talking to family. Modern communication, especially on social networks, can be described as 'fast food' communication, which is quick and easy communication with many people, but without a depth of communication with any single person. However, it does provide a starting point for conversations and other more intimate communication methods. It could be useful to have social networking data aggregated and displayed to older users, of course with appropriate privacy settings.
and filtered according to what the target users might find most interesting. **Question:** Does displaying information from your social networks to older family members improve communication and connection in the family? **Description:** We collect information from our social network feeds that might be of interest to our family, set it on one or two pages and show it to our parents and grandparents - as an email to parents, and as printed sheets of paper to our grandparents. **Further Questions:** What content is of most interest to parents/grandparents? What content are the social media users most comfortable with sharing? **Findings:**

![Sample of an aggregated social networking page](image)

**Figure 4.41: Sample of an aggregated social networking page**

- The feedback for this prototype has been varied - While some testers felt that they would rather learn about their child/grandchild’s life directly from them rather than through an impersonal device, others appreciated the information presented, and thought it would give them more topics to speak about.

- For some of the users, there was a wide difference between the kind of posts they made on social networking services and what their parents/grandparents wanted to know about them. More than one person said that they would prefer to receive this data on a mobile phone or on a screen rather than as a printout.
4.6.3 Peripheral Vision display CEP

**Background:** From our studies about our communication with our families back home, we have found that one major issue while using video calls from a computer is that often, the availability of time for communication is an issue. If we have some way to continue our video chat and still be able to engage in some other activity at the time - have some of the benefits of video chat, but still allow you to do something else alongside like a phone call would - it might increase the frequency of interaction. A display utilizing your peripheral vision allows you to see simple movements and shapes while not impairing your ability to perform most tasks. **Question:** Does peripheral vision give a feeling that the person you are talking to is next to you and still allow you to be engaged in another activity?

**Description:** The CEP setup involves a headset that fixes an iPhone next by the side of the user’s eye so that the image onscreen replaces their peripheral vision. The iPhone is then connected to a stationary iPhone/iPad via facetime. It is fixed such that the person who is communicating with the user can be seen to be facing the same direction that the user is. The user is then instructed to continue to pursue some activity while wearing the headset. **Further Questions:**

- What distance from the camera (in effect, what size of the person on the screen) felt
The most comfortable?
- How intrusive is the headset - do you lose focus on the task you’re engaged in?
- How much of the edge of your vision can the display occupy?
- Can the person on the screen grab your attention if he needs to?
- Are there simple movements that can be used to communicate?

Findings: The tests of this device were unexpectedly successful, with most users agreeing that it induced a feeling of the person being next to them and that it was better than just audio communication. Major findings are listed as below:

- Users were able to work on a task without impairment.
- Some users instinctually tried to turn to the side to look at the person they could see out of the corner of their eye, and reported that not being able to transition to face to face communication was a problem. Also, one user reported dizziness after trying to focus on the image on the display.
- "Being able to listen to the background sounds of the other person working, and feeling their presence next to you when you’re alone, can make you feel less lonely."
- The correct positioning of the screen is critical for the experience to be successful. Lighting and contrast in the image turned out to be very important in being able to make out the person.
- Staying too to the camera is bad, as it makes the wearer uncomfortable, going too far away is bad, as it becomes difficult to see the person. The ideal distance was usually when the head was about 1cm on the display right next to the face.
- Some people we interviewed very enthusiastic about using the device to watch a movie along with someone.

Figure 4.43: Peripheral Vision CEP Tests
• After some use, many users reported they started getting used to not being able to look into the peripheral display and started forgetting they had it on when they were deeply engaged in an activity.

What's next: Can we be more efficient and transmit just the kind of cues that are most easy to catch on the peripheral display? It can reduce the bandwidth requirement and make certain gestures more noticeable. Will increasing contrast, sharpening edges or increasing saturation improve the visibility? Other areas we need to explore:

• Designing the transition from peripheral vision chatting to face to face video chatting on a screen.
• Syncing activities using the headset - listening to music, watching TV or a movie together.
• Using stereo audio to add to the effect of the person being next to the wearer.
• Can we influence the mood of the wearer by immersing them in a soundscape and by displaying appropriate (calming/active) scenes on the display?
• Is it possible to link the displayed image and sound to the activity being pursued? For example, when the user is reading a novel, does adding sounds and video corresponding to the part of the novel he is reading add to the experience?

4.6.4 3D table CFP

After brainstorming and benchmarking, the USTC team decided to make a CFP for the 3D table idea. The 3D table (Fig 4.45) is a game platform providing the experience of playing together for remote players. There are at least three players to fully experience the device: two of them are children who are too young to be able to control digital device, while the other player is a teenager or an adult who is able to control the table
with computer, mobile phone or other digital devices. The table is made up of array of blocks with 3D scanners (Fig 4.46). Rising and falling of these blocks can deliver a 3D image, even a 3D cartoon. If a child put a toy, such as building blocks on his table, the scanners around the table will scan the 3D figure of this toy, transmit it to table of the other child and the blocks on the table will be controlled to represent the outline of the toy like pin screen. At the same time, figure of the toy is transmitted to the digital device of teenager/adult and image of toy will be shown in the software. And blocks on both tables can be controlled by the digital device, thus image or cartoon can be downloaded on tables. In this way, two physical worlds and one digital world are synchronous and everyone in the game is able to change the common world: children by toys and adults by computer. The reason why we chose 3D table are as follows:

- We think that the 3D physical transmission can deliver a better interface and communication experience for the users. While providing a device which can achieve physical entity information exchange, our users can be connected with each other by working on a physical object together.

- From the benchmarking results, we found that many products can exchange information in words, pictures or video forms, but we did not find any existent device which

Figure 4.45: Brief description of concept of 3D table
can achieve 3D physical transmission. We wonder if we can realize this function in CFP process.

Since some classmates of our university have already done the 3D scanning stuff, the critical function of 3D table that will be prototyped and tested should be how to control the array of array of blocks. Apparently, for the large number of blocks, it is unrealistic to use a motor to control only one block. So, the challenge would be to use a motor to control several blocks quickly and precisely. We considered two ways to control the blocks, the first one is air-powered and the second one is driven by motors and gears. (Although both solutions are feasible under modern technology, we do not have resources to accomplish the first solution so we focused on the second one. But it could be efficient if it were made in a factory.) The essential part of the first solution is that we "re-array" the matrix of blocks by controlling them with soft pipes, which are arrayed in circles. And by transforming circular motion to plug-in and plug-out motion, pipes can be quickly aerated and de-aerated theoretically. In the second solution, four motors are used to control a row of blocks. Springs and splines are used in a gadget to fix blocks. (See more details in Design Description.)

The following questions are expected to be answered by our CFP:

- What is the possible refresh rate? Is it fast enough to show a cartoon?
- Are the blocks strong enough to support a toy?
- How precisely can we control the blocks and how precisely should we control the blocks to represent a 3D figure?
- What’s the possible size of the block to not only deliver a physical entity experience but also be feasibly controlled?
- How customers feel about the physical entity information transition?
The result turned out to be unsatisfactory, for the reason that mechanical realization is not as easy as we thought. Although blocks are strong enough to support regular toys and the blocks can be controlled with half centimeter a step, its refresh rate is really low – actually, it takes us 5 seconds to finish a line. So, we decide to change functions of the 3D table. And a CEP is needed.

4.6.5 3D table CEP

Since the restriction of time and our ability, we could only build one prototype to test the realization of the functions of our 3D table CFP, it is impossible for the users to test. Thus, we decided to rebuild a CEP for the following testing part. We are trying to answer the questions:

- Will users feel ‘connected’ by the 3D table?
- Will users enjoy the physical communication?
- Will the 3D table make the communication process more comfortable for the users?

In this CEP, we tested 3D table by playing ‘whac-a-mole’ on it. Since the mechanical ways to control the movements of the blocks can be complex, we decided to create the experience and make it ‘real enough’ for the users by choosing a wizard of oz prototyping execution. We learned from this CEP that people enjoy the physical communication and feel connected. The feeling that an object one’s playing with is controlled by a invisible person is great. It can be proved by the different feelings with and without the board blocking people’s eyesight.
4.6. Critical Function and Critical Experience Prototypes (CFP/CEP)

4.6.6 Life Recorder CEP

SNS are indispensable for digital residents and widely involved in our investigations. Digital residents record their life and communicate with friends in SNS. For physical residents, they would prefer to keep diaries to record their life. But while investigations, we found that statuses in SNS such as Facebook and RenRen are not detailed enough to record one’s mood and experience. Meanwhile, we found the importance of digital legacies, which are often ignored by people. Digital legacies, such as photos and statuses in SNS and comments in websites, are valuable in our lifespan and precious for our family. So we thought of a way of combining SNS with a box to record people’s life and enrich their life stories. With this life recorder, you will have a chance to detail your SNS statuses and record more of your life by voice. First, you can choose a status from those the life recorder selected from your recent statuses and provided you with. Then, you can tell more about this status by a cartoon character’s guiding. The recorder will record your voice and the cartoon character will interact with you to encourage you tell more. In this CEP, we want to find out:

- Would people like to record their mood and stories with this life recorder?
- What can encourage them to tell more and use the life recorder more often?

![Function description of Life Recorder CEP](image)

We used a computer screen to prototype the life recorder. We put social networking statuses on the left part of the screen where users can scan and select them. Software known as iFly is used to recognize users’ instructions. As for cartoon character, we use Ucam’s cartoon function to form a character and one of our team member use another computer to control the moving and words of the character. We tested two users. Each of them selected one of their recent social networking statuses and explained it. They said that it would be a little weird speaking to the screen and the cartoon character helped a lot in solving this problem. Since there are no accumulated status messages in the life recorder, they didn’t feel a sense of accomplishment when finishing this record.
4.7 Family Window

4.7.1 Objective

The first prototype that we built in Winter quarter was the Family Window. Its main function is to simplify video chatting for seniors who are not accustomed to this technology. The objective of this window is to connect older people to younger ones. The electronic window is similar to a real window whereby it shows everything that happens on the other side. Once sharing is not desired, the curtains are shut and the window disconnects on both sides.

We would like a device that would increase communication across generations, and to do that we need to consider the different factors that create problems for communication between people. One important factor is time. Due to the fact that people nowadays have busier schedules and may be in different time zones, synchronous and asynchronous communication must be present. That is why in our device we want to consider video communication that provides quality time for both sides of the family and asynchronous communication like leaving audio, video or written messages.

4.7.2 Window Concept

The Family Window is basically two devices that are located in different houses and connected by always-on video chat system. The reasons we chose the Window as the design concept are:

(a) Windows is familiar to seniors as objects through which they can see what’s on the other side

(b) Will represent the situation that two people can see and talk with each other but cannot physically interact, which is quite similar to video chat

(c) Windows are embedded in the wall and do not occupy any room in the house

The features that we have considered and discussed to add to the always-on video chat system which better resemble a window are:

(a) **Embedded in the wall**: it is probably not feasible to dig into the wall to completely embed the device. One possible solution is to make the device thin and use a frame which looks like a window frame to hide the edges.

(b) **Window curtain**: can also be designed as a switch to open and close the system which is more intuitive for seniors. The window curtain can also help protect user’s privacy.

(c) **Eye contact**: Presence of eye contact is the main difference between talking face-to-face and video chatting. One option to create eye contact between the users on both sides of the device is to hide a camera behind a transparent screen, but this kind of screen is too expensive, therefore we cannot implement it. Another solution is to use the mechanism of so-called teleprompter that includes a mirror which can see through
from behind. However, it is too bulky and cannot be made to look like a window. So the compromising way is to properly design the camera position so as to minimize the eye contact deviation. We do not know the importance of having eye contact via video chatting for seniors, so this may not be an important factor.

(d) **Perspective** : When you walk closer to a real window, your view will change. Including this feature in our design may prove very successful. In addition to making the Family Window look more realistic, it can also allow you to actively control where you want to look at. One solution is to attach a Wii infra-sensor on your head to detect your head direction to display the image of the corresponding perspective. Rough 3D environment construction is also needed. This solution is not feasible in terms of cost and complexity. Another solution is to just detect the face position and zoom in/out or shift the image accordingly. It highly simplifies the mechanism and can still provide good experience since the size of the window is comparatively small. But none of these solutions can address the case that more than one user are standing in front of the window.

(e) **Surface** : We may have a problem making the texture feel like a window’s texture. One way of doing this is to project the image on a real window, which is not feasible. Many factors affect the projection especially sunlight. Another way is to make sure the surface of the screen is made of glass or to just add a layer of glass on it.

### 4.7.3 Features to Consider

The intended features that we have discussed and partly tested are:
1. **Video communication**: Video chatting simplified for seniors

2. **Message system- Leaving messages**: Sending messages to the other family member would enhance our system to continue communication when one side is not present or busy to reply. Leaving messages can be divided into different sections:
   a) **Audio messages**: how to make it intuitive for seniors to check multiple messages?
   b) **Video messages**: has the same problem as audio messages.
   c) **Written messages**: options include:
      i. use the finger to draw on the window (the same experience as drawing things on a foggy window)
      ii. use a pen to draw on the window (the same experience as drawing on white board)
      iii. drawing on a physical sticky note placed on the windowsill. The challenge here is how to simplify the device enough to make the message system attractive to seniors. If they found it too hard to use, or if they do not relate to it due to its technological aesthetics, it would be immediately shut off by them.

3. **Notification system**: We would like to find the best way to notify the user of any pending messages. We thought of three options to implement which are:
   a) **A light that blinks**: this option is a safe choice since it does not produce any noise that might disturb the receiver. This was supported by elders who would like to send non-urgent messages to their children without disturbing their busy lives
   b) **A ringing sound**: this option is desired in certain instances if the device is far away from the user, but seniors where afraid it is a disturbing option
   c) **A voice record of a family member**: We thought that a voice notification recorded by a family member like Hey Dad or Mom! would have a personal touch to the notification system which impressed a few seniors since many have nicknames by their children like Papa which seem more friendly and attractive to seniors

4. **Perspective Adjusting System**

5. **Head Position Adjustment System**: it is better not to show a sub-window to look at yourself as what most video chatting software does. It is also not intuitive for seniors to pay attention to the sub-window so as to keep his/her head position inside the image. We thought of two options that are:
   a) Sound notification when head is out of the camera range.
   b) Blinking on the screen when head is out of the camera range.

Both options are not intuitive and may be disturbing.
4.7.4 Design Iterations and Internal Tests

For the initial design of the Window, the USTC team tried projecting an image on a real window. Such a device does not occupy space and is more similar to real windows. It was found that a window with wire gauze could produce a better image, but the limitation of this design is also very obvious: cannot used in daytime and it is kind of strange to look at the window from the outside. We tried another primitive setup, using a big window with strong support and a handmade curtain as shown in Fig. 4.51. Problems also exist relating to the size of the screen, looking too close to the screen is harmful for the eyes. It is good to have a large screen that could create real-size images, but both of these setups had the common problem in our current design stage. It is almost impossible to have these prototypes tested by seniors. Therefore, we redesigned a mini version of the Window
for user testing. It could be easily installed with an iPad as the screen. Surprisingly, seniors liked this small and portable window when we showed it to them in our interviews. Before user testing, we had some internal function tests in the ME310 loft. One of them was perspective-adjusting system conducted by the USTC team. They used OpenCV to realize eye position tracking and based on this information, the perspective adjusted accordingly by a pedestal driven by a motor. Using this setup, the user experience of such a system was tested. The tests showed that this highly simplified system could actually improve the experience though it used only the information of eye position. However, there was mechanical delay caused by the rotary pedestal setup that might influence the user experience especially for long distance communication. In another test, one of our members used the device with his family while watching the same TV program. Some problems found:
1. When more than one user was on one side, often, users only showed half of their head inside of the screen range. And you can do nothing to change this status, which makes you feel a little despaired. A bit active control could greatly ameliorate this situation, which shows the value of perspective-adjusting feature.

2. When the users on the other side are watching the TV, it is difficult to catch their attention. It is not feasible to ask them to lower the TV volume.

3. Difficult to listen to two people on the other end talking with each other as well as people talking not in front of the screen. The microphone needs to be well selected and configured so as to solve this problem.

We also had a trial of the head position adjustment system. It is not intuitive to use blinking or a sound as a notification system because it doesn’t provide the information of which way to move. So we were thinking of another solution, using the perspective-adjusting feature to facilitate the users to move back: when the user moves out of the screen, the user on the other side can move his head to get the user back to the screen on this side and the user in this side will also move his head according to the new position of the other side’s head. The trial showed that if we reversed the image on one side horizontally, it could make the system a convergent system and users can move back to right position without intention. Otherwise the system becomes divergent. However, reversing the image will also cause the same problems. It makes you feel that the other side looks unnatural and might cause confusion about left and right sides.

4.7.5 User Tests

Here are some thoughts that we got during the user test and interview (Details in Appendix J):

- It is difficult to talk to a person who is squarely in our target segment. They haven’t used any digital devices, and they find it difficult to understand what we are trying to explain.
• Most people would like to talk to their children only once a week. But does this kind of talk the same with non-demanding chatting? Face to face video talk, making appointments, all this makes this communication sort of formal. For some strong connections, initially it is not because of who are eager to do that, but because of the time they spend together, longer accompany facilitate better connection. Perhaps, the central value of the window idea, is to provide a non-demanding chance of communication, so that the connection between family can be strengthened gradually and intentionally, especially in such a society, where different generations have different focus and some of them even get used to weak-connection.

• Most elders we interviewed never tried video chatting with their family or even called their children a lot. The main reason is because they are afraid of bothering their children. That is why they like to email and not directly communicate using phone calls.

4.7.6 Transition to Family Channel

From the user testing and interviews we found that watching grandchildren growing up is one of the important reason seniors might use our device. We also realized that physical interaction is an important part for connecting seniors and their grandchildren. Besides, it might be better to add more functions using the current basic setup without adding to the total cost, which improves the cost performance. Therefore, we moved to our next step: the Family Channel.
4.8 Family Channel

4.8.1 Objective

Based on the Family Window idea, we further explored this area by doing more interview with our users. According the users feedback, grandparents and grandchildren need some interactive activities to keep the conversation interesting. Grandparents are also willing to pass on the family traditions to their grandchildren by telling stories to them. We upgraded our Family Window to a Family Channel by including an additional interactive region.

4.8.2 Functions

4.8.2.1 Interactive Features

Users can do interactive activities with this family channel, for example chess, card game and drawing etc. People can also do video chatting at the same time of playing games. The images from the other side are projected by a pico-projector hanging above. This creates a feeling of two people sharing the same table.

4.8.2.2 Photo Sharing

The Elderly can tells stories to their grandchildren while they share the same physical album on the screen during video chatting. The stories are recorded for legacy purpose.

4.8.2.3 Leaving Notes

Users can use physical pens to leave notes to the user on the other side if necessary. The notes can be retrieved later with their original physical appearance. They can simply write notes physically on the sticky notes at the corner. These notes will be recorded and
sent to the other side. People on the other side can view the notes when they open the curtain.

4.8.3 Implementation

The interactive features are implemented by a camera-projector couple. As shown in Fig. 4.58 The camera on side A captures the real-time image of the interactive region and sends it to the B side. This image will be projected on B side and coincide with the real situation B side and vice versa. This create a virtual table that both A and B works on. For example, when playing chess, each side uses a physical chess board and their own chess pieces. The positions and movements of the pieces are recorded by the cameras and transmitted to the projector on the other side.
4.8. Family Channel

4.8.4 Design Process

4.8.4.1 Interactive Area: Projector vs Screen

For our interactive area, we had the choice of using either a digital screen on the surface, or a projector. Both have advantages and disadvantages but the main conflicting issue is that the screen is clearer than the image from the projector but it does not provide the physical interaction that would enhance the user experience. That is based on actually seeing hands or other items put under the camera from the other side which is projected on your screen. We chose the projector for the interactive features it contains.

4.8.4.2 Asymmetric Design for the elderly and the children

Our device is a combination of several devices that already exist, which results in an advanced product. This product is built mainly for seniors and their needs so others side, with digitally connected people, do not necessarily need a similar device. Therefore, we thought of creating a channel for the elderly where they can communicate with devices that younger people already have like computers or tablets. This reduces the cost and inconvenience of buying two devices for each setup and would be more acceptable for the connected users.

4.8.4.3 Watch TV along with video chatting

Many families value the time spent with each other and are used to sharing several moments in life together. A lot of families like to watch TV together, so we thought of using the device for this purpose whereby the Channel is set on one corner of the living room showing all family members and connected to another remote room. This increases the quality time spent with family members.
4.8. Family Channel

4.8.4.4 Size of screen for video chatting

The size of our channel is very important and it decides the complementary functions. We have two basic paths to choose from Table 4.4. We finally decided to use a smaller setup since it is portable, cheaper and allows room for interaction even though the video it shows is not life size.

<table>
<thead>
<tr>
<th>Small Size- 15 inches</th>
<th>Large Size- 42 inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smaller images, hard for seniors to see</td>
<td>Life size figures, proven to be favored</td>
</tr>
<tr>
<td>Portable, convenient for some people</td>
<td>Not Portable, a space has to be made for it</td>
</tr>
<tr>
<td>Easier to sit close to and play games</td>
<td>Hard to play games close to it since screen is so large</td>
</tr>
<tr>
<td>New Device</td>
<td>Confused for a TV</td>
</tr>
<tr>
<td>Cheaper</td>
<td>More expensive</td>
</tr>
<tr>
<td>Positions: On table</td>
<td>Positions: Mounted on wall (in corner) and Mounted on portable wheels</td>
</tr>
</tbody>
</table>

Table 4.4: Functional Constraints

4.8.4.5 Family Legacy

Many seniors like to save their memories, lessons or stories for their children. Since this is very important and influential, we decided to create a family legacy for seniors through an audio album. Using our interactive space and video chatting, seniors would share their experiences and photos with their children and grandchildren. These stories will be saved into a photo album which then repeats the recorded story once a picture is chosen.
4.8.4.6 Pass-by Notification

The two channels of the window are always on, but people are not present on both sides. That is why we wanted to create a system that notifies one side of the presence of a nearby person. The channel has a light on one side and a sensor on the other that detects the distance of a moving person from the channel. If there is a person near the Channel, the light will turn on and get brighter as the person gets closer to the channel. This allows the seniors to know if there are any people on the other side to connect and talk to.

4.8.5 Technical Difficulties

4.8.5.1 Projector Position

Problem: The focus distance for a normal projector is at least one meter. However, it is not reasonable to build a Family Channel with a height larger than 1 meter due to the convenience of usage. Solution: Firstly, we tried to use a mirror on the top of the screen and put the projector at the bottom of the screen. As shown in the figure, the mirror can reflect the beam to the interactive region. In this way, the distance between the projector and the interactive region is increased while the total height is kept the same. We found it is difficult to calibrate the projector and the mirrors position so as to provide a good visual effect. The fixture has to be rigid enough to prevent any distortion. Even small amount of change would severely affect the image position and quality. We finally decided to use a pico-projector which has shorter focus distance. However, the brightness of pico-projectors are small which may not be enough for a daylight application. Acer C120 pico-projector is what we finally used. It has a focus distance of as short as 30cm and a maximum brightness of 100 lumen, which is suitable for our application.
4.8.5.2 Camera-Projector Loop Enhancement

**Problem**: The projected image is captured by the camera and then transferred to the projector on the other side. This image will be captured by the camera on the other side and transferred back. This forms a loop in which the brightness of the image will enhance and severely impair the quality of the video. **Solution**: One solution we came up with is to insert a polaroid filter in front of the projector lens vertically while insert a polaroid filter in front of the camera horizontally. As shown in the following picture, the image projected by the projector is polarized vertically and cannot be captured by the camera. In this way, the loop enhancement will be greatly reduced.
4.8.5.3 Scanning Interference

**Problem:** The image flickers when the camera is shoot on the video which is projected by the projector. **Solution:** The flicker is caused by the difference in the scanning frequency between the projector and the camera.

To record a computer monitor image, you need to experiment with different refresh rates in the monitor settings or in the host computer software. There are display cards for personal computers whose video drivers allow you to pick the refresh rate. This rate setting may take some experimentation to get it to match your camera setting. If your camera uses 24 fps, use a multiple of 24 – use a refresh rate of 48 Hz or 72 Hz to get rid of the annoying scrolling bars. Use a 640 x 480 mode on the monitor to help lessen the problem. Television sets with the usual cathode ray picture tube do not have an adjustable screen refresh rate. They will either work with your camera or they won’t. [http://electronics.howstuffworks.com/question336.htm]

One possible solution is to set the scanning frequency of the camera and the projector so they are the same.

4.8.5.4 Interviews with users

For our Channel, we talked to several Chinese seniors. We were not able to let them try our device because it was not functional so we described it. Most seniors felt overwhelmed with the excess of functions in the device and had trouble even trying tasks that required simple digital exposure like smart phones, tablets or video chatting applications. We learned that seniors would like to communicate with their children, but did not know how to use modern technology to do so. Additionally, their children had very busy schedules and little time to communicate with their parents so this created other problems between the two, like the children not having time or interest in teaching their parents how to use simple devices for communication.

4.8.5.5 Transition to Album

While discussing our family channel, we discovered that several features needed optimization. We listed all the features currently incorporated in our family channel, then discussed the features one by one to brainstorm possible improvement. After we went through all the ideas, we decided on an order of priority of features. Listing them we got:

- Photo Sharing: for the current window setup, photo sharing function is mainly for grandparent side, put photo on the interactive table to show and tell some stories to their grandkids. But actually, it is young generation sides that usually want to share new photos: grandparents want to see photos sent by daughter/son about their grandkids; teenagers want to share photos of campus life with their parents and grandparents, etc. The most traditional product corresponding to photo sharing is album. What if to implement the photo sharing system as a real album? It automatically detects the page and project photos on it. For young generations, they can choose their own way (email, app, etc.) to upload the photos. We quickly
4.8. Family Channel

built on this basic idea and realize that this system itself is already good enough to be an independent product.

- User interaction (ex. Game): For current setup, we partly implemented an interactive that can be used for sharing drawing, playing card games and chess. However, the system was quite fragile because of problems such as video loop, time delay and strict calibration. One of our ideas for the solutions was to divide the table into two half and to avoid image overlapping. Another idea is to make this interactive function a purely tablet just like iPad but is specifically designed for seniors. The main difference between it and normal iPad is, seniors dont need to have any operation on it. Just connect it with a special port then all the game downloading, initialization can be finished by young generation on the other side by remote control.

- Video experience: The improvements we discussed include: 1) Volume distribution, how to make the voice clear for surrounding seniors. 2) For the case that it might be uncomfortable for anyone nearby can listen to the conversation, probably a phone-like speaker can be provided that when the seniors lift the phone, the conversation can switch to private one.

- Message system: In our Family Channel, seniors will be able to send messages to their children and grandchildren. Three message options are considered: Video, Audio and written messages. For video and audio, probably it is more intuitive to use a knob to fast forward or rewind the video and scrolling a tape to operate the audio message.

- Family Legacy: Seniors tend to look back at their lives, remember all the memories and lessons, and store it for their children to remember them by learn from their experience. We wanted to incorporate a family legacy feature to our design that would create a family legacy for children and grandchildren. However, the users we interviewed did not seem as interested in this idea as we had expected. Actually we didnt brainstorm much for this topic.

- Multiple channels: I was from the user interviews and tests that we got to know many users would like to have connection using this device to more than one person. How to switch between different persons should be well addressed by intuitive interface. One of the solutions we discussed was to make this interface like using TV controller to switch between different channels.

- Non demanding chat We discussed little about this topic. One of the ideas was to have many sensors distributed in two houses as a pair for corresponding places. For example, when my grandpa was in the living room, the indicator (says a lamp) in my living room will be lightened. This system is for establishing space connection so as to facilitate casual conversation. But it will also cause privacy issues.

By thoroughly analyzing each feature, we realized that each of them could be designed into a product. The most attractive feature that we discussed was photo sharing because:

- Simple to realize and is addressing an important need. For many seniors we interviewed that are using iPad, computer or smart phone, receiving photos from their children is one of the main uses.

- Has great potential of being upgraded with novel features based on user need without adding cost.
• The basic idea we discussed is already complete and good enough to be an independent product.

Therefore, we decided to settle down on this idea. Our design then moved to the next stage.
As mentioned in the previous sections, most seniors find it difficult to interact with high tech devices, and are thus limited to older methods of interaction. The few seniors who do use computers and the internet do so to view photos their family sends as attachments. We realized that photo sharing was a need that was not met for the rest of the elderly. While they had albums of physical photos developed from expensive film, their grandchildren had thousands of photos that could be taken at a moment’s notice and no cost from their phones or digital cameras. The challenge would be to find a way to give seniors access to these pictures, while solving problems of interaction with the system and recognizing and designing for the different ways in which the different generations treat photographs. Present attempts to enter this problem space, like digital photo frames, have not been very successful. Digital photo frames show a slideshow of pictures selected by the senior’s children who set up the device, and allow the user very little control over what is displayed. If the senior wanted to see a particular picture again, she would have to wait until it came back or figure out how to navigate the system. Navigation usually involves menus and multiple button presses. Also, the system is not very inviting - it is meant to stay on a desk and be looked at, not interacted with. The USTC team did a preliminary needfinding exercise, and we were pleased to learn that the situation was similar in China as well. Most
elders preferred physical albums over having someone show it to them on a computer, and they use photos to tell stories to their families. (Details: Appendix K) After we decided to select the feature of photo sharing as our primary focus, we leveraged our experience with the projection system in the family channel to come up with a physical system for browsing through photos. The idea was to have a projector and a camera above a notebook, and detecting the page number on the book to display the appropriate image on the page. We realized that having such a physical interface that the seniors were familiar with would ensure that users would not need special instructions on how to use the device, and would not need to 'remember' how to use it. It was important to hide the technology, as we found that many seniors had an almost irrational fear of technology - some of them were afraid they would damage the expensive device or do something wrong, even with simple devices like a mobile phone. The best solution we came up with was to use a lamp on a table as a hiding place for the devices. The album would be fixed under the lamp.

Figure 4.64: Initial Prototype of the Family Album
4.9. Family Album

We went through multiple iterations of the device as we recognized problems and solved them. The first prototype was made up of a projector, lamp, camera, and blank album, which were all connected to a laptop (our working system for now). The album was fixed to the lamp base so seniors cannot change its location which would ruin the projector calibration. The camera was at the stem of the lamp to detect the QR code, which was next to the top left corner of the page. All other electronic devices were hidden in the lamp to provide a simple and familiar feeling for older people and to reduce their resistance to try a new device. We replaced the notebook with an album that looked more like a regular photo album. We also designed it to make it easier to flip pages, and changed the paper to match the aesthetic and be a good surface to project on. We then thought about how we could make it easy for the younger generation to add photos to the album. We built an interface that would allow us to set up an email id and automatically download any image that was sent as an attachment to that inbox. We further recognized that families today have multiple formats of photographs, in varying shapes and sizes, in digital and physical forms. Physical copies of photos tend to get damaged with time and need to be digitized before they are lost. It also makes passing on family albums a lot easier. It would be useful to the user if they could add photos to our album and get them automatically digitized. So we decided to implement a scanning feature where physical rectangular photographs kept on specially marked scan pages would be automatically digitized and mailed to the family. We plan to test this with our target population to see if they appreciate such a feature. We added a second camera for the purpose of scanning.

![Redesigning the album](image)

Figure 4.65: Redesigning the album
We replaced the QR code with a more human-friendly page numbering that we read with an OCR library. We also managed to integrate the function of both of the cameras into one, and crop images to be used for scanning and reading the page number. A sturdier frame was built for fixing the projector and the camera so that their positions could be easily adjusted.

Figure 4.66: *Input methods - smartphone app and email*

Figure 4.67: *Change from QR code to human readable numbers*
We then built an app that allowed us to easily snap and send photos from a smartphone running Windows Phone OS or Android. We also built an automatically generated contents page that would alert the user to new photographs being sent. We have also started working on porting our code to a mini-computer known as the Raspberry Pi, so that we can integrate the entire system into the lamp.

Figure 4.68: Contents page generated, with notification of new photos

Figure 4.69: The tech hidden beneath
4.9.1 User feedback

Once we presented our design to people, we were pleased to receive positive feedback. Not only did seniors love it but people of all ages and technological background encouraged us. From users we got the following feedback:

Figure 4.70: Testing the album

- The album is easy to use and intuitive: Seniors opened the album and immediately knew how to use it although they did not grasp the technology behind it. This is a great feature since older people might resist learning something new, or if they want to learn, younger people do not have the time or patience to teach them.
- Album interface is physical: Providing a physical form of looking through album is essential to seniors because this is what they are used to. This produces a familiar feeling among seniors.
- Magical: Many users did not understand how the album works so they felt the photo magically appears on each page. One woman thought we were using magic paper.

The concerns users had included:

- Photos not clear enough
- Expensive
- Not portable
- Seniors who could use computers and ipads felt this device was too simple
Learnings and Insights: Narrowing down our objective to design and album for photo sharing changed our perspective drastically. We focused on a single feature which allowed us to deliver a device and present it with confidence. This also allowed us to build a fully functional device with the features that we wish to test. Being able to test, we had the chance to show seniors what we are designing and let them test it instead of describing it or future features. From our testing we gathered user feedback that allowed us to iterate our design to incorporate the user input. Designing a simple device with few main functions allows us to optimize the features to incorporate user needs which are required for a product to be successful.

4.9.2 Challenges and future plans

Album Features to enhance:

- Clarity of picture on the album page: Photographs have high resolution and we need to provide equal projection quality and size. The main factor that affects this is the properties of our projector. Paper quality and reflection can also have a major impact on picture clarity. We also need to adjust the projection brightness based on ambient lighting.
- Elegance of device: Aside from making a great electronic device, we want to focus on album aesthetics. We want the device to not only interest older people but to attract them physically. The physical features like album paper, lamp quality, album design, should be of the highest quality. Most importantly, the album should fit perfectly in their living room.
- Input options:
  - Email: Emailing the pictures is our basic form of upload.
  - Facebook/RenRen/Google Plus: Uploading pictures from Facebook accounts (or other social media software) is very desirable especially with younger users.
  - Improve the smartphone app.
- Scanning options: We need to create an easier system to scan photos for seniors to send digitally.
- QR codes/number/bar codes: Our initial design used QR codes that are printed on the album pages but then we turned that to numbers. Our aim is to improve the code to prevent errors in reading the number
- Portability: Options for portability must be studied. Usually albums can be carried around to show to family members, neighbors or friends. If we can create something similar to this effect it would add to the album value.
- Control of content:
  - Deleting content: After viewing photos in the album, seniors might not want to save them. A delete option can be present to remove the picture from the album database.
  - Organizing content: Organizing content is important. Seniors should have the choice of moving pictures from one place to another
- Printing: Once a photo is uploaded to the album, the user might want to print it. Providing printing options might add value to the product. On the other hand, it might just be on function too many for the elderly user.
4.9. Family Album

- Notification System: We have implemented a notification system that alarms the user of new photos. This shows up in the table of contents.
- Multiple connections: We would like several family members to connect to each other. Several users may want to upload pictures on the album and the elderly might want to scan a photo and send it to several people.

We will work on integrating the system into the lamp, after porting the code to work on a raspberry pi system. The challenges involved are in interfacing the USB picoprojector and the camera with the device, and with making the code efficient enough to run on the ARM processor. Solving the problem of intuitive manipulation and deletion of photos is going to be a challenge. Possible solutions include having buttons to the side that allow you to delete or move the photo. Another method might be to have a blank ‘photograph’ in the album which can be moved, and the projected photo moves with it. Perhaps we could have a recycle bin next to the album where we can throw the photos we do not want, and pick up new empty photos from the bottom. Similar solutions could be used for selecting photos for printing too. Other methods we could conceivably use for input include on-off thread switch for the lamp, and a bookmark that could be moved between pages. Perhaps you could cover a photo with both hands to indicate that you want the photo removed. There are several other changes we could implement to improve the user experience. For one, we need to improve the photo scanning algorithm to be more robust and efficient. We need to check for glossy photos, and any glare that might be there. Perhaps we could use special plastic to reduce the glare. We could also compare a photo being scanned to ones that have been scanned previously to ensure repetition does not happen. We could replace the recognition of the written page number and instead write it in invisible Infrared ink, and use an IR camera to read it, and have a more aesthetically pleasing experience. We could allow the seniors to leave an audio description of each photo, or leave comments on the photos they are sent. Perhaps we could record all talk happening when a photo is being looked at. The notification system, which presently involves a ‘New’ sign on the contents page, could be made more noticeable, like a blinking LED near the album. It is also necessary to solve issues about how many different people get to send photos to one album, and which accounts scanned photos as sent to. Managing multiple albums of photos sent by different relatives is going to be challenging. Perhaps, we could show a slideshow of the user’s favorite photos on the cover when the album is closed. We tried to think of ways to get the device to be portable. One idea was to have a screen embedded in the device, and use sheets of ‘paper’ (made of electrochromic glass) that could change their transparency and let the screen below be seen; or just use pages with the center cut out. In the final quarter of our project, we need to implement these ideas, go through multiple rounds of user testing in conditions as close to the end use case as possible - in a family situation, where photos relevant to the seniors are sent to them by their children, before finalizing our design.
4.10 Final Production: Spring Quarter

In this quarter, we started to develop our prototype into actual product which requires elegant design and full consideration of details. In the following sections we will provide details about how we improved our prototype part by part.

4.10.1 Product Iteration

4.10.1.1 Photo Album

The photo album is the most important part as it is the main interface that fully expose to the users. An elegant but traditional-looking album is needed. The main issues to consider for the album are: size of album, color of album, paper quality, paper corners, and binding of pages.

**Color of Album:** We decided to use soft fall colors for the Family Album since it matches senior’s preference and it fits with the lamp and most of their living rooms. The album colors that we used were brown and black. Brown was chosen for our final product (Figure 4.71).

**Size of Album:** We have tried three sizes of photo albums: 8.75” X 7.75”, 11.75” X 10.75”, and 13” X 13”. The two smaller sized albums were by KOLO (Figure 4.71) while the larger photo album was by TAP solutions (Figure 4.72). We found that 8.75” X 7.75” is too small for us to display a nice and large image on the album hence chose the larger pages. The 13”x13” album was not adopted due to problems it caused with page binding.

**Binding of Album:** The method of album page binding is very important. We need a binding solution that will keep the pages of the album flat and not tilted so that the
images could be well projected and the page number pattern could be more easily read by the camera. We first tried using hinge binding (Figure 4.73) but that was not successful. Turning one page the other page would also move and cannot sit in place. There are gaps between each page because of the thick hinge and makes the pages tilted. Besides, the hinge is not good in terms of durability. After much consideration, we chose regular 3-hole binding which provided the most reliable results and flat pages as shown in Figure 4.74. **Paper Choice**: Our main concern while choosing paper for our album is for it to reflect a nice projected image, and to be durable for use by seniors. We searched for different paper thickness and colors. Luckily, we found elastic pages with a soft creamy
4.10. Final Production: Spring Quarter

color and adjusted them into our album. This paper proved to be very durable, easy to flip and could provide a good projection area. To make the pages more elegant, we manually attached metal paper corners as shown in Figure 4.75 to the pages. This also helped in ease of flipping of pages which some seniors may have problems with.

4.10.1.2 Lamp

There were many methods to make a lamp. Since we need to attach a base for the album on the bottom and a base for the electronics on the top, we considered printing a lamp
using 3D printer and then painting it. This option is very flexible in terms of designing our own lamp with all the feature customized. But printing lamp support will consume a great volume of material which is very expensive and it is actually difficult to design a lamp with elegant appearance from scratch. It is also important to keep the lamp support strong and comparatively heavy for stability, for which 3D printed material is not suitable. Therefore, we carefully chose and bought a lamp instead and adjusted it to what we need. Figure 4.76 shows the lamp we have bought and used for our final product. We chose a bronze colored lamp and a cream-colored lamp shade that are preferable by the seniors. The bulb configuration was also modified. We added one more bulbed and made them symmetrically aligned so as to generate light evenly around the shade and eliminate the shadow of devices inside the lamp shade.

Figure 4.76: Lamp used in our final product

4.10.1.3 Software

In last quarter, a computer was used to do all the computation task, which is not our final solution. For our final product, after comparing different types of on-board computer including beagle board, TV stick and etc., we chose Raspberry Pi, which is small in size, cheap and has good enough computation power. Another important reason for choosing
this device is it has a very large community of providing all kinds of solutions for a great variety of application, which is very helpful for us to develop our system on this on-board computer. We firstly used Python to do all the tasks, but the whole system ran very slowly and each detection cycle took several seconds. By converting the python code into C++ version, recompile the Linux kernel so as to clean out all the useless features, change the Nano SD card from Class 4 to Class 10 which provides better read/write speed and improve the page detection algorithm, the detection cycle was successfully reduced to only tens of milliseconds. With the Raspberry Pi, all the electronic components were compact enough to fit inside the lamp shade, which is shown in Fig.4.77.

![All the electronic components are fit inside the lamp shade.](image)

4.10.1.4 Methods of Uploading Photos

To upload a photo onto the Family Album, users can either email them as attachments or send them via the Windows Phone app that we created. We decided to use these two methods since they include all digital users (not all have smart phones or tablets). Another reason for developing apps was that with more features included such as captions and multiple-photo uploading, it became inconvenient for the users to do it by obeying complex format of the email content. An app can realize more features and are necessary for future development of our product. We chose the Sky drive, a cloud drive service from Microsoft for the photo library of the album and locally synchronized every minute in the on-board computer of our device.
4.10.1.5 Switching device on/off

To switch device on/off seniors only need to press a switch. This simple method is used to avoid any complexity. We chose a very large button for sensors’ convenience and fit it into the base of the lamp so that it can be easily seen. There are two options for this button. One is to control the entire system including the on-board computer. Once the button is off, everything will be closed and the system needs to restart. The other option is only controlling the light of the lamp so that the family album can also be used as a normal lamp, but then how to switch on and off the whole system will be a problem since one more switch will make the design a little too complex. In our final product in spring, we chose the second solution since we found that it was very easy for seniors to press the button and mistakenly switch off the whole system.

4.10.1.6 Switching between Albums

Each set of photos are saved as a single album. To switch between those albums, seniors may pull the chain switch and choose whatever album they desire to view. By making the album changeable, more photos can be accommodated in one device and it is also helpful for seniors or young people to organize photos. Another thought of this design is, sensors might have multiple grandkids and children, which could be a problem since it is difficult for sensors to figure out who are sending those photos. A simple solution of projecting the child/grandkid’s photo on the cover to differentiate different albums and chain switch to change album is helpful. This chain switch design might need to be changed since most seniors relate chain switches to on/off button. But from a different perspective, it might not be hard for seniors to get used to this design. We did consider other options such as rolling plate, big button and album tag, but chain switches are the easiest solution and can fit well with the lamp design. The album tag might be useful but a small book to keep the tags might be needed for numerous tags.

4.10.1.7 Method of Identifying Page Number

To Identify the page number on each page we studied many methods. First, we started by using a QR code, which is the quickest and easiest method, but it looks strange to seniors if shown on a page. We considered printing the QR code using transparent IR ink, but the ink was visible on the pages and was a distraction. Next, we considered capturing page numbers. Unfortunately, the page number recognition program was very slow using a Raspberry Pi, and had a lag of few seconds in displaying the image on the next page, so we abandoned that idea. Our final solution is a pattern that consists of three distinct colors. Page number will be detected based on the sequence and colors of the pattern which produces the quickest page identification method. We tried to improve the looking of the pattern so that it can fit better with the album while maintaining the effectiveness of color recognition. The pattern is placed near and along the binder so that when flipping or tilting the page, the pattern can still be detected since the position of the pattern is not changed so much.
4.10.1.8 Hiding Technology

After building a entirely working prototype with on-board computer, camera, projectors and different kind of wires hidden inside the shade, we found that it was still intimidating for seniors to look at from below. Therefore, we tried to design a case that provide good looking and can cover all electronic things. We designed a case that was assembled from multiple plates. Each plate has some features designed for easier assembling. This design can fully exploit the capacity of 3D printer to create complex object while saving materials and make the total cost of this design not quite expensive. The design is shown in reflampcase.

Figure 4.78: Lamp case for hiding technology.

4.10.2 User Test

4.10.2.1 User Test in China

We did the user test in May 22nd in China and invited about ten seniors to try our device. Most of the users gave positive feedback and were impressed by our device. We got much comments and good suggestions during the user test. The feedback details are shown in Table. refustctest. During the user test in China, most people thought our device were creative and could help senior people a lot. There were also some problems. We found that turning back to content page was a main problem for most users. The clearance of photos also need to paid attention to. Whats more, the knob should be more sensitive and obvious for users.
4.10.2.2 User Test in US

In Stanford side, we did a presentation of our device to senior people in Cubberley Community Center. We introduced the functions of our device and how to use it. Many senior people were interested in the device and asked a lot about it. During that day, many of them tried the device and gave us many useful feedbacks. We were amazed to see that
so many senior users were eager to buy our product. Six of them kept asking the precise
time of our device being put into market and couldn’t wait to buy one. One grandpa,
who is father of a tenured professor at Stanford, hoped that we could contact him as
soon as possible after the device was put into market and asked us for our address and
phone numbers. Another senior user wanted to get paper instructions from us and asked
us about the price. He thought the price of 200 dollars was cheap and really acceptable
for him. He said the device was really made for senior people and asked several times
for materials (like handout) of our product. Another senior user liked the device so much
that he wrote a poem for us to show his appreciation. There were also several users who
were interested in the technology and configuration of our device. Some at first falsely
thought the projector was separated from our device and should be fixed by themselves.
After talking with us, they were clearer about our device. While most senior user were
interested in the device and wanted to buy one, some seniors, especially those who are
familiar with computers or iPads, thought our device was not very promising and shouldn’t
be put into market. They believed computers were better for photo sharing and browsing.
We also went to the senior center in Palo Alto and interviewed some senior people about
Family Album. Many senior people who used the device were amazed at the device and
interested in the technology. Some asked us what devices were inside because they were
surprising to see a lamp showing photos. Nearly every person in the user test believed
this was a novel and excellent idea which could be helpful to the seniors. Two grannies

![Image of senior people using the device]

Table 4.7: User testing in Stanford side.

said they loved the appearance of the lamp and album very much. One of them asked
what our device’s name and wanted to consult her family members who were in electronic
engineering field for more about it. When we told her that Family Album was only our
project and was not in the market, she seemed a little disappointed. Other senior people
were also curious to know whether this device is a project for research or a product in
market. A grandpa who learned business in university talked with us a long time for how
to promote our device into market. He thought the Family Album was a useful device
and catered senior people a lot. But, he said, to put it to market would be tough because
price was a matter. He told us that for some people, 50 dollar might even be expensive
to buy the device. A user told us that the photos were not clear enough. She said for
senior people, the photos projected need to be clearer. Another user said that a projected content of album groups would be good because he wanted to put his photos together with his children’s and he wanted to be clear which groups belong to him. During the test, we also found some other problems in the device. In the test, the album often slid down from the stand and interrupted the color recognition. So the album should be more stable on the lamp stand. And when turning the pages, the pages were sometimes stuck and not in the right position for color recognition. That made the device work imperfectly.

4.10.2.3 Conclusion

Most senior users love our device and would like to buy one. They feel it fit their needs and easy to operate. For some senior people who use computers frequently, our device seems not that attractive. And that's why we set our target users to be senior people who don't know how to use computers or don't like using them. And we also got some feedbacks of the inconvenience while using the device. We got suggestions of modifying content page, clearance of photos and knob control. Next step, we will try to do some changes in these aspects and make our device friendlier to use.
5 Design Description

In this section, the design specifications of the Family Album are discussed for future manufacturing or enhancing.

5.1 Full Bill of Materials

Table 5.1: Bill of Materials for Family Album

<table>
<thead>
<tr>
<th>Item</th>
<th>Units</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamp Base</td>
<td>1</td>
<td>$130.5</td>
</tr>
<tr>
<td>Lamp Shade</td>
<td>1</td>
<td>$64.16</td>
</tr>
<tr>
<td>Photo Album</td>
<td>1</td>
<td>$39.15</td>
</tr>
<tr>
<td>Photo Album Pages</td>
<td>20</td>
<td>$60</td>
</tr>
<tr>
<td>3D Print Base for Electronics</td>
<td>1</td>
<td>$327</td>
</tr>
<tr>
<td>3D Print Base for Album</td>
<td>1</td>
<td>$80</td>
</tr>
<tr>
<td>Projector</td>
<td>1</td>
<td>$400.27</td>
</tr>
<tr>
<td>Raspberry Pi</td>
<td>1</td>
<td>$63.04</td>
</tr>
<tr>
<td>Raspberry Pi Case</td>
<td>1</td>
<td>$13.59</td>
</tr>
<tr>
<td>Camera</td>
<td>1</td>
<td>$22.78</td>
</tr>
<tr>
<td>Light Bulbs</td>
<td>2</td>
<td>$4.77</td>
</tr>
<tr>
<td>Light Bulb Sockets</td>
<td>2</td>
<td>$8.65</td>
</tr>
<tr>
<td>Voltage Regulator</td>
<td>1</td>
<td>$5.56</td>
</tr>
<tr>
<td>Chain Switch</td>
<td>1</td>
<td>$12.66</td>
</tr>
<tr>
<td>Button Switch</td>
<td>1</td>
<td>$9</td>
</tr>
</tbody>
</table>

Total Price $1241.13

5.2 Family Album Specifications

The Family Album has four main parts: Lamp base, Lamp shade, Electronics support, and Album base.

5.2.1 Lamp Base and Shade

The lamp base (Figure 5.1) and lamp shade (Figure 5.2) are bought from Pottery Barn with the specifications shown in Table 5.2 and 5.3 accordingly.
5.2. Family Album Specifications

Figure 5.1: *Chelsea Table Lamp Base*

Table 5.2: *Lamp Base Properties*

<table>
<thead>
<tr>
<th>Lamp Base Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vendor Name:</td>
</tr>
<tr>
<td>Name of Product:</td>
</tr>
<tr>
<td>Material:</td>
</tr>
<tr>
<td>Finish:</td>
</tr>
<tr>
<td>Base Diameter:</td>
</tr>
<tr>
<td>Height:</td>
</tr>
</tbody>
</table>
5.2. Family Album Specifications

Table 5.3: Lamp Shade Properties

<table>
<thead>
<tr>
<th>Lamp Shade Specifications</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Vendor Name:</td>
<td>Pottery Barn</td>
</tr>
<tr>
<td>Name of Product:</td>
<td>Burlap Tapered Drum Lamp Shade</td>
</tr>
<tr>
<td>Material:</td>
<td>Rustic texture of burlap pairs</td>
</tr>
<tr>
<td>Color:</td>
<td>Natural</td>
</tr>
<tr>
<td>Size:</td>
<td>Medium</td>
</tr>
<tr>
<td>Diameter at Top:</td>
<td>12.5 inches</td>
</tr>
<tr>
<td>Diameter at Bottom:</td>
<td>15 inches</td>
</tr>
<tr>
<td>Height:</td>
<td>9.5 inches</td>
</tr>
</tbody>
</table>
5.2.2 Electronics Support

The electronics support is the platform designed for all electronics to fit on and stay hidden. It is built out of SLA 3D printed parts and acrylic. It is fixed inside the lamp cover so it is not easily visible. It contains two parts: the support for all electronic device, including: the projector, the camera, the RPi and the voltage adapters, as shown in Figure 5.3.; the second part is the casing (Figure 5.4) which is covers all the electronic devices. It protects for the electronic devices from being damaged, and hides the technology from the seniors.

![Electronics Support](image)

**Figure 5.3: Electronics Support**

![Electronics Casing](image)

**Figure 5.4: Electronics Casing**

The support is fabricated using 3D printing thanks to its flexibility for complicated shapes. The inner part is designed as simple and compact as possible to save space and reduce weight. The outer part is designed to be small pieces which can be assembled together in the shape of a polyhedron. This can save the time and material for the 3D printing process since the time and material largely depend on the height of the part. By breaking the polyhedron into smaller flat pieces, the height is greatly reduced.

The support is spray painted for an even finish. The process is shown below: 1).
5.2. Family Album Specifications

sanding (300 grit) 2). washing with paint thinner 3). 3 coats of primer 4). sanding (600 grit) 5). 3 coats of paint 6). 3 coats of clear coat (matte finish)

5.2.3 Album Base

The Album base is designed to fit the album such that it is placed elegantly in a specific position, where users do not alter its position. It contain two parts: 1) switch holder and 2) album holder. They serve as the connection between the lamp, the album and the switch.

Switch holder does not only hold the switch, but also connects the lamp base and the album holder. It is fabricated using 3D printing due to its complex shape, shown in Figure 5.5.

The switch holder is painted similarly to the casing.

Album holder holds the album in a fixed position, which is the necessary for the page detection function. The fixture use 4 pieces of magnets which are mounted into the album base and the album itself. The album can move to the desired position when it approaches due to the magnetic force. These is also a mechanism on the album which can help the album to slide into the right position and reinforce the album when it is fixed. This method made it possible to remove the album during transportation and to fix the position of the album during usage. The album holder (Figure 5.6) is fabricated by laser cutting since the all parts contain only planer shapes.

5.2.4 Photo Album

The photo album we used was a KOLO-Trivino model with 11.75” X 10.75” dimensions. 4 magnets are embeded at the back of the album for fixture. As show in Figure 5.7.
5.2. Family Album Specifications

Figure 5.6: *Album Holder*

Figure 5.7: *Photo Album used in our device*
5.3 Product Electronics

The Family Album contains several electronic parts: Projector (with adapter), Raspberry Pi, Camera, Light bulbs and sockets, Voltage Regulator, Chain Switch, Button Switch. The lamp power is separated from the electronic system and is controlled by a button switch connected with 110V power. Another route of wires from 110V power goes into an adaptor which outputs 12V for the projector. The 12V power source is also connected to a 5V adaptor for the Raspberry Pi. Camera and chain switches are both supported by the 5V power source. The whole system is described in Figure 5.8.

5.3.1 Projector

The projector used in the Family Album is a micro projector, shown in Figure 5.9, with the specifications shown in Table 5.4.
### Table 5.4: Projector Properties

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Projection System</strong></td>
<td></td>
</tr>
<tr>
<td>Native Resolution</td>
<td>XGA (1024x768)</td>
</tr>
<tr>
<td>Brightness</td>
<td>110 ANSI-Lumens</td>
</tr>
<tr>
<td>Contrast Ratio</td>
<td>2000:1</td>
</tr>
<tr>
<td>Noise</td>
<td>30dB</td>
</tr>
<tr>
<td>Projections Lens</td>
<td>Manual Focus</td>
</tr>
<tr>
<td>Projection Image</td>
<td>Available Size 7 - 100 inch</td>
</tr>
<tr>
<td>Lamp</td>
<td>Triple RGB LEDs with Vibrant Color Technology, Life 15000 hrs</td>
</tr>
<tr>
<td>Projection Angle</td>
<td>33.4 Deg</td>
</tr>
<tr>
<td><strong>General Specifications</strong></td>
<td></td>
</tr>
<tr>
<td>Audio Output</td>
<td>Stereo 1w speakers, Stereo speaker/</td>
</tr>
<tr>
<td></td>
<td>headphone mini-jack</td>
</tr>
<tr>
<td>Color</td>
<td>Gloss Black</td>
</tr>
<tr>
<td>Storage Capacity</td>
<td>Built in 1 Gb flash memory + microSD/TF card</td>
</tr>
<tr>
<td></td>
<td>+ USB Host reader</td>
</tr>
<tr>
<td>Language</td>
<td>English, Chinese</td>
</tr>
<tr>
<td>Aspect Ratio Control</td>
<td>4:3</td>
</tr>
<tr>
<td>Dimension</td>
<td>132<em>125</em>47mm</td>
</tr>
<tr>
<td>Weight</td>
<td>1.0 lbs</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>50w</td>
</tr>
<tr>
<td>Power Supply</td>
<td>AC100 240V (Free Voltage), 50Hz/60Hz</td>
</tr>
<tr>
<td>Supported Formats</td>
<td>MP4/MP3/WMA/oGG/WAV/AVI/WMV/SMV/BMP/JPG/GIF/TXT</td>
</tr>
<tr>
<td>Conformances</td>
<td>CE, FCC Class A</td>
</tr>
<tr>
<td><strong>Inputs/Outputs</strong></td>
<td></td>
</tr>
<tr>
<td>Video In</td>
<td>HDMI, VGA (mini-VGA), Composite A/V (3.5 mm Jack)</td>
</tr>
<tr>
<td>Audio Out</td>
<td>3.5 mm Stereo Headphone Jack</td>
</tr>
<tr>
<td>USB</td>
<td>5 Pin Mini USB</td>
</tr>
<tr>
<td><strong>Included Accessories</strong></td>
<td></td>
</tr>
<tr>
<td>Infrared Remote Control</td>
<td>Tripod, Composite A/V cable,</td>
</tr>
<tr>
<td>VGA video cable</td>
<td>USB Data Cable</td>
</tr>
</tbody>
</table>
5.3.2 Raspberry Pi (RPi)

The electronic system is run and controlled using a Raspberry Pi shown in Figure 5.10 with properties shown in Table 5.5.

Figure 5.10: Raspberry Pi which controls Family Album System
Table 5.5: *Raspberry Pi Properties*

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System on a Chip</strong></td>
<td>Broadcom BCM2835 (CPU, GPU, DSP, SDRAM, and single USB port)</td>
</tr>
<tr>
<td><strong>CPU</strong></td>
<td>700 MHz ARM1176JZF-S core (ARM11 family)</td>
</tr>
<tr>
<td><strong>GPU</strong></td>
<td>Broadcom VideoCore IV</td>
</tr>
<tr>
<td></td>
<td>OpenGL ES 2.0 (24 GFLOPS)</td>
</tr>
<tr>
<td></td>
<td>MPEG-2 and VC-1 (with license), 1080p30 h.264/MPEG-4 AVC high-profile decoder and encoder</td>
</tr>
<tr>
<td><strong>Memory (SDRAM)</strong></td>
<td>512 MB (shared with GPU)</td>
</tr>
<tr>
<td><strong>USB 2.0 ports</strong></td>
<td>2 (via the built in integrated 3-port USB hub)</td>
</tr>
<tr>
<td><strong>Video input</strong></td>
<td>A CSI input connector allows for the connection of a RPF designed camera module</td>
</tr>
<tr>
<td><strong>Video outputs</strong></td>
<td>Composite RCA (PAL and NTSC), HDMI (rev 1.3 &amp; 1.4), raw LCD Panels via DSI, 14 HDMI resolutions from 640350 to 19201200 plus various PAL and NTSC standards</td>
</tr>
<tr>
<td><strong>Audio outputs</strong></td>
<td>3.5 mm jack, HDMI, and, as of revision 2 boards, I²S audio (also potentially for audio input)</td>
</tr>
<tr>
<td><strong>Onboard storage</strong></td>
<td>SD / MMC / SDIO card slot (3.3V card power support only)</td>
</tr>
<tr>
<td><strong>Onboard network</strong></td>
<td>10/100 Ethernet (8P8C) USB adapter on the third port of the USB hub</td>
</tr>
<tr>
<td><strong>Low-level peripherals</strong></td>
<td>8 GPIO, UART, I²C bus, SPI bus with two chip selects, I²S audio +3.3 V, +5 V, ground</td>
</tr>
<tr>
<td><strong>Power ratings</strong></td>
<td>700 mA (3.5 W)</td>
</tr>
<tr>
<td><strong>Power source</strong></td>
<td>5 volt via MicroUSB or GPIO header</td>
</tr>
<tr>
<td><strong>Size</strong></td>
<td>85.60 mm 53.98 mm (3.370 in 2.125 in)</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>45 g (1.6 oz)</td>
</tr>
<tr>
<td><strong>Operating systems</strong></td>
<td>Arch Linux ARM, Debian Linux, Fedora, FreeBSD, Plan 9, Raspbian OS, RISC OS, Slackware Linux</td>
</tr>
</tbody>
</table>
5.3.3 Camera

The Family Album includes a camera to detect a code which relates to a page number so that each page can contain a specific photo. For this purpose, we used a Logitech Webcam C210 as shown in Figure 5.11. The camera specifications are shown in Table 5.6.

Figure 5.11: Logitech Webcam C210 used in Family Album
### Table 5.6: Logitech Webcam C210 Specifications

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Device Type</strong></td>
<td>Web camera</td>
</tr>
<tr>
<td><strong>Connectivity Technology</strong></td>
<td>Wired</td>
</tr>
<tr>
<td><strong>Software Included</strong></td>
<td>Drivers &amp; Utilities, Logitech Vid HD</td>
</tr>
<tr>
<td><strong>Features</strong></td>
<td>USB 2.0 compatibility, RightSound technology, Snap-shot button</td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td>Color</td>
</tr>
<tr>
<td><strong>Max Digital Video Resolution</strong></td>
<td>640 x 480</td>
</tr>
<tr>
<td><strong>Audio Support</strong></td>
<td>Yes : Built-in microphone</td>
</tr>
<tr>
<td><strong>Computer Interface</strong></td>
<td>USB</td>
</tr>
<tr>
<td><strong>Interfaces</strong></td>
<td>1.0 x USB - 4 pin USB Type A</td>
</tr>
<tr>
<td><strong>Compatible Slots</strong></td>
<td>None</td>
</tr>
<tr>
<td><strong>Cables Included</strong></td>
<td>1.0 x USB cable - 5.0 ft</td>
</tr>
<tr>
<td><strong>Microsoft Certifications</strong></td>
<td>Certified for Windows Vista</td>
</tr>
<tr>
<td><strong>Power Device</strong></td>
<td>None</td>
</tr>
<tr>
<td><strong>Battery</strong></td>
<td>None</td>
</tr>
<tr>
<td><strong>OS Required</strong></td>
<td>Microsoft Windows Vista, Microsoft Windows 7, Microsoft Windows XP SP2 or later</td>
</tr>
</tbody>
</table>

**Peripheral / Interface Devices**
- USB port, Internet connection, CD-ROM

**System Requirements Details**
- Windows 7/Vista
- 1.0 GHz - RAM 512.0 MB - HD 200.0 MB
- Windows XP SP2 or later - 1.0 GHz - RAM 512.0 MB - HD 200.0 MB
5.3.4 Light Bulbs and Sockets

5.3.4.1 Light Bulbs

The Family Album aims to feel familiar to seniors, so we decided to use a warm white light bulb. We use two light bulbs in order to distribute the light more evenly around the electronics in the center. Model: EcoSmart 9-Watt (40W) Soft White CFL Light Bulbs (4-Pack) (E)

![Light bulbs used](image)

**Figure 5.12: Light bulbs used**

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Brightness</strong></td>
<td>550 lumens</td>
</tr>
<tr>
<td><strong>Estimated Yearly Energy Cost</strong></td>
<td>$1.08 (Based on 3 hrs/day, 11/kWh. Costs depend on rates and use.)</td>
</tr>
<tr>
<td><strong>Life</strong></td>
<td>9.1 years (Based on 3 hrs/day)</td>
</tr>
<tr>
<td><strong>Light Appearance</strong></td>
<td>2700K (Soft White)</td>
</tr>
<tr>
<td><strong>Energy Used</strong></td>
<td>9-watts (equivalent to a 40-watt standard incandescent light bulb)</td>
</tr>
<tr>
<td><strong>Lumens per Watt</strong></td>
<td>61</td>
</tr>
<tr>
<td><strong>Contains Mercury</strong></td>
<td>Y (For more on clean-up and safe disposal visit: epa.gov/cfl)</td>
</tr>
<tr>
<td><strong>Lighting application</strong></td>
<td>Indoor/Outdoor</td>
</tr>
<tr>
<td></td>
<td>Enclosed only; Ideal for use in table lamps, sconces, ceiling mount fixtures and other general lighting applications</td>
</tr>
<tr>
<td><strong>Shape</strong></td>
<td>Spiral shape with a medium base</td>
</tr>
<tr>
<td><strong>Dimmable</strong></td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Uses 75% less energy compared to a standard incandescent light bulb</td>
</tr>
<tr>
<td></td>
<td>Meets Federal minimum efficiency standards for Energy Star rating</td>
</tr>
</tbody>
</table>
### Table 5.8: Light Bulb Specifications

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3-Way</strong></td>
<td>No</td>
</tr>
<tr>
<td>Actual Color Temperature (K)</td>
<td>2700 K</td>
</tr>
<tr>
<td>Assembled Depth (in.)</td>
<td>1.9 in</td>
</tr>
<tr>
<td>Assembled Height (in.)</td>
<td>3.6 in</td>
</tr>
<tr>
<td>Assembled Width (in.)</td>
<td>1.9 in</td>
</tr>
<tr>
<td>Average Life (hours)</td>
<td>10000</td>
</tr>
<tr>
<td>Bulb Diameter (In.)</td>
<td>1.9</td>
</tr>
<tr>
<td>Bulb Length (In.)</td>
<td>3.6</td>
</tr>
<tr>
<td>Bulb Type</td>
<td>Household</td>
</tr>
<tr>
<td>Color Temperature</td>
<td>Soft White</td>
</tr>
<tr>
<td>Commercial / Residential</td>
<td>Commercial / Residential</td>
</tr>
<tr>
<td>Dimmable</td>
<td>No</td>
</tr>
<tr>
<td>Energy Star Compliant</td>
<td>Yes</td>
</tr>
<tr>
<td>Indoor/Outdoor</td>
<td>Indoor</td>
</tr>
<tr>
<td>Light Bulb Base Type</td>
<td>Medium</td>
</tr>
<tr>
<td>Light Color</td>
<td>Soft White</td>
</tr>
<tr>
<td>Light Output (lumens)</td>
<td>550 lm</td>
</tr>
<tr>
<td>Manufacturer Warranty</td>
<td>9 Year Warranty</td>
</tr>
<tr>
<td>Number in Package</td>
<td>4</td>
</tr>
<tr>
<td>Returnable</td>
<td>90-Day</td>
</tr>
<tr>
<td>Specialty Bulb Type</td>
<td>Household / General Purpose</td>
</tr>
<tr>
<td>Start-Up Type</td>
<td>Rapid</td>
</tr>
<tr>
<td>Watt Equivalence</td>
<td>40 W</td>
</tr>
<tr>
<td>Wattage (watts)</td>
<td>8 W</td>
</tr>
</tbody>
</table>
5.3. Product Electronics

5.3.4.2 Bulb Sockets

To connect the two light bulbs to power, we used two Westinghouse Keyless Sockets as shown in Figure 5.13 with clear specifications in Table 5.9

![Westinghouse Keyless Socket](image)

Figure 5.13: *Westinghouse Keyless Socket used to power up the two light bulbs*

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembled Depth (in.)</td>
<td>1.19 in</td>
</tr>
<tr>
<td>Assembled Width (in.)</td>
<td>1.19 in</td>
</tr>
<tr>
<td>Color/Finish Family</td>
<td>Black</td>
</tr>
<tr>
<td>Manufacturer Warranty</td>
<td>N/A</td>
</tr>
<tr>
<td>Assembled Height (in.)</td>
<td>1.75 in</td>
</tr>
<tr>
<td>CSA Listed</td>
<td>No</td>
</tr>
<tr>
<td>ETL Listed</td>
<td>No</td>
</tr>
<tr>
<td>Material</td>
<td>Plastic</td>
</tr>
</tbody>
</table>

Table 5.9: *Light Bulb Socket Specifications*

5.3.5 Voltage Regulator

The projector in our product is supplied with 12 VDC while the Raspberry Pi requires 5 VDC. That is why we use a voltage regulator (Miniature USB Car Charger Adapter) to convert 12 V to 5 V as the one shown in Figure 5.14 where the output is through a USB port.

5.3.6 Switches

5.3.6.1 Chain Switch

We used a chain switch, Figure 5.15 to flip through different sets of pictures.
5.3. Product Electronics

Figure 5.14: Voltage regulator to transform 12 Volts into 5 Volts to power the Raspberry Pi.

Figure 5.15: Chain switch used to flip through different albums
5.3.6.2 Toggle Switch

A toggle switch was used (Leviton Decora 15-Amp Illuminated Switch - White Figure 5.16) to turn the Family Album on and off. The switch’s specifications are shown in Table 5.16.

![Toggle switch used to turn on/off Family Album](image)

Table 5.10: Toggle Switch Specifications

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amperage (amps)</td>
<td>15 A</td>
<td>Assembled Depth (in.)</td>
</tr>
<tr>
<td>Assembled Height (in.)</td>
<td>4.06 in</td>
<td>Assembled Width (in.)</td>
</tr>
<tr>
<td>Color</td>
<td>White</td>
<td>White</td>
</tr>
<tr>
<td>Decorative</td>
<td>No</td>
<td>Electrical Product Type</td>
</tr>
<tr>
<td>LED/CFL Compatible</td>
<td>No</td>
<td>Locator Light</td>
</tr>
<tr>
<td>Switch Style</td>
<td>Toggle</td>
<td>Switch Type</td>
</tr>
<tr>
<td>UL Listed</td>
<td>1-UL Listed</td>
<td>Voltage (volts)</td>
</tr>
</tbody>
</table>
5.4 Software Programs

The Family Album works using several software programs working on the Raspberry Pi, all written on C++. The following sections are the crucial parts of the whole system.

1. RPi C++ program work flow, as shown in the following Figure 5.17.

Figure 5.17: C++ program work flow
5.4. Software Programs

1. Page Detection Program
2. Uploading a photo onto the album via email
3. Uploading a photo onto the album via Windows Phone Application

5.4.1 Page Detection Program

To detect the page number on the album papers, we tried several methods:

1. Detecting a number printed on each page: Method was too slow to work on Raspberry Pi, it took several seconds for the image to come up after flipping each page.

2. Detecting an invisible QR code printed on each page: The infra red ink was not invisible, but produced a mark that would show clearly on each page. Therefore, this method was abandoned.

3. Detecting color patterns printed on each page: Taking the average of a color pattern on each page was the fastest method, therefore we applied this to the Family Album.

   The pattern printed on each page is made up of 11 square blocks placed vertically on a album page as shown in Figures 5.18 and 5.19. The squares are made up of three colors that match the colors of the photo album: Red (Has value 2), brown (Has value 1) and beige (Has value 0). Three colors were chosen since the program requires three distinct colors to work. From Figure 5.20 we can see that the first two blocks (1 & 2), middle block (6), and last two blocks (10 & 11) are the same on every page for decorative reasons and as reference. Blocks 3,4,5 and 7,8,9 are symmetric about block 6. First, the camera cleans up the image using Gauss Filter then it detects blocks 2 and 6 as reference points. The program specifies a threshold for the colors.

   The program calculates the color values as: Block 3+3xBlock 4+9xBlock 5. After checking if blocks 3&7, 5&8, 5&9 are of the same color, the program returns a page number. This program is shown in Appendix P.

5.4.2 Uploading a photo onto the album via email

The program used to upload a photo onto the album is shown in Appendix Q and works as follows:

Fetchmail daemon runs every five minutes, connects to the live.com POP3 server, and downloads new emails. It then pipes the email to Procmail. Procmail checks if the email is from a list of approved senders, then pipes it to the shell script. It is able to do filename processing, adding attachment, opening in a text editor like wordpad

The shell script uses munpack to extract the attachments from the email, then for each attachment, it resizes the photo to 1024x768 while maintaining the aspect ratio, converts it to JPG format, adds the subject of the email as a caption and saves it in the album folder structure. It also creates an entry for the photo in the photo list, (albumX.txt), with
the 'from' email address, the date/time, the subject of the email and the filename. The code will run on the server, and the pi will sync with the server once every five minutes.
Figure 5.19: Color pattern printed on album pages to detect page number on newest version of album and colors.

Figure 5.20: Analysis of colored pattern on pages
5.5 Windows Phone app

The phone app allows control over all photos on the Family Album. It can be used to add and delete photos, change captions, move photos between albums and rename albums.

The main page shows you a list of albums, with a thumbnail of the first photo. You can click on the thumbnail to enter the album and see the pictures. There, you can find options to delete photos or move it to another album. On the main page, you can also create new albums. You can also click a new picture, add a caption and upload it to the lamp all within the app. You can also select a photo from the phone’s gallery.

For the young generation, we need a convenient interface for them to upload and manage photos for the older generation. We take advantage of Microsoft’s cloud storage service, SkyDrive, to store photos. For the phone app, powerful development tools such as LiveSDK and Visual Studio Integrated Development Tools are provided by Microsoft. We develop a windows phone app based on these tools which have functions of uploading photos, deleting photos, moving photos, uploading titles, creating albums etc. We make the user interface as simple as possible. Meanwhile, we add useful organizing functions the younger generation can appreciate, as shown in Figure 5.21.
Figure 5.21: a. Welcome page; b. Editing photo title and description; c. Browsing and managing albums d. Create new album; e. Delete album by long pressing; f. The button down are delete and upload new g. 5. Move to a new album
6 Project Management

6.1 Project Planning

6.1.1 What happened in Fall Quarter?

Fall quarter was the initiation point of our project. The first challenge was to set up a system for organized communication and collaboration with our team members and our global team. From there, we started benchmarking and need finding. Fall quarter was spent exploring technology and trying out extreme designs hoping to create new devices.

Fall Deliverables:

- Benchmarking Document and Presentation
- Critical Function Prototypes
- Critical Experience Prototype
- CFP/CEP Presentation and Document
- Fall presentation and Brochure
- Fall Documentation

Figure 6.1: Milestones for Fall Quarter
Figure 6.2: Timeline for Fall Quarter (part 1)
6.2. What happened in Winter Quarter?

After completing the Fall quarter, our team delved deeper into methods for methods of communication between family members that we had identified. The first two weeks of the quarter were spent discussing previous ideas and future paths to follow while working on our Paper Robot Mission. In the third week we decided that video chatting could be a promising direction our exploration could move in, aiming to provide visual interaction and personal satisfaction for old and young users. From there, our ideas diverged on how to incorporate features in our device, with the center feature being video chatting.

Discussing with our global team, we came up with the Window idea, a channel that is always on which connects two houses. Looking through the Window would allow you to see what’s on the other side at all times. Simple functions where associated with the Window like closing/opening the curtain to turn the Window off/on and sending/receiving messages (audio, video or written).

In the fourth week of Winter 2013, we started our user testing. Building a miniature of our basic setup, considering at first the Window having a 42 inch screen, and using
6.2. What happened in Winter Quarter?

Ipads as our functioning system, we went to Avenidas to talk to seniors and get feedback regarding our device. This was our first visit to a senior center, and it proved to be very beneficial. We had a problem explaining our vision because we did not have a functioning system for seniors to try it but we did gather useful input. Some seniors compared our Window to Skype and did not see how it differed; however, some did like the function of writing notes to their children since they did not want to interrupt their childrens busy schedules.

We got positive reviews from the teaching team regarding our Dark Horse presentation mainly because we actually went out and talked to our target users to find what they really need and not just speculate what they might like.

The simplicity of our device and its similarity to existing technology made us want to be creative. We tried to create an all-in-one device. To add physical interaction between the two sides using the Window, we created an interactive space, comprised of a projector and a camera. This space created room to include game playing, photo sharing, story-telling, and note writing/sending. At this point, our Family Window turned into a Family Channel.

Thinking our device is too simple drove us to add unnecessary features, which compromised the quality of our design. It took us two weeks (Week 5 and 6) to develop a small part of each feature which did not leave us with enough time to implement a functional system. We talked to seniors a few times in these two weeks, but by explaining the device to them, they got overwhelmed and confused. Most seniors did not care for most of the features. That is why our Funktional Prototype turned out to be an overload of functions which were not tested properly nor completed successfully. Both Microsoft and the Teaching team did not feel confident about the exact purpose of the device.

Despite our excessive features, we decided to continue on the same path for the Functional Prototype. However, we decided that we need to talk to more users. A week (Week 8) into this, we sat down and discussed the reality of our situation and decided that we are going to choose only one feature and work on that alone. We listed a few features that each of us wanted to focus on and during our meeting we eliminated features by the value we saw in each feature for us and for our user. As we discussed photo sharing, we came up with our Family Album idea. The idea was favored by all team members and we saw great opportunity for it so we immediately began working on it.

Therefore, we stepped away from the Family Channel and the video chatting feature and we created our first prototype in two days and presented it on Week 8. With encouragement from the teaching team and our own motivation, we successfully designed our Functional Prototype-Family Album and presented it on Week 9. The excess of features had lessened our impact on users and decreased our focus on our device. Once we narrowed our features down to a single one, we began designing details that created a pleasurable experience for users, even if it was for a single feature.

All the work done for this album was in the last three weeks of our quarter. In these
6.2. What happened in Winter Quarter?

weeks we were more efficient because we knew what we wanted to make, how to make it, how to test it, and how to make it better. Multiple features did not overwhelm us. That is why we finally presented a device that we are confident will turn out to be a successful creation.

6.2.0.1 Any lessons learned from time management in Winter quarter?

The deadlines for our "Missions" were approximately evenly spaced which formed a habit within our team. Since we had two weeks for each mission, we learned to take decisions quickly, deciding what product to work on in the first few days, ordering our required devices, then building our product. The last three days were spent on testing and getting user feedback.

Our Design Process:

- **Discussions:** This is the most important part of our process. We needed to delve into all ideas before choosing the solution that fits our purpose.
6.2. What happened in Winter Quarter?

- **Gathering our devices:** Gathering what’s around us and ordering what we need online or buying it from shops close by took time. We learned to order early and take quick decisions regarding important devices.

- **Building our device:** Building our device requires work on the physical structure and software part. Making both requires effort to reduction of errors.

- **User Testing:** After completing our basic prototype building, we test and iterate.

  Luckily, we did not waste much time this quarter but there were some measures to take for better time management. For the Spring quarter we will do the following to increase our efficiency and reduce time wasted:

  - Order products ahead of time to prevent delays
  - Set two meetings per week for pure discussion among Stanford team. This is when we are most concentrated and productive
  - Document steps regularly to ensure all material is present and prevent stress at the end of the quarter
  - Visit seniors frequently and at all stages of our product, not only the final stage
  - Divide task evenly and based on interest, all members focusing on a task that can be done by one or two people is not efficient.

6.2.1 What happened in Spring Quarter?

In Spring Quarter, we built the Family Album. To do that, we had to divide the work among ourselves to be able to complete the project. At first, one person was focusing on the physical design (in charge of lamp, album and other physical parts) while three members were finalizing the software. This was our "Part X", a fully functional part of our product, and it was the most urgent issue since we cannot continue with our user testing without it being done. Unfortunately, it took us more than the given time, so we had to submit it a week later than it was due (Due date April 18).

Our "Penultimate Design", Fully functioning part of product which could be presented at EXPE, was completed a week later than expected (Due date May 16) due to incomplete physical design. That is probably since not enough members were working on the physical design. Also, important machines, like 3D printer, at the Stanford workshop were broken due to heavy use, and this caused a delay in our product.

As for user testing, our two main events were on May 8, where we had a 15 minute presentation at the Cubberley Community Center in Palo Alto for 50-100 seniors, and May 29 where we gathered user feedback from the same venue.
6.3 Budget

Fall Budget:

<table>
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<th>Items</th>
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<th>Number</th>
<th>Total (Including tax and shipping)</th>
<th>Date</th>
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</thead>
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<td>9.97</td>
<td>1</td>
<td>10.8</td>
<td>2/11/2012</td>
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<td>The exploratorium</td>
<td>15</td>
<td>3</td>
<td>45</td>
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<tr>
<td>The exploratorium Tactile Dome</td>
<td>12</td>
<td>3</td>
<td>36</td>
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<td>3</td>
<td>21</td>
<td>18/11/2012</td>
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<tr>
<td>Caltrain Ticket</td>
<td>7</td>
<td>3</td>
<td>21</td>
<td>18/11/2012</td>
</tr>
<tr>
<td>Bus Tickets</td>
<td>2</td>
<td>6</td>
<td>12</td>
<td>18/11/2012</td>
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<td>Fry’s components</td>
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<td>96.9</td>
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<td>46.05</td>
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<td>49.91</td>
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<td>Total</td>
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Table 6.1: Budget for Fall
### 6.3. Budget

Winter Budget:

<table>
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<tr>
<th>Reference</th>
<th>Date</th>
<th>Vendor Name</th>
<th>Description of Expense</th>
<th>Amount Incl Sales Tax</th>
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<td>Duron 3 pieces</td>
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<td>Sara</td>
<td>3-Mar</td>
<td>Target</td>
<td>Album for functional prototype</td>
<td>$16.26</td>
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<tr>
<td>Pcard</td>
<td>23-Jan</td>
<td>Anatolian Kitchen</td>
<td>SUIS</td>
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<td>Mishel</td>
<td>21-Feb</td>
<td>PRL</td>
<td>Duron</td>
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<td>Li Xuesen</td>
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<td>Frys</td>
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<td>26-Jan</td>
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<td>Duron</td>
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<td>29-Jan</td>
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<td>Mishel</td>
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<td>Amazon</td>
<td>Wide Angle Camera</td>
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<td>Raspberry Pi Model B Revision</td>
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<td>Amazon</td>
<td>PKG (4) 2” Square Linear Polarized Filter</td>
<td>$12.95</td>
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</table>

| Total Spent in Winter Quarter | $1,493.84 |

Table 6.2: ME310 Expenses Spreadsheet - Winter Quarter AY13
6.4 How were the resources allocated in Winter Quarter?

In this quarter our major spending was on devices with advanced features such as pico projectors and wide angle cameras (almost $600) and computer screen (almost $200). These items were not present in the loft. Table 6.2 shows our expenses for Winter 2013. Some of the devices were not used in the final product. We realize we need to buy only the required devices, but at that stage we were designing the Window and Channel and did not have time to waste waiting for deliveries. In the end of the quarter, we used half of our designate budget ($1500).

<table>
<thead>
<tr>
<th>Date</th>
<th>Vendor Name</th>
<th>Description of Expense</th>
<th>Amount Incl Sales Tax</th>
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## 6.4. How were the resources allocated in Winter Quarter?

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|            | **Total**                 |                                   | **$2,993.41** |

Table 6.3: ME310 Expenses Spreadsheet - Spring Quarter AY13
6.5 How were the resources allocated in Spring Quarter?

In Spring quarter we spend almost $2500 on our product, $120 on transportation and $400 on SUDS.

6.6 Distributed Team Management

We planned and managed our project in a systematic way. Before each stage, schedules were made as a guide. During the implementation of the project, various documentations were made to record the progress, including meeting log, budget log and idea log etc. Time management tools were used to set up target and milestones. With the aid of video conference, we can communicate with USTC team twice a week for cooperation.

6.6.1 Communication with Global Team: USTC

Video Conference twice a week with global team, during which we report progress to each team and plan for further work. We give feedback and suggestion to each other and improved our work accordingly.

We use Tencent QQ as our communication Tool. QQ provides a convenient way to do meet with the global team. It can provide better quality free video chatting than most of the product in the market especially inside China. Features such as Intuitive Groups Management and Creation, Easy to Use, Improved Translator, Customize Your User Interface greatly enhance its function.

![Figure 6.6: QQ communication tool](image)

6.6.2 File Management

Google Drive provides an easy way to manage and share file. It also offers collaborative editing on documents, spreadsheets, presentations. Our documents are divided into several groups for easy management:
6.6.3 Team website

http://me310microsoft.weebly.com/

We build our team website based on a free web service provider, Weebly. Weebly is a free web-hosting service featuring a proprietary drag-and-drop website builder. We divide our website into several sections, namely: Home, Timeline, Blog, Prototype, Calendar, Feedback and People. The timeline will show what we have done and up-to-date new about our project in time sequence. The blog will provide more details about those events. Prototype records all of the prototypes we have made.

![Project website](image.jpg)

Figure 6.7: Project website.
6.7 Reflection

6.7.1 Sara Jaafar

I have joined the Microsoft team in Winter 2013 and ME 310 has proved to be the most interesting course I have taken. Joining a group late is challenging and, although team dynamics may be hard to adjust to at first, I had a great time with my group. Throughout the weeks, we have learned two major lessons. The first one is to talk to your users and understand what they want. We cannot simply design a device in a room and impose it on others. The second lesson we learned is that focusing on a few functions for our product is all that is required. Once we add more functions, the strength and impact of each function is decreased. Although these issues were told to us by the teaching team continuously, we did not realize their importance until we saw their effect on us and on our product.

I had a great time in ME310 with valuable lessons to keep for the future.

6.7.2 Mishel Johns

I have enjoyed working on the Microsoft project with my team, and I very firmly believe that we had the best project prompt this year, and possibly the best solution too! I love the fact that our prompt is so open ended, and that we have been let free to explore the problem space and find what we would like to work on, and think of a lot of crazy ideas. ME310 has been a lot of work, but it has been great fun too.

Our team has spent a lot of time over the first two quarters coming up with ideas for a product. It was never getting ideas that was a problem, it was selecting one and convincing the whole team that it worked that was troublesome. The last quarter has been challenging in that all of our team lacked experience in designing and building a professional device, and also because some of our team members were very busy with other projects and courses during the period. Equitably distributing the workload among the four of us has been a challenge.

Other challenged we faced included finding users who matched our target user in a developing country. The seniors we could talk to and test our devices on in Silicon Valley were not quite the target user we were looking for. Also, our prototypes needed to be tested in a family context rather than at a senior center. The Wednesday Mahjongg sessions at the Cubberley Community Center were invaluable in this regard.
6.7. Reflection

The difference between the academic timetables between USTC and Stanford were a cause of difficulties, as we were on holiday for a month in December when USTC was in session, while they were not available in January. Also, they had the end-semester examinations very close to EXPE. Overall, I believe our cooperation went very well. We couldn’t have done several parts of our presentation and documentation without timely help from the USTC side.

ME310 has been a great experience, and I’m going to miss the loft and the people next year.

6.7.3 Shiquan Wang

In this quarter, we mainly focused on how to improve our design and delved into the details. Through the process, I felt that the team collaboration was not very efficient. All of us were busy and lacked execution. One lesson for me is, it is better to focus on one thing and concentrate on it rather than have lots of different works but don’t have the time to do it well. I was really impressed by other team’s final presentation. There are lots of techniques to make presentation, demo and booth interesting and I learned a lot from the presentation. I kind of regretted that we did all the technical stuff by our own. It consumes lots of time and cannot provide a perfect output compared with focus more on the design and get all the necessary concepts implemented efficiently even resort to outsourcing so as to provide a complete product with all the necessary elements to make it as an outstanding product.

6.7.4 Xuesen Li, Tony

The design activities in this spring quarter provides me a valuable experience. Our team made great progress during this period based on last quarter. In this quarter, we focused more on the manufacturing stage, which is the transition from funky prototype to final prototype. We tried to refine details to make them perfect, such as the album paper, the projector position and electronics supports. The email, phone app and the C++ program are also done in this quarter.

While making something functional is not so hard, making it perfect it very challenging. Every detail has to be
considered before the final decision is done. We also encountered many problems and difficulties during the design process. Sometimes the ideas among each one are hard to converge even after long discussion. I believe listing the ideas out on a white board is a feasible method in order to discuss the same topic again and again. This largely solved our problem.

To sum up, I think our Family Album is a successful project which can address real problems among seniors. I enjoy the process of the making the album and working with my teammates.

6.7.5 Yingwei Li

This quarter, we tried some interesting ideas and found that our imagination is indeed unlimited! And I think we should learn more from the interview from potential users—sometimes the ideas just pop out during the interview! Finally, I really look forward to the stanford team’s trip to China!!! We’ll have a lot of fun together!
6.7.6 Yikang Liu

I’ve spend another period of meaningful and pleasing time with my teammates in ME310 this quarter. The course, although not as new and attractive to me as in last quarter, has still brought me lots of precious experience, skills, and knowledge. We made some mistakes last quarter. For example, students in Stanford and in USTC didn’t communicate enough and our works were not sufficiently related, which violated an essential spirit of this course, cooperation. Besides, we didn’t have enough communication with liaison in MSRA so that many of works were not updated to MSRA as soon as possible, which impeded improvements of our ideas. At the end of last quarter, we realized our mistakes and the team functioned more efficiently as a whole this quarter. For example, in dark horse prototype and funktional prototype, each team was responsible for a part of function of the whole prototype or a specific solution to a common topic. And in functional prototype, interview in China supported the idea came up with by Stanford University. Its a fantastic experience to be in an international cooperation beyond geographical distance. As usual, we ran into some problems. Since we’ve narrowed down on a topic this quarter, I strongly felt how hard it was to realize an idea. An idea may be fancy when first brought up, but one would find flaws in that idea and difficulties in realization. I felt the tough but attractive circle of developing a product and I realized the importance of turning to professionals for help and conveying an idea efficiently and correctly to a technician or an instructor. I am looking forward to students in Stanford University visiting USTC, which means that we can talk and work together face to face again! I think I really suffered from a long-distance collaboration.

6.7.7 June Zhang

This quarter we came up with and prototyped two ideas, family window and family lamp. When we first thought of the window thing, we believed it to be a really good idea. For me, it’s quite cool to video chat with parents or grandparents using a huge window as screen. And this family window could be part of my house, so chatting with remote relatives would be more natural. But a large transparent window-like screen is really hard to buy. And then we two sides had some divergence on whether it should be a window-like device. At this point the really amazing idea, family lamp, was come up with by Stanford guys. It was a function of family window but now amplified to be a single device. Compared with family window, this prototype is easier for us to accomplish, and its usefulness surpasses family window too. We did some interview among old people about the lamp thing and received great response. They believes it to be a promising product
and some are even eager to buy it. It seems we’ve found a wonderful idea and well do our best to accomplish it. Liaison of Microsoft and TA in Stanford rendered us much help and advice. Time spent working with the team is great and I’m really looking forward to the visit of Stanford students in March.

6.7.8 Yunjun Wu

This semester is really an interesting and hard-working time for all of us, and for most of the time I had all these complex moods for this project and all our work. Well, the most intensive mood is the pity for all those great ideas we abandoned during the design process. I really miss some of the thoughts we had in last semester, for example the 3D table. It is a really fancy idea and every time I introduced it to someone else, although it was tough to explain how it would work, it made me feel really exciting and proud. Of course I miss the Family Window since we once thought that we will focus on this design in the end. After the funky-system prototype when we decided to change the design I really got anxious: why should we change? The window was so good and we had already spent so much efforts and time on it. It was a really tough time for both side of the team to know that the family window didn’t work out to accept that we need to change again. It was reasonable because even compared with our final design of the album, the family window still has its highlights: it can really create the experience of being together for the family members who are separated by the distance. However, we abandoned it as well as the 3D table and many other great ideas of the team. Although it can be a little sad for me to say goodbye to those ideas, being part of the design process of the family album is still fascinating and may be one of the most interesting experience in my life. When I got back to school after the Spring Festival, heard about the new idea of the album for the first time, I thought that would be boring. However, when I explored more about the idea and when we thought about the details of the scenario for this product, I got the feel that, after so many trying, so many unsuccessful exploration, we finally got back to where we came from the original topic of our project: connect the digital and the physical residents. Well, in fact, I think that the album is the best design ever in this whole process: it bridges the two different types of people by the most common activity in a family: photo sharing and makes it comfortable for every side of the users. The system of the phone and album make it possible for us to realize this fancy product. Knowing the final settlement of our design was a relief for me and all of us. When we started the functional-system prototype I feel so unconfident for there would be a lot of programming work that I was not good at. I had to study all these things from the start. Although I was really worried about it, I still tried my best to achieve every function of the phone app. I admit that sitting in front of the computer and writing the code everyday was really a challenge for me, but finally I survived and achieved most of the functions with the
help of Yingwei. I'm proud for my work. In brief, it was a meaningful semester for me. I really appreciate my teammates who experience all of these together with me. I'm sure the next section will be better.
We would like to thank the ME310 Teaching Team, including Prof Mark Cutkosky, Prof. Larry Leifer, George Toye, Tyler Bushnell, Scott Steber and Annika Matta for their valuable feedback and advice at all stages in the project. We would like to thank all of them, especially Tyler, for taking the time to analyze our project progress and suggest corrections. We are also grateful to our coaches Adrit Lath and Rafat Mehdi, who have been very supportive of our project and have helped us out multiple times with advice and ideas.

We would also like to express our gratitude to the following people who have been of invaluable help to us. We would specially like to thank Dave Jaffe from the Mechanical Engineering Design Group for his advice and support, and for the brainstorming session he had with our team.

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</tr>
<tr>
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Scott is an Associate Professor of Computer Science at Stanford University. He co-directs the Human-Computer Interaction Group and holds the Bredt Faculty Scholar development chair. Organizations around the world use his lab’s open-source design tools and curricula; several books and popular press articles have covered his research and teaching.

<table>
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David is a Class Lecturer and Student Project Coach of Mechanical Engineering at Stanford University. His research includes Using a Simulator to Improve Driving Ability after Brain Injury, Pressure/Motion Feedback to Protect Skin of Sensorimotor Impaired Elders, Improving Stepping-Over Responses in the Elderly using Simulated Objects

We would also like to thank the following organizations which agreed to let us visit them and talk to seniors.
City of Mountain View Senior Center

- Senior.Center@mountainview.gov
- 650-903-6448
- City of Mountain View Senior Center 266 Escuela Avenue

La Comida Dining Room

- manager@LaComida.org
- 450 Bryant Street
- Palo Alto, CA 94301
- (650) 322-3742
Bibliography


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Appendix

Appendix A - Family Album testing

Interview about the family lamp

Why did this interview? After coming up with the idea of family lamp and making a functional system prototype, we decided to find out how old people feel about its function and whether it can replace the formal way of old people viewing photos. Since the device is connected with the computer and not easy to move, we took several photos and made a video of how to use the family lamp to show the elderly.

What did we ask in the interview? We interviewed four old people and gathered a great amount of useful information. In each interview, we firstly introduced our product with showing them photos. Then the video of how to use the family lamp was played to the elderly. At last, we asked them the questions listed below. 1. By what means do you usually look over photos? 2. Why/why not use these ways to view photos? 3. What do you think of our device? 4. Do you think our device can take the place of your formal way of viewing photos

What did the elderly tell us? Granny Li said she usually viewed photos in albums, which means she develops most of her photos. Her daughter bought her an ipad before, but she seldom uses it. She isn’t accustomed with ipad and thinks it difficult to operate. On the contrary, she treats albums a traditional way of viewing photos and believes it makes her more comfortable. She appreciates the album-form of our product, but doubts weather she will feel natural watching the projected photos.

Granny Huang loves the family lamp a lot and talked with us excitedly for nearly ten minutes. Similar to Granny Li, she also prefers looking over photos in albums compared with ipads or computers. And she told us that most old people would prefer albums because of reminiscence. She appreciates the simple operation of our device since she thinks powering on and operating computers is annoying. Whats more, she said that this device can not only transmit photos but also all kind of actual pictures. Referring to the electronic reading machine her granddaughter has, she believes with our device she can make a colorful book or even a electronic reading machine for her granddaughter herself. She thinks the family lamp to be a really promising product and said she would buy one first once it is put in the market.

Grandpa Shen develops most of his photos and he doesn’t store photos in the computer.

Chapter 8
But if his son has taken some photos, he will take them to Grandpa Shen's house in iPad and shows Grandpa Shen. Grandpa Shen told us that his son always used iPad to look over photos but he doesn't. After watching the video, Grandpa Shen agrees that this device, the family lamp, can take the place of traditional albums. He said he would be willing to use family lamp to replace his albums if he had one.

At last we came to Granny Hao, who is the only one in the interviewed four to look over photos in computers. She told us that she didn't have many albums at home and her children sent photos to her computer so that she could watch there. But she thinks albums to be more reliable because it's actual but computer breakdowns may damage photos in it. She is amazed at our device and believes it to be a wonderful product.

What did we learned? From the information we got from the old people, we drew several conclusions. 1. Most old people prefer using albums to look over photos because of reminiscence and accustomization. 2. The elderly love simple operation. They are unwilling to use devices with complex operating steps. So we need to make the operations of family lamp be as easy as possible, including powering on, powering off, and deleting photos and so on. 3. The family lamp caters their needs of using albums and viewing up-to-date photos from their family members. This makes us confident about the usefulness of our device. 4. Maybe this device can deliver more things than photos, just as Granny Huang has mentioned.
Appendix B - Raspberry Pi Setup

Configuration

The Raspberry Pi is overclocked to 1 GHz, and the HDMI output is set to the projector’s natural output of 1024x768 @ 60Hz. This is set in the config.txt file:

disable_overscan=1
hdmi_group=2
hdmi_mode=16
hdmi_drive=2
arm_freq=1000
core_freq=500
sdram_freq=600
over_voltage=6
gpu_mem=128

Loading on startup

The following is added to /home/pi/.profile to autoload the executable on startup, without lauching the desktop manager.

#start code
echo "Starting Album"
cd /home/pi/exec/pics/
X & sudo DISPLAY=:0 ./lamp &

Syncing with the server

This is in a shell script that is run using cron once every minute to sync the files with skydrive. The server is a laptop at 10.32.41.216 running sshd on cygwin and the skydrive application. The RSA key file is kept on the pi to connect without asking for a password.

#!/bin/sh

rsync -avz --delete -e "ssh -i /home/pi/exec/id_rsa" lampserver@10.32.41.216:/cygdrive/c/Users/lampserver/Download

Main code

Makefile: (the code is compiled on the Pi)

CC=g++
CFLAGS=-c -Wall -lwiringPi -I `pkg-config opencv --cflags --libs`
DEPS = lamp001.h

%.o: %.c $(DEPS)
$(CC) -c -o $@ $(CFLAGS)

all: lamp

lamp: main.o displayImage.o pageDetect.o fileOp.o makeTable.o global.o readAlbum.o
$(CC) main.o displayImage.o pageDetect.o fileOp.o makeTable.o global.o readAlbum.o `pkg-config opencv --cflags --libs`
main.o: main.cpp
$(CC) $(CFLAGS) main.cpp

displayImage.o: displayImage.cpp
$(CC) $(CFLAGS) displayImage.cpp

pageDetect.o: pageDetect.cpp
$(CC) $(CFLAGS) pageDetect.cpp

$(CC) $(CFLAGS) fileOp.cpp

makeTable.o: makeTable.cpp
$(CC) $(CFLAGS) makeTable.cpp

global.o: global.cpp
$(CC) $(CFLAGS) global.cpp

readAlbum.o: readAlbum.cpp
$(CC) $(CFLAGS) readAlbum.cpp

clean:
rm -rf *o hello

Main:

#include </usr/include/opencv2/highgui/highgui.hpp>
#include </usr/include/opencv2/opencv.hpp>
#include </usr/include/opencv2/imgproc/imgproc.hpp>
#include </usr/include/opencv2/core/core.hpp>
#include <dirent.h>
#include <stdio.h>
#include <iostream>
#include <fstream>
#include<sys/types.h>
#include<time.h>
#include "lamp001.h"
#include <wiringPi.h>

using namespace std;
using namespace cv;

int main()
{
    //usleep(1000000);
    //srand(time(NULL));
//clock_t oldTime, newTime;
//oldTime = clock();
//for(int i = 0; i < 20; i++)
// for(int j = 0; j < 100; j++)
// readpage[i][j] = 0;

int pageNumber = 1;
int oldPageNumber = -1;
int oldoldpagenumber = -1;
int error = 0;
int ncount = 0;

string filename;
string title;
string date;
string readornot;
string emailadd;
Mat src;
Size imageSize(320,240);
VideoCapture cap(0); // open the default camera
cap.set(CV_CAP_PROP_FRAME_WIDTH, imageSize.width);
cap.set(CV_CAP_PROP_FRAME_HEIGHT, imageSize.height);

namedWindow("show",CV_WINDOW_NORMAL);
cvSetWindowProperty("show",CV_WND_PROP_FULLSCREEN, CV_WINDOW_FULLSCREEN);
cvResizeWindow("show",1024, 768);

if(wiringPiSetup() == -1)
return 1;
pinMode(8, INPUT);

int Old_PIN8_ = -1;
_ALBUMNOW_ = 1;

readAlbum();

cout<<"preparation done!"<<endl;
//makeTable();
while(1)
{

if(cap.isOpened())
{

_PIN8_ = digitalRead(8);
cout<<"PIN8: "<<_PIN8_<<"\n";
if(Old_PIN8_ != _PIN8_)
{
    readAlbum();
    Old_PIN8_ = _PIN8_; 
    oldPageNumber = -1;
    cout<<"album changed"<<endl;
}
    cout<<"%%%"<<_ALBUM"\n";

cap >> src;
//imshow(" ", src);
waitKey(30);
pageNumber = pageDetect(src);
//cin>> pageNumber;

cout<<"############ Page Number "<< pageNumber"\n";

//newTime = clock();
//if(newTime - oldTime > 1 0000)
//{

//oldTime = newTime;
//}

if(pageNumber == -1)
nocount = nocount+1;
else
nocount = 0;

if (((pageNumber == oldPageNumber) && (oldoldpagenumber == oldPageNumber)))
{
    ;
}
else if((nocount > 5) || (pageNumber == 0))
{
    //cout << "error when reading page number..."<<endl;
    nocount = 5;
    //disp album cover
    oldPageNumber = pageNumber;
    oldoldpagenumber = oldPageNumber;
    pageNumber = 0;
    cout<<"malakabum cover"<<pageNumber"\n";
    /*
    error = fileOp(READFILE,0, filename, title, date, emailadd, readornot);
    if(error != 0 )
    {
        cout <<filename<<endl;//<<" "<<title" "<< date" "<<emailadd" " <<readornot" " "endl;
        Mat image(1024, 768, CV_8UC3);
        //Mat image;
        cout << "./"+_ALBUM="/"+filename<<"\n";
image = imread("./+_ALBUM+/"+filename, 1 );
imshow("show", image );
waitKey(30);
//readpage[_ALBUMNOW_] [pageNumber] = 1;
}
else
{
cout<<"file read error 
"
}
* */
displayImage("/home/pi/exec/logo.jpg");
}
else if(pageNumber == -1)
{
    //makeTable();
}
else
{
    oldPageNumber = pageNumber;
    oldoldpagenumber = oldPageNumber;
    cout<<"pagenorepeat"<<getPageNumber<<"\n";
    error = fileOp(READFILE,pageNumber-1, filename, title, date, emailadd, readornot);
    if(error != 0)
    {
        cout <<filename<<endl;" " <<title" " << date" " <<emailadd" " <<readornot" " <<endl;
        displayImage("./+_ALBUM+/"+filename);
        //readpage[_ALBUMNOW_] [pageNumber] = 1;
    }
    else
    {
        cout<<"file read error 
";
        displayImage("/home/pi/exec/black.jpg");
    }
}
else
{
cout<<"camera not opened"<<endl;
}
return 0;
}

Global:

#include"lamp001.h"
#include<iostream>
#include </usr/include/opencv2/highgui/highgui.hpp>
#include </usr/include/opencv2/opencv.hpp>
#include </usr/include/opencv2/imgproc/imgproc.hpp>
```cpp
#include </usr/include/opencv2/core/core.hpp>
std::string _ALBUM; // = "photos02";
cv::Mat _IMG_;  
int _PIN8_;  
int _ALBUMNOW_;  
int old_page;

lamp.h

#ifndef LAMP001_H_
#define LAMP001_H_

#include </usr/include/opencv2/highgui/highgui.hpp>
#include </usr/include/opencv2/opencv.hpp>
#include </usr/include/opencv2/imgproc/imgproc.hpp>
#include </usr/include/opencv2/core/core.hpp>
#include <string>
#include <iostream>
#define _REFRESH_ 300000
#define READFILE 1
#define UPDATEFILE 2
#define MAXIMG 100 //max images in a album
#define LINESPACE 2
#define UPSPACE 100
#define LEFTSPACE 200
#define _ALBUM_NAME_ "_ALBUM_.txt"

using namespace std;

extern string _ALBUM;
extern cv::Mat _IMG_;  
extern int _PIN8_;  
extern int _ALBUMNOW_;  
extern int old_page;
//extern int readpage[20][100];

int numberRecog();
int fileOp(int operation, int page, string &name, string &title, string &date, string &email,);
void displayImage(std::string imageName);
int cameraRead();
cv::Mat takePhoto();
int pageDetect(cv::Mat src_from);
int makeTable();
int updateFile();
```
int readAlbum();

#endif /* LAMP001_H */

File Operations

/*
 * fileOp.cpp
 *
 * Created on: Apr 24, 2013
 * Author: xuesen
 */
#include "lamp001.h"
#include <fstream>
#include <iostream>
#include <string>
#include <sys/types.h>
#include <dirent.h>
#include </usr/include/opencv2/highgui/highgui.hpp>
#include </usr/include/opencv2/opencv.hpp>
#include </usr/include/opencv2/imgproc/imgproc.hpp>
#include </usr/include/opencv2/core/core.hpp>

using namespace std;

int fileOp(int operation, int page, string &_name, string &_title, string &_date, string &_email, {
    // read file
    int i = 0;
    string filename[MAXIMG];
    string title[MAXIMG];
    string date[MAXIMG];
    string readornot[MAXIMG];
    string emailadd[MAXIMG];
    string albumName = "./"+_ALBUM+"/"+_ALBUM+".txt";
    cout<<"albumName: "<<albumName<<endl;
    ifstream files;
    files.open(albumName.c_str(), ifstream::in);
    if(files.is_open())
    {
        while(!files.eof())
        {
            //cout<<"I is: "<<i<<endl;
            getline(files, filename[i],\t');
            getline(files, title[i],\t');
            getline(files, date[i],\t');
            getline(files, emailadd[i],\t');
            getline(files, readornot[i],\n');
++i;
}
files.close();
}
else
{
    cout<<"files not opened";
}

if(operation == READFILE)
{
    if (page > (i-2))
    {
        cout<<"page number exceed range"<<endl;
        //_name = "/home/pi/exec/black.jpg"
        return 0;
    }

    _name = filename[page];
    _title = title[page];
    _date = date[page];
    _email = emailadd[page];
    _read = readornot[page];

    return 1;
}

return 0;
}

Display Image

#include </usr/include/opencv2/highgui/highgui.hpp>
#include </usr/include/opencv2/opencv.hpp>
#include </usr/include/opencv2/imgproc/imgproc.hpp>
#include </usr/include/opencv2/core/core.hpp>
#include <stdio.h>
#include <iostream>
#include <fstream>
#include "lamp001.h"

using namespace std;
using namespace cv;

void displayImage(string imageName)
{
    cout<<imageName<<endl;
    Mat image(1024, 768, CV_8UC3);
    //Mat image;
    image = imread( imageName, 1 );
    imshow("show", image );
waitKey(30);
return;
}

Read Album List

#include "lamp001.h"
#include <fstream>
#include <iostream>
#include <string>
#include<sys/types.h>
#include <dirent.h>
#include </usr/include/opencv2/highgui/highgui.hpp>
#include </usr/include/opencv2/opencv.hpp>
#include </usr/include/opencv2/imgproc/imgproc.hpp>
#include </usr/include/opencv2/core/core.hpp>

int readAlbum()
{
int i = 0;
string albumName[MAXIMG];
string albumTitle[MAXIMG];
   ifstream files;
   files.open(_ALBUM_NAME_,ifstream::in);
   if(files.is_open())
   {
      while(!files.eof())
      {
        ++i;
        getline(files, albumName[i],'	');
        getline(files, albumTitle[i],'
');
      }
      files.close();
    }
    else
    {
      cout<<"files not opened";
      return 0;
    }

    ++_ALBUMNOW_;
    if (_ALBUMNOW_ > (i-1))
    {
        _ALBUMNOW_ = 1;
    }
       _ALBUM = albumName[_ALBUMNOW_];
       //cout<< _ALBUM;
       return 1;
}
Make Contents Page

```cpp
#include "lamp001.h"
#include <iostream>
#include <fstream>
#include <usr/include/opencv2/highgui/highgui.hpp>
#include <usr/include/opencv2/opencv.hpp>
#include <usr/include/opencv2/imgproc/imgproc.hpp>
#include <usr/include/opencv2/core/core.hpp>
#include <string>
using namespace std;
using namespace cv;

int makeTable()
{
    /*
    int fontFace = FONT_HERSHEY_DUPLEX;
    double fontScale = 1;
    int thickness = 2;
    int baseline=0;
    Mat img(768, 1024, CV_8UC3, Scalar(210,250,225));
    Size textSize;
    
    int i = 0;
    int j = 0;
    string filename[MAXIMG];
    string title[MAXIMG];
    string date[MAXIMG];
    string readornot[MAXIMG];
    string emailadd[MAXIMG];

    ifstream files;
    files.open(_ALBUM.c_str(),ifstream::in);
    if(files.is_open())
    {
        while(!files.eof())
        {
            ++i;
            //cout<<"I is:"<<i<<endl;
            getline(files, filename[i],'	');
            getline(files, title[i],'	');
            getline(files, date[i],'	');
            getline(files, emailadd[i],'	');
            getline(files, readornot[i],'
');
        }
    }
    */
```
files.close();
}
else
{
cout<<"files not opened";
}

for(j = 1; j < i; j++)
{
textSize = getTextSize(title[j], fontFace, fontScale, thickness, &baseline);
Point textOrg((img.cols - textSize.width)/2, UPSPACE+textSize.height*LINESPACE*j);
Point NumOrg(LEFTSPACE, UPSPACE+textSize.height*LINESPACE*j);
Point NewOrg((img.cols + textSize.width)/2, UPSPACE+textSize.height*LINESPACE*j);

stringstream ss;
ss << j;
putText(img, ss.str(), NumOrg, fontFace, fontScale, Scalar(0,0,0), thickness, 16);
putText(img, title[j], textOrg, fontFace, fontScale, Scalar(0,0,0), thickness, 16);
if(readpage[_ALBUMNOW_][j] == 0)
{
putText(img,"New!", NewOrg, fontFace, 0.6, Scalar(0,0,150), thickness, 16);
}
}

//_IMG_ = img;
//imwrite("./image/_CONTENT_.jpg",img);
imshow("show", img);
* */
return 0;

---

Read Page Number Pattern

#include <iostream>
#include </usr/include/opencv2/highgui/highgui.hpp>
#include </usr/include/opencv2/opencv.hpp>
#include </usr/include/opencv2/imgproc/imgproc.hpp>
#include </usr/include/opencv2/core/core.hpp>
#include <math.h>
#include <stdio.h>
#include "lamp001.h"

using namespace std;
using namespace cv;

//Controlled parameter
#define BLUR_SIZE 3
#define NUM_BLOCK 7
#define NUM_GROUP 2
#define H_INIT_POS_X 144
#define H_INIT_POS_Y 107
#define H_INCRE_X (277-144)/6
#define H_INCRE_Y (69-107)/6
#define H_REFER_X_b 118
#define H_REFER_Y_b 114
#define H_REFER_X_w 215
#define H_REFER_Y_w 88
#define INIT_POS_X 150
#define INIT_POS_Y 122
#define INCRE_X (277-150)/6
#define INCRE_Y (88-122)/6
#define REFER_X_b 127
#define REFER_Y_b 129
#define REFER_X_w 218
#define REFER_Y_w 102

//define TRED_B_W 65  //the threshold between dark blak and white

int pageDetect(cv::Mat src) {
    int p_num; //page number
    int b_num[NUM_BLOCK]; //block number;
    int px, py; // pixel position
    int thred_color;
    int R,G,B;
    int g1_p_num, g2_p_num;
    double thred_red;

    GaussianBlur(src, src, Size(BLUR_SIZE,BLUR_SIZE), 2, 2);
    px = REFER_X_w;
    py = REFER_Y_w;

    //detect the calibration block
    R=src.at<cv::Vec3b>(py,px)[2];
    G=src.at<cv::Vec3b>(py,px)[1];
    B=src.at<cv::Vec3b>(py,px)[0];
    thred_color=R+G+B;
    thred_red=R-G;
    if (thred_red<0)
        thred_red=0;
    thred_red=thred_red;
}
px = REFER_X_b;
y = REFER_Y_b;

//detect the calibration block
R = src.at<cv::Vec3b>(py, px)[2];
G = src.at<cv::Vec3b>(py, px)[1];
B = src.at<cv::Vec3b>(py, px)[0];
thred_color = (thred_color + R + G + B) / 2;

px = INIT_POS_X;
y = INIT_POS_Y;

for (int i = 0; i < NUM_BLOCK; i++) {
    R = src.at<cv::Vec3b>(py, px)[2];
    G = src.at<cv::Vec3b>(py, px)[1];
    B = src.at<cv::Vec3b>(py, px)[0];

    //Judge the color
    if (R - G >= thred_red + 8 && R - B >= thred_red + 8) {
        b_num[i] = 2; //red
    }
    //else if (R > TRED_B_W && G > TRED_B_W && B > TRED_B_W) {
    else if ((R + B + G) < thred_color) {
        b_num[i] = 1; //black
    } else {
        b_num[i] = 0; //white
    }

    px = px + INCRE_X + i * 0;
    py = py + INCRE_Y - 0 * i;
    cout << b_num[i] << " ";
}

g1_p_num = b_num[0] * 9 + b_num[1] * 3 + b_num[2] * 1;

//group 3's colors have different indication
//white is still 1
//red and black is now 2 & 0 instead of 0 & 2
//using the mapping: (A-1)*(-1)+1

//g3_p_num = ((b_num[2] - 1) * (-1) + 1) * 9 + ((b_num[1] - 1) * (-1) + 1) * 3 + ((b_num[0] - 1) * (-1) + 1) * 1;
//cout << g1_p_num << g2_p_num << g3_p_num;

//self correction, if not consistent, return -1
    p_num = g1_p_num;
}
px = H_REFER_X_w;
py = H_REFER_Y_w;

//detect the calibration block
R = src.at<cv::Vec3b>(py, px)[2];
G = src.at<cv::Vec3b>(py, px)[1];
B = src.at<cv::Vec3b>(py, px)[0];
thread_color = R + G + B;
thread_red = R - G;
if (thread_red < 0)
    thread_red = 0;
thread_red = thread_red;

px = H_REFER_X_b;
py = H_REFER_Y_b;

//detect the calibration block
R = src.at<cv::Vec3b>(py, px)[2];
G = src.at<cv::Vec3b>(py, px)[1];
B = src.at<cv::Vec3b>(py, px)[0];
thread_color = (thread_color + R + G + B) / 2;

px = H_INIT_POS_X;
py = H_INIT_POS_Y;

for (int i = 0; i < NUM_BLOCK; i++){
    R = src.at<cv::Vec3b>(py, px)[2];
    G = src.at<cv::Vec3b>(py, px)[1];
    B = src.at<cv::Vec3b>(py, px)[0];

    // Judge the color
    if (R - G >= thread_red + 8 && R - B >= thread_red + 8) {
        b_num[i] = 2;  // red
    }
    else if (R > TRED_B_W && G > TRED_B_W && B > TRED_B_W) {
        else if ((R + B + G) < thread_color) {
            b_num[i] = 1;  // black
        }
    }

    else {
        b_num[i] = 0;  // white
    }
}

px = px + H_INCRE_X + i * 0;
py = py + H_INCRE_Y - 0 * i;
cout << b_num[i] << " ";}
```cpp
}  
g1_p_num=b_num[0]*9 + b_num[1]*3 + b_num[2]*1;
g2_p_num=b_num[6]*9 + b_num[5]*3 + b_num[4]*1;

//group 3 's colors have different indication  
//white is still 1
//red and black is now 2 & 0 instead of 0 & 2
//using the mapping: (A-1)*(-1)+1

//g3_p_num=((b_num[2]-1)*(-1)+1)*9 + ((b_num[1]-1)*(-1)+1)*3 + ((b_num[0]-1)*(-1)+1)*1;
//cout<<g1_p_num<<g2_p_num<<g3_p_num;

//self correction, if not consistent, return -1
p_num=g1_p_num;
}

p_num=-1; //not consistent
//p_num=g1_p_num;
if (p_num==0){  
p_num=-1;
}
}

cout<<"The page number is: "<<p_num<<"\n";
return p_num;
}

Appendix C - Server Setup

The server is a Windows 7 computer with the skydrive application installed and syncing the folder. The computer also runs Cygwin with sshd to act as an ssh server for the rsync connection from the Pi.

Folder structure

The main directory has a file _ALBUM.txt which contains the folder names and titles of all the albums. Each album in _ALBUM.txt has a child folder.

- child1: Skydrive album1
- child2: Sky2
- child3: Sky3
```
child4 Sky4
child2 Email Album 1

child1.txt

Image328.jpg Wed Skydrive 0
Image265.jpg Wed Skydrive 0
Image966.jpg browse Wed Skydrive 0
Image580.jpg haapp Wed Skydrive 0
Image820.jpg geoge Wed Skydrive 0
Image805.jpg Wed Skydrive 0
Image474.jpg caribou Wed Skydrive 0
Image996.jpg sweet Wed Skydrive 0
Image283.jpg hu Wed Skydrive 0
Image727.jpg smile2 Wed Skydrive 0
Image371.jpg smile Wed Skydrive 0
Image400.jpg happy Wed Skydrive 0
Image647.jpg cheers Wed Skydrive 0
Image619.jpg heyyy Wed Skydrive 0
Image586.jpg hey Wed Skydrive 0
Image804.jpg inno Wed Skydrive 0
Image600.jpg fridge Wed Skydrive 0

Image265.jpg.txt: file for each image

Image265.jpg Wed Skydrive 0

Email input

We use the fetchmail daemon, with procmail and munpack to download emails and save the image attachments. Fetchmail has been set up to authenticate with the windows live server automatically.

/.fetchmailrc

set daemon 300
poll pop3.live.com
protocol pop3
service 995
user 'me310msra@outlook.com'
password 'R4spberry'
keep
options ssl
sslcertpath /cygdrive/c/Users/lampserver/Downloads/Skydrive/certs/
smtphost localhost/50025
mda '/usr/bin/procmail -d %T'
./procmailrc

:0c
* "To: me310msra@outlook.com
| /cygdrive/c/Users/lampserver/Downloads/Skydrive/process
#list of approved email ids here
# *From: blah

Email code: process

#Author: Mishel Johns

#input piped data
DATA=$(</dev/stdin)

#unpack attachments
cd /cygdrive/c/Users/lampserver/Downloads/Skydrive/tmp
echo "$DATA" > mail.txt
../munpack -q mail.txt
cd..

#check if munpack worked
if [[ $? == 0 ]]
then
echo "munpack sucessful"
fi

#check for no of files in tmp folder
cd tmp/
IMGS='ls *.jpg *.png *.bmp *.gif 2>/dev/null'
NUMNEWIMGS='echo "$IMGS" |wc -w'
cd..

#check for no of files in pics folder
#decide what folder to put the photos into (default folder, if full then next folder)
cd children/
LISTALBS='find -maxdepth 1 -mindepth 1 -type d'
for FOLDER in $LISTALBS
    do
cd $FOLDER
    NUMIMGS='ls *.jpg *.png *.bmp *.gif 2>/dev/null |wc -w'
cd..
    if test `expr "$NUMIMGS" + "$NUMNEWIMGS"` -gt 20
    then
echo "$FOLDER full, moving to next one."
    else
break
    fi
done
cd..
echo "Saving in folder $FOLDER"

# if necessary add line to album.txt
cd children/
if test 'cat _ALBUM_.txt | grep $FOLDER | wc -w' -eq 0
then
  echo "Creating new album"
  echo -e $FOLDER"\tEmail Album" >> _ALBUM_.txt
fi

cd ..

# getting details from the email
SUBJECT='echo "$DATA" | (formail -z -c -uSubject: -xSubject: | head -c -1 )'
FROMADDR='echo "$DATA" | (formail -z -c -uFrom: -xFrom: | head -c -1 )'
SENTDATE='echo "$DATA" | (formail -z -c -uDate: -xDate: | head -c -1 )'

# resize photos, output to the right folder
cd tmp/
COUNT=1
for FILE in $IMGS
do
  FILENAME="../children/$FOLDER/\'expr "$NUMIMGS" + "$COUNT"\'.jpg
  convert -resize 1024x768 $FILE -background black -gravity center -extent 1024x768 $FILENAME
  # convert $FILE -undercolor '#00000080' -fill white -pointsize 50 -gravity south -annotate +0+0 "$SUBJECT"
  # fix word wrapping - use caption
  if [[ $? == 0 ]]
  then
    echo "Successfully saved image $((COUNT++)) in ${FILENAME:14:30}"
  else
    echo "Error in saving image $((COUNT++)) in ${FILENAME:14:30}"
  fi

# for each file, add a line in the albumx.txt
echo -e "$FILENAME:21:30\t$SUBJECT\t$SENTDATE\t$FROMADDR\t1" > ../children/${FILENAME:14:30}.txt
done

# delete everything in tmp
rm *

cd ..

# adding caption

else
  echo "munpack error"
fi
Joining text files

This gets the text description files for each image in an album and joins it together to get the description file for the album.

```bash
ntls.sh

update()
{
    for album in * #Skydrive/children/* #backup/*
    do

    if test -d "album"
    then

        echo $album
        albumname=$(basename $album)
        newlog=`ls -t $album/*.txt 2>/dev/null` #
        newlogloc="/tmp/"albumname"log.new"

        echo $newlog>$newlogloc
        oldlogloc="/tmp/"albumname"log.old"

        if test -e $oldlogloc
        then
        if (diff $newlogloc $oldlogloc) then
        continue
        fi
        fi
        echo "updated"

        albumtxt="$album"/(basename $album).txt";
        rm -f $albumtxt
        for phototxt in $newlog
        do
        # echo "txt"$phototxt
        photoname=${phototxt:0:'expr index "$phototxt" '.''}

        photoname+=".jpg"
        echo $photoname
        if test -e $photoname
        then

            cat $phototxt >>$albumtxt
            # echo "" >> $albumtxt
            # echo "!! "$phototxt
```
Appendix D - Windows Phone app

The phone app works on the files in the Skydrive folder using the Windows Live SDK, and creates the description text files that can be joined by the server.

App.xaml.cs

using System;
using System.Collections.Generic;
using System.Linq;
using System.Net;
using System.Windows;
using System.Windows.Controls;
using System.Windows.Documents;
using System.Windows.Input;
using System.Windows.Media;
using System.Windows.Shapes;
using Microsoft.Phone.Controls;
using Microsoft.Phone.Shell;
using Microsoft.Live;

namespace FamilyAlbum
{
    public partial class App : Application
    {
        private static LiveServicesViewModel viewModel = null;
    }
}
/// <summary>
/// A static ViewModel used by the views to bind against.
/// </summary>
/// <returns>The MainViewModel object.</returns>
public static LiveServicesViewModel ViewModel
{
    get
    {
        // Delay creation of the view model until necessary
        if (viewModel == null)
            viewModel = new LiveServicesViewModel();

        return viewModel;
    }
}

private static LiveConnectSession session = null;

/// <summary>
/// A static ViewModel used by the views to bind against.
/// </summary>
/// <returns>The MainViewModel object.</returns>
public static LiveConnectSession Session
{
    get
    {
        return session;
    }
    set
    {
        session = value;
    }
}

/// <summary>
/// Provides easy access to the root frame of the Phone Application.
/// </summary>
/// <returns>The root frame of the Phone Application.</returns>
public PhoneApplicationFrame RootFrame { get; private set; }

/// <summary>
/// Constructor for the Application object.
/// </summary>
public App()
{
    // Global handler for uncaught exceptions.
    UnhandledException += Application_UnhandledException;

    // Standard Silverlight initialization
    InitializeComponent();
// Phone-specific initialization
InitializePhoneApplication();

// Show graphics profiling information while debugging.
if (System.Diagnostics.Debugger.IsAttached)
{
    // Display the current frame rate counters

    // Show the areas of the app that are being redrawn in each frame.

    // Enable non-production analysis visualization mode,
    // which shows areas of a page that are handed off to GPU with a colored overlay.

    // Disable the application idle detection by setting the UserIdleDetectionMode property
    // application's PhoneApplicationService object to Disabled.
    // Caution:- Use this under debug mode only. Application that disables user idle
    // and consume battery power when the user is not using the phone.
    PhoneApplicationService.Current.UserIdleDetectionMode = IdleDetectionMode.Disabled;
}

// Code to execute when the application is launching (eg, from Start)
// This code will not execute when the application is reactivated
private void Application_Launching(object sender, LaunchingEventArgs e)
{
}

// Code to execute when the application is activated (brought to foreground)
// This code will not execute when the application is first launched
private void Application_Activated(object sender, ActivatedEventArgs e)
{
    // Ensure that application state is restored appropriately
    if (!App.ViewModel.IsDataLoaded)
    {
        App.ViewModel.LoadData();
    }
}

// Code to execute when the application is deactivated (sent to background)
// This code will not execute when the application is closing
private void Application_Deactivated(object sender, DeactivatedEventArgs e)
{
}

// Code to execute when the application is closing (eg, user hit Back)
// This code will not execute when the application is deactivated
private void Application_Closing(object sender, ClosingEventArgs e)
{
    // Ensure that required application state is persisted here.
}

// Code to execute if a navigation fails
private void RootFrame_NavigationFailed(object sender, NavigationFailedEventArgs e)
{
    if (System.Diagnostics.Debugger.IsAttached)
    {
        // A navigation has failed; break into the debugger
    }
}

// Code to execute on Unhandled Exceptions
private void Application_UnhandledException(object sender, ApplicationUnhandledExceptionEventArgs e)
{
    if (System.Diagnostics.Debugger.IsAttached)
    {
        // An unhandled exception has occurred; break into the debugger
    }
}

#region Phone application initialization

// Avoid double-initialization
private bool phoneApplicationInitialized = false;

// Do not add any additional code to this method
private void InitializePhoneApplication()
{
    if (phoneApplicationInitialized)
        return;

    // Create the frame but don’t set it as RootVisual yet; this allows the splash
    // screen to remain active until the application is ready to render.
    RootFrame = new PhoneApplicationFrame();
    RootFrame.Navigated += CompleteInitializePhoneApplication;

    // Handle navigation failures
    RootFrame.NavigationFailed += RootFrame_NavigationFailed;

    // Ensure we don’t initialize again
    phoneApplicationInitialized = true;
}

// Do not add any additional code to this method
private void CompleteInitializePhoneApplication(object sender, NavigationEventArgs e)
public partial class MainPage : PhoneApplicationPage
{
    // Constructor
    public MainPage()
    {
        InitializeComponent();
        AppBarButtonCaptureScene();
        // Set the data context of the listbox control to the sample data
        AlbumListBox.SelectedItem = null;
        DataContext = App.ViewModel;
    }

    // private bool phototaken = false;
    // Constructor
    public MainPage()
    {
        InitializeComponent();
        AppBarButtonCaptureScene();
        // Set the data context of the listbox control to the sample data
        AlbumListBox.SelectedItem = null;
        DataContext = App.ViewModel;
    }
}
Loaded += MainPage_Loaded;
}

private void MainPage_Loaded(object sender, RoutedEventArgs e)
{
    Loaded -= MainPage_Loaded;
}

private void AlbumListBox_SelectionChanged(object sender, SelectionChangedEventArgs e)
{
    if (App.ViewModel.SelectedAlbum != null)
    {
        App.ViewModel.FolderId = App.ViewModel.SelectedAlbum.ID;
    }
}

private void captureAppBarButton_Click(object sender, EventArgs e)
{
    App.ViewModel.phototaken = true;
    App.ViewModel.TakeNewPhoto();
    reverseStoryboard.Begin();
    AppBarButtonCaptureScene();
}

{
    App.ViewModel.SelectedAlbum = null;
}

private void Panorama_SelectionChanged(object sender, SelectionChangedEventArgs e)
{
    if (e.AddedItems.Count < 1) return;
    if (!(e.AddedItems[0] is PanoramaItem)) return;
    PanoramaItem selectedItem = (PanoramaItem)e.AddedItems[0];
    string strTag = (string)selectedItem.Tag;
    if (strTag.Equals("new"))
        AppBarButtonCaptureScene();
    else if (strTag.Equals("album"))
    {
        App.ViewModel.GetAlubmData();
        //App.ViewModel.GetForlderID();
        AppBarButtonBrowseScene();
    }
void AppBarButtonCaptureScene()
{
    // Creates an application bar and then sets visibility and menu properties.
    ApplicationBar = new ApplicationBar();
    ApplicationBar.Opacity = 0.6;

    // This code creates the application bar icon buttons.
    send = new ApplicationBarIconButton(new Uri("/icons/appbar.feature.email.rest.png", UriKind.Relative));
    edit = new ApplicationBarIconButton(new Uri("/icons/edit.png", UriKind.Relative));
    capture = new ApplicationBarIconButton(new Uri("/icons/appbar.feature.camera.rest.png", UriKind.Relative));
    upload = new ApplicationBarIconButton(new Uri("/icons/appbar.upload.rest.png", UriKind.Relative));

    // Labels for the application bar buttons.
    send.Text = "send";
    edit.Text = "edit";
    capture.Text = "capture";
    upload.Text = "upload";
    if (!App.ViewModel.phototaken)
    {
        send.IsEnabled = false;
        edit.IsEnabled = false;
    }

    // This code will create event handlers for buttons.
    send.Click += new EventHandler(sendAppBarButton_Click);
    edit.Click += new EventHandler(editAppBarButton_Click);
    capture.Click += new EventHandler(captureAppBarButton_Click);
    upload.Click += new EventHandler(uploadAppBarButton_Click);

    // This code adds buttons to application bar.
    ApplicationBar.Buttons.Add(send);
    ApplicationBar.Buttons.Add(edit);
    ApplicationBar.Buttons.Add(capture);
    ApplicationBar.Buttons.Add(upload);
}

void AppBarButtonBrowseScene()
{
    // Creates an application bar and then sets visibility and menu properties.
    ApplicationBar = new ApplicationBar();
    ApplicationBar.Opacity = 0.6;

    // This code creates the application bar icon buttons.
}
manage = new ApplicationBarIconButton(new Uri("/icons/folder.png", UriKind.Relative));
setting = new ApplicationBarIconButton(new Uri("/icons/appbar.feature.settings.rest.png", UriKind.Relative));

//Labels for the application bar buttons.
manage.Text = "manage";
setting.Text = "setting";

//This code will create event handlers for buttons.
manage.Click += new EventHandler(manageAppBarButton_Click);
setting.Click += new EventHandler(settingAppBarButton_Click);

//This code adds buttons to application bar.
ApplicationBar.Buttons.Add(manage);
ApplicationBar.Buttons.Add(setting);

private void sendAppBarButton_Click(object sender, EventArgs e)
{
    PhotoText.IsEnabled = false;
    App.ViewModel.SendPhoto(PhotoText.Text, PhotoDes.Text);

    myStoryboard.Begin();
    App.ViewModel.phototaken = false;
    AppBarButtonCaptureScene();
    PhotoText.Visibility = Visibility.Collapsed;
    PhotoText.IsEnabled = true;
    PhotoDes.Visibility = Visibility.Collapsed;
    PhotoText.Text = "";
    PhotoDes.Text = "";
}

private void editAppBarButton_Click(object sender, EventArgs e)
{
    //PhotoText.Visibility = Visibility.Visible;
    PhotoDes.Visibility = Visibility.Visible;
}

private void manageAppBarButton_Click(object sender, EventArgs e)
{
    Popup popup = new Popup();
    popup.Height = 300;
    popup.Width = 400;
    popup.VerticalOffset = 100;
    PopoutUserControl control = new PopoutUserControl();
    popup.Child = control;
    popup.IsOpen = true;
control.btnOK.Click += (s, args) =>
{
    popup.IsOpen = false;
    App.ViewModel.CreateFolder(control.tbx.Text);
};

control.btnCancel.Click += (s, args) =>
{
    popup.IsOpen = false;
};

private void settingAppBarButton_Click(object sender, EventArgs e)
{
}

private void uploadAppBarButton_Click(object sender, EventArgs e)
{
    App.ViewModel.phototaken = true;
    App.ViewModel.Upload();
    reverseStoryboard.Begin();
    AppBarButtonCaptureScene();
}
public ApplicationBarIconButton send { get; set; }

public ApplicationBarIconButton edit { get; set; }

public ApplicationBarIconButton capture { get; set; }

public ApplicationBarIconButton upload { get; set; }

public ApplicationBarIconButton manage { get; set; }

public ApplicationBarIconButton setting { get; set; }

protected override void OnBackKeyPress(System.ComponentModel.CancelEventArgs e)
{

    while (NavigationService.BackStack.Any())
    {
        NavigationService.RemoveBackEntry();
        this.IsHitTestVisible = this.IsEnabled = false;
    }

}
if (this.ApplicationBar != null)
    foreach (var item in this.ApplicationBar.Buttons.OfType<ApplicationBarIconButton>())
        item.IsEnabled = false;

private void AlbumDelete(object sender, RoutedEventArgs e)
{
    SkydriveAlbum selectalbum = (SkydriveAlbum)((MenuItem)sender).DataContext;
    MessageBox.Show(selectalbum.Title);
    App.ViewModel.DeleteAlbum(selectalbum);
}

Loadingpage.xaml.cs

using System;
using System.Collections.Generic;
using System.Linq;
using System.Net;
using System.Windows;
using System.Windows.Controls;
using Microsoft.Phone.Controls;
using Microsoft.Phone.Shell;
using System.Windows.Media;
using System.Windows.Shapes;
using Microsoft.Live;
using Microsoft.Live.Controls;

namespace FamilyAlbum
{
    public partial class Loadingpage : PhoneApplicationPage
    {
        public Loadingpage()
        {
            InitializeComponent();
        }

        private void SignInButton_SessionChanged(object sender, LiveConnectSessionChangedEventArgs e)
        {
            if (e.Session != null && e.Status == LiveConnectSessionStatus.Connected)
SkydriveAlbum.cs

using System;
using System.Net;
using System.Windows;
using System.Windows.Controls;
using System.Windows.Documents;
using System.Windows.Ink;
using System.Windows.Input;
using System.Windows.Media;
using System.Windows.Shapes;
using System.ComponentModel;
using System.Collections.ObjectModel;

namespace FamilyAlbum
{
    public class SkydriveAlbum: INotifyPropertyChanged
    {
        public SkydriveAlbum()
        {
            this.Photos = new ObservableCollection<SkydrivePhoto>();
        }

        /// <summary>
        /// A collection for ItemViewModel objects.
        /// </summary>
public ObservableCollection<SkydrivePhoto> Photos { get; private set; }

private string _id = string.Empty;
public string ID
{
    get
    {
        return this._id;
    }

    set
    {
        if (this._id != value)
        {
            this._id = value;
            this.NotifyPropertyChanged("ID");
        }
    }
}

private string _title = string.Empty;
public string Title
{
    get
    {
        return this._title;
    }

    set
    {
        if (this._title != value)
        {
            this._title = value;
            this.NotifyPropertyChanged("Title");
        }
    }
}

private string _albumPicture = string.Empty;
public string AlbumPicture
{
    get
    {
        return this._albumPicture;
    }

    set
    {
        if (this._albumPicture != value)
        {
        
```
this._albumPicture = value;
this.NotifyPropertyChanged("AlbumPicture");
}
}
}

private string _description = string.Empty;
public string Description
{
    get
    {
        return this._description;
    }
    set
    {
        if (this._description != value)
        {
            this._description = value;
            this.NotifyPropertyChanged("Description");
        }
    }
}

public event PropertyChangedEventHandler PropertyChanged;
private void NotifyPropertyChanged(String propertyName)
{
    PropertyChangedEventHandler handler = PropertyChanged;
    if (null != handler)
    {
        handler(this, new PropertyChangedEventArgs(propertyName));
    }
}

SkydrivePhoto.cs

using System;
using System.ComponentModel;
using System.Diagnostics;
using System.Net;
using System.Windows;
using System.Windows.Controls;
using System.Windows.Documents;
using System.Windows.Ink;
using System.Windows.Input;
using System.Windows.Media;
using System.Windows.Shapes;

namespace FamilyAlbum
{
    public class SkydrivePhoto : INotifyPropertyChanged
    {
        private string _id = string.Empty;
        public string ID
        {
            get
            {
                return this._id;
            }
            set
            {
                if (this._id != value)
                {
                    this._id = value;
                    this.NotifyPropertyChanged("ID");
                }
            }
        }

        private string _description = string.Empty;
        public string Description
        {
            get
            {
                return this._description;
            }
            set
            {
                if (this._description != value)
                {
                    this._description = value;
                    this.NotifyPropertyChanged("Description");
                }
            }
        }

        private string _photoUrl;
        public string PhotoUrl
        {
private string _photoUrl;
public string PhotoUrl
{
    get
    {
        return _photoUrl;
    }
    set
    {
        if (value != _photoUrl)
        {
            _photoUrl = value;
            NotifyPropertyChanged("PhotoUrl");
        }
    }
}

private string _subtitle;
public string Subtitle
{
    get
    {
        return _subtitle;
    }
    set
    {
        if (value != _subtitle)
        {
            _subtitle = value;
            NotifyPropertyChanged("Subtitle");
        }
    }
}

private string _title;
public string Title
{
    get
    {
        return _title;
    }
    set
    {
        if (value != _title)
        {
            _title = value;
            NotifyPropertyChanged("Title");
        }
    }
}
public event PropertyChangedEventHandler PropertyChanged;  
private void NotifyPropertyChanged(String propertyName)  
{  
    PropertyChangedEventHandler handler = PropertyChanged;  
    if (null != handler)  
    {  
        handler(this, new PropertyChangedEventArgs(propertyName));  
    }  
}  

AlbumDetailPage.xaml.cs  

using System;  
using System.Collections.Generic;  
using System.Linq;  
using System.Net;  
using System.Windows;  
using System.Windows.Controls;  
using System.Windows.Documents;  
using System.Windows.Input;  
using System.Windows.Media;  
using System.Windows.Shapes;  
using Microsoft.Phone.Controls;  
using Microsoft.Phone.Shell;  
using System.ComponentModel;  

namespace FamilyAlbum  
{
    public partial class AlbumDetailPage : PhoneApplicationPage  
    {
        public AlbumDetailPage()  
        {
            InitializeComponent();  
            foreach (var talbum in App.ViewModel.Albums)  
            {
                ApplicationBarMenuItem newmenu = new ApplicationBarMenuItem();  
                newmenu.Text = talbum.Title;  
            }  
        }  
    }  
}
newmenu.Click += new EventHandler(MovePhoto);
ApplicationBar.MenuItems.Add(newmenu);

}

private void MovePhoto(object sender, EventArgs e)
{
    if (App.ViewModel.SelectedPhoto == null)
    return;
    ApplicationBarMenuItem menuItem = sender as ApplicationBarMenuItem;
    foreach (var talbum in App.ViewModel.Albums)
    {
        if (menuItem.Text == talbum.Title)
        {
            App.ViewModel.MovePhoto(talbum.ID);
    break;
        }
    }
}

private void PhoneApplicationPage_Loaded(object sender, RoutedEventArgs e)
{
    this.DataContext = App.ViewModel;
    App.ViewModel.DownloadPictures(App.ViewModel.SelectedAlbum);
}

private void uploadIcon_Click(object sender, System.EventArgs e)
{
    App.ViewModel.Upload();
}

private void downloadIcon_Click(object sender, System.EventArgs e)
{
    //App.ViewModel.Download();
    App.ViewModel.Delete();
}
using System;
using System.ComponentModel;
using System.Collections.Generic;
using System.Diagnostics;
using System.Text;
using System.Windows;
using System.Windows.Controls;
using System.Windows.Data;
using System.Windows.Documents;
using System.Windows.Input;
using System.Windows.Media;
using System.Windows.Shapes;
using System.Collections.ObjectModel;
using Microsoft.Live;
using Microsoft.Phone.Tasks;
using System.Threading;
using Microsoft.Xna.Framework.Media;
using System.IO;
using System.IO.IsolatedStorage;

namespace FamilyAlbum
{
    public class LiveServicesViewModel : INotifyPropertyChanged
    {
        #region Constructor

        public LiveServicesViewModel()
        {
            this.Albums = new ObservableCollection<SkydriveAlbum>();
        }

        #endregion

        #region Properties

        public ObservableCollection<SkydriveAlbum> Albums { get; private set; }

        private string _profileImage;
        private string _fullName;
        /// <summary>
        /// Sample ViewModel property; this property is used in the view to display its value using
        /// </summary>
        /// <returns></returns>
        /// <returns>
        public string ProfileImage
private SkydriveAlbum _selectedAlbum;
/// <summary>
/// Sample ViewModel property; this property is used in the view to display its value using
/// </summary>
/// <returns></returns>
public SkydriveAlbum SelectedAlbum
{
    get
    {
        return _selectedAlbum;
    }
    set
    {
        _selectedAlbum = value;
        NotifyPropertyChanged("SelectedAlbum");
    }
}
private string _uploadLocation;
public string uploadLocation
private string _folderid;
private SkydriveAlbum _folder = new SkydriveAlbum();
public SkydriveAlbum Folder
{
    get
    {
        return _folder;
    }
    set
    {
        _folder = value;
    }
}
public string FolderId
{
    get
    {
        return _folderid;
    }
    set
    {
        _folderid = value;
    }
}
private string ChildrenFolder="folder.da62924b99b1037d.DA62924B99B1037D!386";
private SkydrivePhoto _selectedPhoto;
/// <summary>
/// Sample ViewModel property; this property is used in the view to display its value using
/// </summary>
/// <returns></returns>
public SkydrivePhoto SelectedPhoto
{
    get
    {
        return _selectedPhoto;
    }
    set
    {
        _selectedPhoto = value;
        NotifyPropertyChanged("SelectedPhoto");
    }
}
private BitmapImage _newphoto = new BitmapImage();
public BitmapImage NewPhoto
{
    get
    {
        return _newphoto;
    }
    set
    {
        _newphoto = value;
        NotifyPropertyChanged("NewPhoto");
    }
}
private BitmapImage _stepone = new BitmapImage();
public BitmapImage StepOne
{
    get
    {
        return _stepone;
    }
    set
    {
        _stepone = value;
        NotifyPropertyChanged("StepOne");
    }
}
public BitmapImage StepThree, StepFour;
private BitmapImage _steptwo = new BitmapImage();
public BitmapImage StepTwo
{
    get
    {
        return _steptwo;
    }
    set
    {
        _steptwo = value;
        NotifyPropertyChanged("StepTwo");
    }
}
private double _newphotowidth;
public double NewPhotoWidth
{
    get
    {
        return _newphotowidth;
    }
    set
    {
        _newphotowidth = value;
        NotifyPropertyChanged("NewPhotoWidth");
    }
}
private double _newphotoheight;
public double NewPhotoHeight
{
    get
    {
        return _newphotoheight;
    }
    set
    {
        _newphotoheight = value;
        NotifyPropertyChanged("NewPhotoHeight");
    }
}

private WriteableBitmap _steponeimage;
public WriteableBitmap StepOneImage
{
    get
    {
        return _steponeimage;
    }
    set
    {
        _steponeimage = value;
        NotifyPropertyChanged("StepOneImage");
    }
}

private WriteableBitmap _steptwoimage;
public WriteableBitmap StepTwoImage
{
    get
    {
        return _steptwoimage;
    }
    set
    {
        _steptwoimage = value;
        NotifyPropertyChanged("StepTwoImage");
    }
}

private WriteableBitmap _stepthreeimage;
public WriteableBitmap StepThreeImage
{
    get
    {
        return _stepthreeimage;
    }
    set
    {
        _stepthreeimage = value;
        NotifyPropertyChanged("StepThreeImage");
    }
}

private WriteableBitmap _stepfourimage;
public WriteableBitmap StepFourImage
{
    get
    {
        return _stepfourimage;
    }
    set
    {
        _stepfourimage = value;
        NotifyPropertyChanged("StepFourImage");
    }
}

private string _photoname;
public string PhotoName
{
    get
    {
        return _photoname;
    }
    set
    {
        _photoname = value;
        NotifyPropertyChanged("PhotoName");
    }
}

public bool phototaken = false;
#endregion

#region Methods

/// <summary>
/// Creates and adds a few ItemViewModel objects into the Items collection.
/// </summary>
public void LoadData()
{

// GetProfileData();
GetAlubmData();
//GetForlderID();
this.IsDataLoaded = true;
}

public void GetForlderID()
{
    if (App.Session == null)
        return;
    LiveConnectClient Getid = new LiveConnectClient(App.Session);
    Getid.GetCompleted += new EventHandler<LiveOperationCompletedEventArgs>(GetidCompleted);
    Getid.GetAsync("me/skydrive/my_photos");
}

public void TakeNewPhoto()
{
    CameraCaptureTask cameraCaptureTask;
    cameraCaptureTask = new CameraCaptureTask();
    cameraCaptureTask.Completed += new EventHandler<PhotoResult>(cameraCaptureTask_Completed);
    cameraCaptureTask.Show();
}

private void cameraCaptureTask_Completed(object sender, PhotoResult e)
{
    if (e.TaskResult == TaskResult.OK)
    {
        uploadLocation = "/shared/transfers/Image" + DateTime.Now.Millisecond + ".jpg";

        //here I save the image to Isolated Storage. Also I am changing the size of it to
        bmp.SetSource(e.ChosenPhoto);
        WriteableBitmap writeableBitmap = new WriteableBitmap(bmp);

        using (var isoFile = IsolatedStorageFile.GetUserStoreForApplication())
        {
            using (var stream = isoFile.CreateFile(uploadLocation))
            {
                if (bmp.PixelHeight>bmp.PixelWidth)
                    writeableBitmap.SaveJpeg(stream, bmp.PixelWidth, bmp.PixelHeight, 0,
                else
                    writeableBitmap.SaveJpeg(stream, bmp.PixelWidth, bmp.PixelHeight, 0,
            }
        }

        //now read the image back from storage to show it worked...
using (var isoFile = IsolatedStorageFile.GetUserStoreForApplication())
{
    using (var imageStream = isoFile.OpenFile(
        uploadLocation, FileMode.Open, FileAccess.Read))
    {
        NewPhoto.SetSource(imageStream);
    }
}
SetSize();

public void SendPhoto(string photoname,string photodes)
{
    if (App.Session == null)
        return;

    LiveConnectClient uploadClient = new LiveConnectClient(App.Session);
    uploadClient.BackgroundTransferPreferences = BackgroundTransferPreferences.AllowBattery;
    uploadClient.BackgroundUploadCompleted +=
        new EventHandler<LiveOperationCompletedEventArgs>(uploadClient_BackgroundUploadCompleted);

    string userState = uploadLocation; // arbitrary string to identify the request.
    if (photoname != "")
    {
        using (IsolatedStorageFile isf = IsolatedStorageFile.GetUserStoreForApplication())
        {
            if (isf.FileExists("/shared/transfers/Image" + photoname + ".jpg"))
            {
                isf.DeleteFile("/shared/transfers/Image" + photoname + ".jpg");
            }

            isf.MoveFile(uploadLocation, "/shared/transfers/Image" + photoname + ".jpg");
            uploadLocation = "/shared/transfers/Image" + photoname + ".jpg";
            uploadClient.BackgroundUploadAsync(Folder.ID/*SelectedAlbum.ID*/, new Uri(uploadLocation,
            uploadClient.BackgroundUploadAsync(Folder.ID/*SelectedAlbum.ID*/, new Uri(uploadLocation,
            //if (photodes != ")
            UploadPhotoDes(uploadLocation,photodes);
    }

    public void UploadPhotoDes(string uploadphoto,string photodes)
    {
        IsolatedStorageFile myIsolatedStorage = IsolatedStorageFile.GetUserStoreForApplication();
        string uploadtext = uploadphoto + ".txt";
        string photoname = uploadphoto.Substring(uploadphoto.LastIndexOf('/')+1);
if (photodes == "")
    photodes = " ";
using (StreamWriter writeFile = new StreamWriter(new IsolatedStorageFileStream(uploadtext,
{

    writeFile.WriteLine(photoname + \\	"\t" + photodes + \\	"\t" + "Wed" + \\	"\t" + "Skydrive" + \\	"\t" + "0");
    writeFile.Close();
}
    if (App.Session == null)
        return;
LiveConnectClient uploadClient = new LiveConnectClient(App.Session);
uploadClient.BackgroundTransferPreferences = BackgroundTransferPreferences.AllowBattery;
uploadClient.BackgroundUploadCompleted +=
    new EventHandler<LiveOperationCompletedEventArgs>(uploadphotodes_BackgroundUploadCompleted);
uploadClient.BackgroundUploadAsync(Folder.ID/*SelectedAlbum.ID*/, new Uri(uploadtext,

private void uploadphotodes_BackgroundUploadCompleted(object sender, LiveOperationCompletedEventArgs e)
{
    if (e.Error == null)
    {
        using (IsolatedStorageFile isf = IsolatedStorageFile.GetUserStoreForApplication())
        {
            isf.DeleteFile((string)e.UserState);
        }
    }
}
public void SetSize()
{
    NewPhotoHeight = NewPhoto.PixelHeight * width / NewPhoto.PixelWidth * 0.5;
    NewPhotoWidth = width * 0.5;
}
void GetidCompleted(object sender, LiveOperationCompletedEventArgs e)
{
    if (e.Error != null || e.Result == null)
        return;
    Folder.Title = (string)e.Result["name"];
    Folder.Description = (string)e.Result["description"];
    Folder.ID = (string)e.Result["id"];
FolderId = Folder.ID;

private void GetProfileData()
{
    if (App.Session == null)
    return;
    LiveConnectClient clientGetMe = new LiveConnectClient(App.Session);
    clientGetMe.GetCompleted += new EventHandler<LiveOperationCompletedEventArgs>(clientGetMe_GetCompleted);
    clientGetMe.GetAsync("me");

    LiveConnectClient clientGetPicture = new LiveConnectClient(App.Session);
    clientGetPicture.GetCompleted += new EventHandler<LiveOperationCompletedEventArgs>(clientGetPicture_GetCompleted);
    clientGetPicture.GetAsync("me/picture");
}

void clientGetPicture_GetCompleted(object sender, LiveOperationCompletedEventArgs e)
{
    if (e.Error == null && e.Result != null)
    {
        ProfileImage = (string)e.Result["location"];  
    }
}

void clientGetMe_GetCompleted(object sender, LiveOperationCompletedEventArgs e)
{
    if (e.Error == null && e.Result != null)
    {
        FullName = (string)e.Result["name"];  
    }
}

public void GetAlbumData()
{
    if (App.Session == null)
    return;
    LiveConnectClient clientFolder = new LiveConnectClient(App.Session);
    clientFolder.GetCompleted += new EventHandler<LiveOperationCompletedEventArgs>(clientFolder_GetCompleted);
    clientFolder.GetAsync(ChildrenFolder + "/files");
}

void clientFolder_GetCompleted(object sender, LiveOperationCompletedEventArgs e)
{
    if (e.Error != null || e.Result == null)
    {
        return;
    }
}

List<object> data = (List<object>)e.Result["data"];
/Albums.Clear();
foreach (IDictionary<string, object> album in data) {
    //
    if ((string) album["type"] != (string) "folder")
        continue;
    SkydriveAlbum albumItem = new SkydriveAlbum();
    albumItem.Title = (string)album["name"];
    albumItem.Description = (string)album["description"];
    albumItem.ID = (string)album["id"];  //SelectedAlbum = albumItem;
    Folder = albumItem;
    bool already=false;
    foreach (SkydriveAlbum talbum in Albums)
        if (talbum.ID == albumItem.ID)
            { already = true;
            break;
            }
    if (already)
        continue;
    Albums.Add(albumItem);
    GetAlbumPicture(albumItem);
    //DownloadPictures(albumItem);
}
}
private void GetAlbumPicture(SkydriveAlbum albumItem)
{
    if (App.Session == null)
        return;
    LiveConnectClient albumPictureClient = new LiveConnectClient(App.Session);
    albumPictureClient.GetCompleted += new EventHandler<LiveOperationCompletedEventArgs>(albumPictureClient_GetCompleted);
    albumPictureClient.GetAsync(albumItem.ID + "/picture", albumItem);
}
void albumPictureClient_GetCompleted(object sender, LiveOperationCompletedEventArgs e)
{
    if (e.Error == null && e.Result != null)
    {
        SkydriveAlbum album = (SkydriveAlbum)e.UserState;
        album.AlbumPicture = (string)e.Result["location"];
    }
}
public void DownloadPictures(SkydriveAlbum albumItem)
{
    if (App.Session == null)
return;

LiveConnectClient folderListClient = new LiveConnectClient(App.Session);
folderListClient.GetCompleted += new EventHandler<LiveOperationCompletedEventArgs>(folderListClient_GetCompleted);
folderListClient.GetAsync(albumItem.ID + "/photos", albumItem);
}

void folderListClient_GetCompleted(object sender, LiveOperationCompletedEventArgs e)
{
    if (e.Error != null || e.Result == null)
    {
        return;
    }

    SkydriveAlbum album = (SkydriveAlbum)e.UserState;

    //album.Photos.Clear();
    List<object> data = (List<object>)e.Result["data"];

    foreach (IDictionary<string, object> photo in data)
    {
        var item = new SkydrivePhoto();
        item.Title = (string)photo["name"];  
        item.Subtitle = (string)photo["name"]; 

        item.PhotoUrl = (string)photo["source"]; 
        item.Description = (string)photo["description"]; 
        item.ID = (string)photo["id"]; 
        bool already = false;
        foreach (var existitem in album.Photos)
            if (existitem.ID == item.ID)
                {  
                already = true;
                break;
        }
        if (already)
            continue;
        if (App.Session == null)
            return;
        LiveConnectClient albumPictureClient = new LiveConnectClient(App.Session);
        albumPictureClient.GetCompleted += new EventHandler<LiveOperationCompletedEventArgs>(GetPhotoidCompleted);
        List<object> userstate = new List<object>();
        userstate.Add(album);
        userstate.Add(item);
        albumPictureClient.GetAsync(item.ID + "/picture?type=thumbnail", userstate);

        // Stop after downloading 10 images
void GetPhotoidCompleted(object sender, LiveOperationCompletedEventArgs e)
{
    if (e.Result == null)
        return;
    var item = (SkydrivePhoto)(((List<object>)e.UserState)[1]);
    item.PhotoUrl = (string)e.Result["location"];  
    SkydriveAlbum album = (SkydriveAlbum)(((List<object>)e.UserState)[0]);
    album.Photos.Add(item);
}

class DeleteAlbum(SkydriveAlbum delalbum)
{
    if (App.Session == null)
        return;
    LiveConnectClient DeleteClient = new LiveConnectClient(App.Session);
    DeleteClient.DeleteAsync(delalbum.ID);
    Albums.Remove(delalbum);
}

class MovePhoto(string newalbumid)
{
    if (App.Session == null)
        return;
    LiveConnectClient MovePhotoClient = new LiveConnectClient(App.Session);
    MovePhotoClient.MoveAsync(SelectedPhoto.ID, newalbumid);

    string photoname=SelectedPhoto.Title;
    string txtname = photoname + " .txt";
    MoveTxt(txtname , newalbumid);
    SelectedAlbum.Photos.Remove(SelectedPhoto);
}

class MoveTxt(string photoname, string newalbumid)
{
    if (App.Session == null)
        return;
    LiveConnectClient FindTxtClient = new LiveConnectClient(App.Session);
    FindTxtClient.GetCompleted += new EventHandler<LiveOperationCompletedEventArgs>(FindTxtClientForMove_GetCompleted);
    List<object> userstate = new List<object>();
    userstate.Add(photoname);
    userstate.Add(newalbumid);
    FindTxtClient.GetAsync(SelectedAlbum.ID + "/files", userstate);

    void FindTxtClientForMove_GetCompleted(object sender, LiveOperationCompletedEventArgs e)
    {
    }
if (e.Error != null || e.Result == null)
{
    return;
}

string photoname = (string)(((List<object>)e.UserState)[0]);
string newalbumid = (string)(((List<object>)e.UserState)[1]);
List<object> data = (List<object>)e.Result["data"];
string txtid = "";
foreach (IDictionary<string, object> file in data)
    if ((string)file["name"] == (string)photoname)
    {
        txtid = (string)file["id"];
        break;
    }
if (txtid == "")
    return;
if (App.Session == null)
    return;
    LiveConnectClient MoveTxtClient = new LiveConnectClient(App.Session);
    MoveTxtClient.MoveAsync(txtid, newalbumid);

public void CreateFolder(string foldername)
{
    if (App.Session == null)
    return;
    LiveConnectClient CreateFolderClient = new LiveConnectClient(App.Session);
    Dictionary<string, object> folderData = new Dictionary<string, object>();
    folderData.Add("name", foldername);
    CreateFolderClient.PostAsync(ChildrenFolder, folderData);
}

#region INPC
public event PropertyChangedEventHandler PropertyChanged;
private void NotifyPropertyChanged(String propertyName)
{
    PropertyChangedEventHandler handler = PropertyChanged;
    if (null != handler)
    {
        handler(this, new PropertyChangedEventArgs(propertyName));
    }
#endregion
```csharp
internal void Delete()
{
    if (SelectedPhoto == null)
    {
        return;
    }

    if (App.Session == null)
        return;
    LiveConnectClient DeleteClient = new LiveConnectClient(App.Session);
    DeleteClient.DeleteAsync(SelectedPhoto.ID);
    DeleteTxt(SelectedPhoto.Title);
    SelectedAlbum.Photos.Remove(SelectedPhoto);
}

internal void DeleteTxt(string photoname)
{
    if (App.Session == null)
        return;
    LiveConnectClient FindTxtClient = new LiveConnectClient(App.Session);
    FindTxtClient.GetCompleted += new EventHandler<LiveOperationCompletedEventArgs>(FindTxtClient_GetCompleted);
    //clientFolder.GetAsync("/me/albums");
    string txtname = photoname + ".txt";
    FindTxtClient.GetAsync(SelectedAlbum.ID + "/files", txtname);
}

void FindTxtClient_GetCompleted(object sender, LiveOperationCompletedEventArgs e)
{
    if (e.Error != null || e.Result == null)
    {
        return;
    }
    List<object> data = (List<object>)e.Result["data"];
    string txtid = "";
    foreach (IDictionary<string, object> file in data)
    {
        if ((string) file["name"] == (string)e.UserState)
        {
            txtid = (string)file["id"];
            break;
        }
    }
    if (txtid == "")
        return;
    List<object> data = (List<object>)e.Result["data"]; // for checking turret data
    string txtid = "";
    foreach (IDictionary<string, object> file in data)
    {
        if ((string) file["name"] == (string)e.UserState)
        {
            txtid = (string)file["id"];
            break;
        }
    }
    if (txtid == "")
        return;
}
```
if (App.Session == null)
    return;
LiveConnectClient DeleteTxtClient = new LiveConnectClient(App.Session);
DeleteTxtClient.DeleteAsync(txtid);

} internal void Download()
{
    if (SelectedPhoto == null)
    {
        return;
    }

    if (App.Session == null)
        return;
    LiveConnectClient downloadClient = new LiveConnectClient(App.Session);
downloadClient.BackgroundDownloadCompleted +=
        new EventHandler<LiveOperationCompletedEventArgs>(downloadClient_BackgroundDownloadCompleted);

    string path = SelectedPhoto.ID + "\content";
    Uri downloadLocation = new Uri("/shared/transfers/" + SelectedPhoto.Title, UriKind.RelativeOrAbsolute);
    string userState = SelectedPhoto.ID; // arbitrary string to uniquely identify the request.

    using (IsolatedStorageFile isf = IsolatedStorageFile.GetUserStoreForApplication())
    {
        if (isf.FileExists("/shared/transfers/" + SelectedPhoto.Title))
        {
            return;
        }
    }
    downloadClient.BackgroundDownloadAsync(path, downloadLocation, userState);
}

private void downloadClient_BackgroundDownloadCompleted(object sender, LiveOperationCompletedEventArgs e)
{
}

internal void Upload()
{
    PhotoChooserTask task = new PhotoChooserTask();
    task.ShowCamera = true;
    task.Completed += new EventHandler<PhotoResult>(task_Completed);
    task.Show();
}

void task_Completed(object sender, PhotoResult e)
{
    if (e.ChosenPhoto == null)
    {
    }
return;
}

uploadLocation = "/shared/transfers/Image" + DateTime.Now.Millisecond + ".jpg";

BitmapImage bmp = new BitmapImage();
bmp.SetSource(e.ChosenPhoto);
WriteableBitmap writeablebitmap = new WriteableBitmap(bmp);
var width = bmp.PixelWidth;
var height = bmp.PixelHeight;
BackgroundWorker worker = new BackgroundWorker();
worker.DoWork += (o, args) =>
{
    using (IsolatedStorageFile store = IsolatedStorageFile.GetUserStoreForApplication())
    {
        using (IsolatedStorageFileStream stream = store.CreateFile(uploadLocation))
        {
            /*byte[] buffer = new byte[1 << 10];
            int bytesRead;
            while ((bytesRead = e.ChosenPhoto.Read(buffer, 0, buffer.Length)) > 0)
            {
                stream.Write(buffer, 0, bytesRead);
            }*/
            if (height > width)
                writeablebitmap.SaveJpeg(stream, width, height, 0, 100);
            else
                writeablebitmap.SaveJpeg(stream, width, height, 0, 100);
        }
    }
};

worker.RunWorkerCompleted += (o, args) =>
{
    using (var isoFile = IsolatedStorageFile.GetUserStoreForApplication())
    {
        using (var imageStream = isoFile.OpenFile(
            uploadLocation, FileMode.Open, FileAccess.Read))
        {
            NewPhoto.SetSource(imageStream);
            SetSize();
        }
    }
};
Appendix E - Need-finding

Table A-1: Results and Insights of needfinding in the nursing house

<table>
<thead>
<tr>
<th>Results</th>
<th>Insights</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. “I’ll use the public phone in the nursing house and the nurse will</td>
<td>We’ve always thought about devices for personal use. However this</td>
</tr>
<tr>
<td>help me dial.”</td>
<td>phenomenon pointed out a new direction—we can also considering building a</td>
</tr>
<tr>
<td>“I have a phone but the nurse helps me keep it. When I need to dial or</td>
<td>device that works for a group of people.</td>
</tr>
<tr>
<td>text my family, she’ll help.”</td>
<td></td>
</tr>
</tbody>
</table>
2. “I'll record all the numbers on a piece of paper and refer to it when I need to dial.” (actually there were only a few numbers needed to be recorded)

3. Most people suffer from disabilities related to hands or eyesight. These disabilities block their way to digital world to some extent. Some people mentioned that they can’t travel places they’ve always dreamt of because of the disabilities.

4. Some old people kept photos in an album and they thought the idea of e-album was good. Meanwhile, most of the elders love magnification function. However, some of them had problems in manipulating the device because of the disabilities in their hands.

There’s an obvious need that the elderly need a convenient way to record phone numbers, time to take pills and other information.

We may think of ideas about building devices that make up for the inconvenience caused by their disabilities. A “virtual travel” machine might be a solution which will simulate the scenario of the sight spot.

While it seems easy and intuitive for the young generation to magnify the photos using finger control, for the elderly it becomes obscure. It seems that they’re more receptive to buttons.

Table A-2: Situation of the Elderly
<table>
<thead>
<tr>
<th></th>
<th>What Stuff You Always Record</th>
<th>Use What Materials to record important things</th>
<th>Daily Entertainment</th>
<th>How Often do You Travel? Want to Travel?</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td></td>
<td>majiang</td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>watching TV, cooking</td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>listening to radio, peking opera</td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>doing handwork, opera, chatting</td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>8</td>
<td>time of appointments</td>
<td>notebook or cardboard</td>
<td>cooking, ping-pang, watching TV</td>
<td>Y, three times a year</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td>reading, handwork.</td>
<td>N</td>
</tr>
<tr>
<td>10</td>
<td>Birthday of family members</td>
<td>cardboard</td>
<td>opera, reading, shopping</td>
<td>Y, twice a year</td>
</tr>
</tbody>
</table>
Appendix F - Photo Sharing Needfinding

We interviewed the elders in USTC, trying to get a glimpse of their habits of photo sharing to improve our prototype, family album. Questions below were asked.

1. How would you share photos with your family when you have returned from a travel? Use computers or printed-out photos? 2. How would you share photos with a family who lives far away? 3. How would your children share their photos with you? 4. For those who had experience with computers, which way would they like? Using computers or physical albums? 5. What story would you tell when you share photos with others? 6. How many albums do you have?

Most of the interviews are based on a conversation of a casual style. So we might not follow the sequence of the questions above.

Here is what we got from each interviewee.

Interviewee 1: She likes real album and there is a closet of albums in her house. She doesn't like computers and large screens (staring at screens makes her feel sick). When browsing photos with my family, everyone has to crowd around the computer. But real albums can be passed to everyone. There are lots of irrelevant things in the computer such as photos of stars, movies, and computers lack a sense of exclusiveness. Photos in the computer can be easily deleted by accident. She will tell stories while sharing photos with her children.

Interviewee 2: He has three sons, two of them are in Hefei and the other one is in Shanghai. They'll use phones to communicate with each other. His son will help him with the computers to browse photos, because he can't use computers.

Interviewee 3: She lives in Henan province and her son lives in Hefei, which is about 200 miles away from Henan province. She is now living in Hefei to look after her granddaughter. She has 5 albums. When meeting friends at home, she will share stories about those photos with her friends. She prefers physical albums than digital one because she thinks it's easier for her to browse. She did have an opportunity to use her son's iPad and believes that it is an advantage of iPad to store many photos. But she still likes the feeling of turning pages of albums. She also remarked, if there's a device that can combine the feeling of an album and the capacity of an iPad, it would be extremely wonderful!

Interviewee 4: She lives in the same city (Hefei) as her children. Her children would help her with the computers when she wants to view photos on the computer. She prefers a physical album and she will use the album to tell stories to her grandchildren.

Interviewee 5: She lives far away from her son. She's now here visiting her son. Her son will send MMS which contains photos and texts describing the situation. She likes this way because it's fast to share the most recent photos. She has a lot of physical albums too, which record the growing up of her son. And they're of great value to her.

Interviewee 6: She will use email to share photos with her sister living in Beijing. She also sends photos while they're video chatting and share comments on the photos during the chat. She has just learnt to use iPad. It worked smoothly for her. But she still thinks highly of those old black-and-white photos in her albums. She will treasure them even if the photos can be digitalized.
into the ipad. Browsing the albums can bring the feeling of recalling the past and this is beautiful.

Interviewee 7: She has more than ten albums. She lives with her son, but when her son studied aboard, they used video chat to communicate and send photos by emails. She doesn’t have a ipad, but she saw her son use it. Her daughter is at hometown, away from her, but they exchange the photos when they meet instead of using the internet to send the photos. She likes to print out the photos and selects to retain them. She feels that both the computer and the album has the advantages. Computers are more comprehensive while printed photos are more familiar. She will tell the children stories about the old photos.

Interviewee 8: She has a lot of albums at home. Her husband enjoyed taking photos when his was young. She prints all her photos out. Her children comes back home to see her every one or two weeks and show her the photos of their parties and trips using the computer. Her children took away some of their photos of their childhood and that made her husband really angry. When they tell stories of their childhood to their children, the children love the stories.

There are another 4 more interviewees who rarely browse their albums.

Here is the conclusion: 1. 7 out of 8 interviewees prefer physical albums mainly because they like the feeling of turning the pages when browsing the photos. Technical difficulty involved in using computers is another reason. 2. 3 of 8 of them use MMS or emails to share photos with family who lives far from them. And its often under the help of a younger family member. 3. They mention the large capacity of digital devices. Its an attraction for them. 4. They use photos to tell stories to the younger generation. Stories include the time and place where the photo was taken. And they’ll tell them what life was like when the photo was taken, how the person in the photo grew up etc.

These conclusions convince us that one essential advantage of our prototype is that it combines the large memory and feeling of turning pages together by projecting photos on a real blank album. And most of them seem to have more than one physical album at home, each for a different category. So there’s a question for us: how to switch from one category to another using this lamp-album device?

Appendix G - Fall Quarter Prototype Descriptions

Tactile Messaging CFP

The CFP uses two Arduino Uno boards with Atmega328 microcontrollers to interface with all the sensors and actuators. The circuit was first implemented on breadboards, and later ported to permanent soldered boards after testing. The first version of the device used a resistive heater, as the heating element, but the response was too slow, and the element did not have the ability to cool itself down, so we could not effectively communicate the feeling of the hand being taken off. So, we moved to a thermoelectric (Peltier) heater/cooler, which responds quite rapidly.

The boards communicate with each other using serial communication at 9600 baud. Each byte of data sent contains information about one of the following, based on the first two bits of the data:

00 - temperature
01 - pressure  
10 - accelerometer  
11 - gyroscope

The remaining six bits then have a scaled value of the value being measured. For instance, 0 = 15 Celsius or lower input from the IR sensor, and 64 = 45 Celsius or higher.

Pin configurations:  
Master (Input module)  
- Pin 9 (heater)  
- Pin 10 (motor)  
  - Pin A4, A5 (I2C pins) - (Accelerometer and IR temperature sensor)  
Slave (Output module)  
- Pin A4, A5 (I2C pins) - (IR temperature sensor)  
  - A0: pressure sensor

Figure 8.1: Prototype schematic

Figure 8.2: Earlier version of the prototype, using a resistive heating element
The pressure sensor is a pad whose resistance falls with pressure. The sensor is connected between power and ground in series with a standard resistor, and the voltage at the junction measured using the analogue to digital converter in the Arduino.

The accelerometer-gyroscope combo, the MPU 6050, uses the I2C protocol to send the data to the Arduino. Standard libraries exist to read the data sent by the accelerometer. The IR temperature sensor also uses I2C to send temperature data to the Arduino. The I2C protocol allows multiple devices to be ‘daisy-chained’ and thus communicate through the same port.

The vibration motor is a 3V motor with an off-axis mass. It is controlled with the Motor Driver shield for Arduino built by Adafruit Industries. The Thermoelectric heater can take 12V and 58W max, but we supply it a max power of 5V, from the Motor Driver Shield. The voltage supply can be inverted to cool the device down.

Social Networking Aggregator CEP

The CEP involves selecting two pages worth of information from social networking feeds of the user, collecting and organizing it before printing it out and showing it to their family members who do not use social networking sites.
All kinds of posts, including status messages, shared links, events, maps, friends added, photos uploaded and photos tagged in were part of the aggregated print, so that we could have feedback on what content was appreciated the most.

Figure 8.5: The CEP print

While the CEP had the user manually select the posts to be shown to their grandparents, the idea is that the final product can use the privacy settings within Facebook to decide what posts the user is willing to show to his family. There will also have to be a 'grandparent filter', which removes posts that will not be of interest to elders, and also adds a layer to make things simpler. For instance, when there is an event that the user attended, it can give a short description of what the event is. It could also clarify for the seniors terms that younger people use but are not common among older people.

Peripheral Vision CEP

The CEP setup involves a headset that fixes an iPhone next by the side of the user’s eye so that the image onscreen replaces their peripheral vision. The iPhone is then connected to a stationary iPhone/iPad via FaceTime. It is fixed such that the person who is communicating with the user can be seen to be facing the same direction that the user is.

The first design for our headset involved fixing the iPhone in a holder which can slide on a Sony headset. This had the advantage of being light, however, it was unbalanced and had a tendency to fall off or feel precarious.

Another issue was that the display could be adjusted up or down, but had to stay in the plane of the ear. This turned out to a problem, and we
discovered that people’s heads are shaped very differently. We then redesigned the device by integrating into a helmet and adding a counterweight that stabilized it. We fixed the phone using an adjustable wire so that the user could place the display exactly where they wanted it.

The prototype used an iPhone 5 as the display. The display specifications are:

- 4-inch (diagonal) widescreen Multi-Touch display
- 1136-by-640-pixel resolution at 326 ppi
- 800:1 contrast ratio (typical)
- 500 cd/m² max brightness (typical)

Apple claims that the iPhone will last for up to 10 hours with Wi-Fi on. Apple FaceTime needs a Wi-Fi network to work. Apple has not released technical specifications for the service yet. The camera used is an iPhone camera - Video recording, HD (1080p) up to 30 frames per second with audio.

We also use the iPhone FaceTime camera occasionally - FaceTime HD camera with 1.2MP photos and HD video (720p) up to 30 frames per second.

The iPhone has inbuilt video stabilization. Total weight of the device (including the phone) - 0.5kg

3D Table

As was mentioned in design development, we came up with two ways to control several blocks with one air cylinder or motor. The first one is not realized for limits of resource.

Air-powered Way

Figure 8.6: The structure of air-powered 3D table (left) and the structure of block-pipe-valve-gear system (right)

Fig 8.6 (left) shows the whole structure of the device and (right) show details of essential parts of the device. Each block is actually a plunger connected to a pipe. When aerating and de-aerating through pipes, blocks can go up and go down. A valve is used at the other end of each pipe, blocks can be re-arrayed in a circle placing upon a plan with teeth in a circle.
A gear with airway is fitted between teeth and valve Fig 8.7. When the plate rotates, the gear will be forced to roll on the plane and at the same time, tip of teeth on gears will be pushed into or pulled out of valves (Figure 5.1.1-3). By controlling the air cylinder to work at the proper time, the movement of blocks will be precisely controlled.

Gear-and-spline-driven way

In this CFP design, four motors are used to control a row of blocks (Fig 8.8 left). Motor A makes the platform where motor C is placed move in the row direction. When motor C faces the spline, motor B and B’ move and push the spline that is connected to blocks. Thus, the spline separates from the spline.
fixed on the table and can be moved by motor C, pushing or pulling the block (as is shown in Fig 8.8 right).

After it is moved to the right place, motor B and B’ move again, but in an opposite direction. And springs stretch and push spline to make it fixed on the other spline, which is fixed on the table. Thus, the blocks are fixed and steady on table.

Materials used in the prototype are listed in Appendix I, where figures show several essential parts of the prototype.
Appendix H - Tactile Messaging CFP Component Specifications

Arduino:

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<tr>
<th>Specification</th>
<th>ATmega328</th>
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<td>Clock Speed</td>
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Atmega328:

- 131 Powerful Instructions – Most Single Clock Cycle Execution
- Internal Calibrated Oscillator
- External and Internal Interrupt Sources
- I/O and Packages
  - 23 Programmable I/O Lines
  - 28-pin PDIP, 32-lead TQFP, 28-pad QFN/MLF and 32-pad QFN/MLF
- Operating Voltage: 1.8 - 5.5V
- Temperature Range: -40C to 85C
- Speed Grade: 0 - 20 MHz @ 1.8 – 5V

IR sensor:

- Factory calibrated in wide temperature range:
  - -40...+125 [°C] for sensor temperature and
  - -70...+380 [°C] for object temperature.
- Simple adaptation for 8...16V applications
- Measurement resolution of 0.02°C
- Power saving mode

Accelerometer: MPU 6050

- Digital-output X-, Y-, and Z-Axis angular rate sensors (gyroscopes) with a user-programmable full-scale range of ±250, ±500, ±1000, and ±2000/sec
- Gyroscope operating current: 3.6mA
- Digital-output triple-axis accelerometer with a programmable full scale range of ±2g, ±4g, ±8g and ±16g
- Accelerometer normal operating current: 500µA
- Orientation detection and signaling
- User-programmable interrupts
Appendix I - 3D Table Design Description

3D table

Stepping motor*3  20mm*20mm*34mm  1.8Ncm  4V 0.6A  step angle: 1.8
Stepping motor  42mm*42mm*35mm  0.1Nm  4V 0.95A  step angle: 1.8

Sliding platform disassembled from a printer  length: 310mm
Nylon spline  tooth module: 1  length: 1m
gears*4:  tooth module: 1  inner diameter: 4mm  outer diameter: 12mm
PMMA board
Screw
Foam
MCU: ATMEGA328P-AU
Stepping motor driver: L298N
Battery  12V  <6A
Voltage transformer  8-45V -> 5V
Wire
Appendix J - Family Channel User testing

We brought the portable mini window to the Senior Center in Palo Alto. The selected user feedback showed as below:

Mary Dodge: 76 years old, uses Skype, emails, and phones for communication with her family members (Children and grandchildren).

- Privacy issues: she does not want to be seen all the time, feels its rude for someone to close the curtain on her. Does not want to be interrupted over dinner
- Why not use regular communication tools? Hows it different from Skype?
- Positive comment: device is centralized to all family members so she does not need to talk to several members for same issue
- Prefers video interaction with grandchildren (younger ones) and not their parents or grownups
- Spending time each day on the device might be too much (ex. Half an hour daily is too much), and prefers a weekly meeting
- Activity over the device with grandchildren is desirable
- Prefers the device to be with multiple connections
- Would like the device to be with multiple friends as well
- Would use it only for distant relations, communicates with close members by usual communication tools
- Would pay $300 and less for such a device
- Device is not essential in her life
- Looking directly at people is not attractive for her
- In her opinion the device is nice for older people
- We should consider people at nursing homes, suggested: Forum, Sequoias, Channing House, and VI (The V)
- Device is good for committees (not really our purpose)

Mark:

- Prefers to write messages on a paper to be sent, rather than on the screen, would be better if I were able to take the paper away with me
- Would like blinking or family voice record alert
- Prefers window on the wall rather than screen on table less demanding of your attention
- Would like to leave voice/audio message for family without disturbing them.
Figure 8.9: Interview with Mary Dodge
- Remote control would be useful too lazy to get up to switch the window on and off.

- Avoid Non-intuitive controls, avoid having to dig deeper, like scrolling to an item in the menu in the phone.

- Since I need to spend a bit of money on it, I would prefer if I could also use it to talk to my friends.

- It is good to have device other than computer that has thousands of functions.

Jack: Hard of hearing and shaking in hands. Does not use a phone or a computer, his wife communicates with their children using the phone, and video chats once a week.

- Finds it difficult to use the phone because of hearing problems, needs a phone with extra-high volume.

- We asked him to test leaving messages by writing - he cannot use his finger, or a pen on the screen or a pen on paper because of tremors. He would need to leave an audio or a video message.

- He can receive a written message, but it will have to be in large characters so he can read it. Audio messages will be difficult. Video would be good because he can see the lips move.

- He does not want to talk to his children every day, once a week should be fine.
Appendix K - Technology Benchmarking Online
Appendix L - CFP CEP Handout
Appendix M - Fall Final Brochure
Appendix N - Dark Horse Handout
Appendix O - Funky Prototype Handout
Appendix P - Functional Prototype Handout
Appendix Q - Winter Final Brochure
Appendix R - Part X is done Handout
Appendix S - Penultimate Handout
Appendix T - EXPE Brochure
Appendix U - EXPE Poster
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| **Features** | Focuses the client up a normal display of software and copy |}

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- **Benchmarks:**
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  - Features
- **Description:**
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**Notes:**
- This table represents a summary of the document's content, focusing on the primary topics and findings.
- The natural text is created by rephrasing the original content to improve readability and coherence.

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**Additional Information:**
- The document includes a detailed methodology section, which outlines the research process and data collection methods.
- The results section provides empirical evidence and statistical results that support the conclusions drawn from the data.
- The discussion section further explores the implications of the findings and their relevance to the field of study.

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**References:**
- A comprehensive list of references is provided at the end of the document, including all the sources cited within the text.
- The references are formatted according to a specific citation style, ensuring academic integrity and transparency.
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**River City**

- River City offers a variety of digital resources and services for community engagement.
- **Preserving Family Memories**
  - [Preserving Family Memories](http://example.com)
  - [Digital Historian](http://example.com)

**OLPC**

- OLPC's mission is to provide equal access to education through the use of technology.
- **Connecting Children**
  - [Connecting Children](http://example.com)
  - [Children's Technology](http://example.com)

**square courses on humans**

- OLPC's focus is on providing educational technology to children and families globally.
- **OLPC Completes Human Studies**
  - [OLPC Completes Human Studies](http://example.com)
  - [Human Studies](http://example.com)

**Childhood**

- OLPC's efforts are centered around improving educational opportunities for children.
- **Leading to Educational Reforms in Children in third world**
  - [Educational Reforms](http://example.com)
  - [Children in Third World](http://example.com)

**10 Ways Tech Makes Our Age Easier**

- OLPC aims to make technology accessible and easy to use.
  - [10 Ways Tech Makes Our Age Easier](http://example.com)
  - [Tech and Age](http://example.com)
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Motivation
We are exploring methods of remote companionship and communication to strengthen connections between family members and intimate friends which have been impaired by:

• Disparity in communication tool preference
• Lack of time
• Geographical separation

Function 1
Conveying the exact temperature of your hand when you are holding it so the other end can feel your temperature or warm up your hand by holding his device.

Function 2
Conveying your hand’s movements when holding the device to the other end.

CFP Finding from Testing

• Most users thought that the temperature communication is interesting especially when:
  - Temperature output is quick and responsive
  - Able to heat the other’s hand up by both holding on the devices.
• Shape and material for touch and feeling temperature are very important.
  - Small enough to be put into a pocket and taken with one anywhere
  - Able to squeeze it to convey nervousness and anxiousness
  - Soft and can press on the face to feel the warmth
• Functions preferred depend on who to use with.
  - More likely to use the temperature conveying function with spouse/lover.
  - Use the movement conveying function to express emotion or emphasize words when audio/video chatting with parents.
• Hope to have other input and output movement.
  - Complex input movement such as drawing smiling face in the air; squeeze
  - Respiring movement; Deflation/inflation; Simple project.
  - It might work better along with audio or video chat
Function 1
Feel family’s or friends’ presence and keep the interaction alive while working or entertaining alone.

Function 2
Create a comfortable peripheral vision and sound background to improve working/entertainment environment.

User Experience
- Among 9 users, 5 felt the device can provide a feeling of that someone was next to them.
- 4 users found the experience more engaging than expected.
- 5 users think the device lets them be engaged in work but still have connection with the other side.

Testing for Device Optimization
- 4 users felt uncomfortable about unable to see clearly the screen when they want.

Other Useful Findings
- Waving and approaching can easily be realized even when deeply engaged in something. Other movement such as stretch and leaving depends on users attention.
- Background sounds, function of sharing music, stereo audio could

Optimization
- Distance to Camera ~30 in
- Display Angle ~15 deg

Other Factors
- Position of user in Image
- Screen Brightness
- Screen Light Reflection
- Image Contrast
Our team, consisting of three students from Stanford University and four from USTC, has been tasked by Microsoft Research Asia to ‘Design and build a device that can bridge the divide between people ‘living’ in the digital world and people only living in the physical world’.

**BACKGROUND**

Today, there is a significant and growing divide between younger members of a family that communicate most often using the internet and digital technology, and older members that are either uncomfortable with or incapable of utilizing the same technology.

**VISION**

We aim to reconnect families by building a device that allows generations of a family to maintain communication despite being physically separated. The product will encourage families to stay in touch by improving accessibility to technology and by efficient utilization of time.

**REQUIREMENTS**

- Enhance communication between members of different generations in family.
- Be suitable for users belonging to multiple generations
- Affordable to a middle class family in China, including initial and recurring cost.
- Efficient use of time, requires less time to be dedicated to communication.
- Flexible connectivity options, can utilize multiple options for connectivity.
- Portable device requirements, should comfortably fit into a pocket, and should carry enough charge to last a day.
The Peripheral Vision Goggle aims to use peripheral vision to maintain a visual connection in remote communication, while at the same time allowing the user to be engaged in another activity that requires his central field of vision.

Most users felt that the goggle quite realistically simulated the presence of a person next to them, and many instinctually tried to turn to see the person.

We found that responsiveness - quick transfer of touch and temperature information - was important to the overall experience, as was the shape of the device and the material used.

Other input and output options, like squeezing the cube and deflating/inflating the cube, were also suggested. Some users thought it would work better with audio messages or video chat.

The goggles did not significantly affect their performance in tasks. However, the inconvenience of having to wear the device, and the inability to see the person face to face was expressed.

The feedback we received included an appreciation of having information passed along that could spark a conversation later, but also worries about the lack of personal interaction. That most of the posts on social networks are not of interest to older people was an issue, and most users preferred the data to be presented on a screen.

The Touch Cube tests the importance of communicating the sensation of touch via temperature and vibration in maintaining a feeling of intimacy while connecting.

Other input and output options, like squeezing the cube and deflating/inflating the cube, were also suggested. Some users thought it would work better with audio messages or video chat.

The Peripheral Vision Goggle aims to use peripheral vision to maintain a visual connection in remote communication, while at the same time allowing the user to be engaged in another activity that requires his central field of vision.

The Social Networking Aggregator creates a printed version of your social networking feeds for older members of your family. It aims to test the utility of the kind of information posted in social networking services.

The feedback we received included an appreciation of having information passed along that could spark a conversation later, but also worries about the lack of personal interaction. That most of the posts on social networks are not of interest to older people was an issue, and most users preferred the data to be presented on a screen.
Background and Focus

Problems we identified:
- Lack of time to dedicate solely to communication
- Unnatural pressure on communication over video chat, because all your attention is on it

Opportunity we identified:
- Casual, non-demanding and more natural communication method in physically separated families
- Communication over common activities like over food, while watching TV

The idea

- A 'window' that connects two households, typically two generations of a family.
- Built like a window to make the function and usage obvious.
- The window switches on when there's someone nearby and shows you what's happening on the other side, when the curtains are not drawn closed

The aim: Learning about seniors using video chats with their families

The test: Asking a pair of seniors who don’t use video chats to communicate over video using our window, interview others about their experiences with video chats

Insights:
- Seniors prefer old methods of communication like the phone. “I know what my son looks like, I don’t need to see him.”
- Daily communication with the family is not requested, they prefer weekly video chats. If the family lives in drivable distance, them coming over once a week would be good enough.
- Communication with young grandchildren is valued more than with grownups, online activities with grandchildren are appreciated
- Chatting over dinner might be considered as a disturbance.
- More than a dedicated video connection with one home, it might be useful if I can connect to multiple homes, and also talk to friends of my own age.
The question: **What methods of leaving messages work best in this context?**

The test: Ask senior users to leave a written message in three ways – writing with a pen on the screen, writing with a finger on a screen, and writing with a pen on a sheet of paper next to the screen. Ask them about messages they receive on the answering machine, and about how they think a video message would be useful.

Insights:

- Messages written on paper are preferred over messages written in screen by pen or finger
- Many seniors cannot use writing of any sort, on the screen or on paper, due to tremors. Writing will have to be in very large font.
- Audio messages are not useful for those hard of hearing; video will allow them to see the movement of the lips too. Audio and video messages are desirable since they are more personal and are easier for the seniors to send and receive.

The question: **Can we make a window more realistic by changing the view in the window based on where we are looking from?**

The test: Change the video in the window by using a camera mounted on a robotic frame, in response to either rotation of the head or the position of the head in front of the window.

Insights:

- The effect does make the window more realistic.
- The robotic motion is slow, quicker response might be possible with a fish-eye lens and image transformation.

The question: **How can we let the users know when they are in the frame of the camera?**

The test: Try multiple methods, collect feedback

Insights:

- If one of the two cameras used in video chat is mirrored, the intuitive leaning to the side to see a person who’s moved too far will bring the person back to the center. This effect works counter intuitively in a normal video chat. However, mirroring produces other problems, like making the person haircut flip, and reversing any text in the frame.

The question: **Is projecting the digital ‘window’ on to a real translucent window viable?**

The test: Use a projector to project the video chat video on to a translucent window, both in the day and at night.

Insights:

- Difficult to set up the projector so it doesn’t interfere with the person in front of the window
- Privacy issues with the video being seen from the outside
Problem Statement

Grandparents: Grandparents need to pass on family traditions and heritage to grandchildren who live far away but they don’t have time to get together and their relationship is weak.

Grandchildren: Grandchildren need to satisfy their curiosity or obligations by satisfying their grandparents’ need to have a relationship with them; Grandchildren need to learn and be cared for while not getting bored.

Solution Statement

A product that allows grandparents and kids to interact in interesting ways (play games, share photos, tell stories) while also seeing each other face to face.

A product that facilitates meeting and tracks sharing of legacy information between children and grandparents and creates a record of that legacy.

A product that encourages grandparents to talk in order to record legacy information with a comfortable setting.
**Features**

**Interactive Game:** Users can play game in a physical setting, which is created by cameras and projectors. For example, when playing chess, each side uses a physical chess board and his own chess pieces. The positions and movements of the pieces are recorded by the cameras and transmitted to the projector on the other side.

**Talking Album:** The Elderly can tell stories to their grandchildren while they share the same physical album on the screen during video chatting. The stories are recorded for legacy purpose.

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**The calibration of optical devices requires special attention, including optical alignment, focus distance and zooming.**

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**Leaving Notes:** Users can use physical pens to leave notes to the user on the other side if necessary. The notes can be retrieved later with their original physical appearance.

**Notification:** Users can greet people on the other side to initiate a talk.
Functional Prototype

Family members are always sharing photographs together, either electronically via internet or physically by printing the photos and mailing them. We noticed that grandparents are especially interested in their grandchildren’s growth. For the seniors who do not know how to use the internet or avoid using it, we merged the digital and physical features to create an easy method for younger generations to send photos and older generations to receive them. Focusing our functional prototype on one single need, we decided to create a digitalized photo album for photo sharing.

**Objective:** We would like our photo album to be intuitive for the elderly. People already connected to the internet and technology can transform the digital format of pictures into a physical format for disconnected people to be able to view. Additionally, elderly with physical photos can scan their photos and send them automatically to an email address by simply placing the photo at a specific section of the album.

**Basic Description:** Our photo album resembles ordinary albums whereby different photos are present on each page but the difference is that these photos are projected onto each page.

The setup is made up of a projector, lamp, camera, and blank album, which are all connected to a laptop (our working system for now). The album is fixed to the lamp base so seniors cannot change its location which would ruin the projector calibration. The camera is at the stem of the lamp to detect the QR code. Our aim is to make that code invisible (read only by an IR camera) or change the code into printed numbers which can be detected and related to a certain photo. All other electronic devices are hidden in the lamp to provide a simple and familiar feeling for older people. This would reduce their resistance to try a new device.
User testing:

We interviewed several people, focusing on Chinese seniors. Most users liked our prototype. Grandparents want to see pictures of their children and grandchildren and the computer is hard for them to use while our album is easy to use and they would not need any training.

As was highlighted in our interviews, younger people are very busy to communicate with their parents or grandparents. This album would decrease the time to input pictures, increasing the communication and photo sharing between generations.

Concerns and future enhancement:

From user testing we found a few issues that we need to deal with for our album to be beneficial and desired by people. The most relevant issues that people are concerned about are:

- They would like the album to hold many pictures (more than the pages can hold)
- They would like to save the photo or print it
- Price of album might be too expensive for simply photo sharing for the average person
- Might not have internet connection, so device will not be useful
- Some desire more photos per page
- The album function is too simple for people who know how to use Ipads, so they would like new extra features in the device
- Would like album to be portable along with lamp
- Would like the album to be separate from lamp
- Pages must be enhanced to be able to flip through album easily
- Pictures projected must be clear and large
Our objective is to provide a gateway for older generations to technology and connect them with younger generations. We want to supply the elderly who are disconnected from the digital world with means to transform physical matters into electronic signals to be communicated to digitally connected generations.

The Family Album is a means of sharing photos that is intuitive for the elderly. Digital pictures are transformed to physical photos on the album page for older people to flip through easily where no new learning would be required. Busy children can send photos to their parents to enjoy via email to the album. From the seniors' side, photos can be scanned once placed on the album and sent to their children's email address. The Family Album is a tool for communication that would require little effort but great satisfaction.
Future Development

Future development of our product aims at enhancing the user experience, making the Family Album pleasurable to use. Photo quality, user interface, and album aesthetics will be perfected to user needs.

**Features to enhance:**
- Clarity, size and position of photo
- Simple photo scanning
- Better options for uploading photos

**Features to include:**
- Intuitive method of organizing and deleting photos
- Printing of photos
- Audio description of selected photos
- Multiple connections
- Adequate notification system

Our Family Album will be designed to be the best gift for children to buy for their parents.

Palo Alto User testing results:
- Album is easy to use, intuitive and very attractive
- Photo not very clear on page
- Flipping through album is hard for some seniors
- More features desired aside from photo sharing for more technically inclined seniors
- High price is a concern
- Some prefer portable device

Interviews in China results:
- 7 out of 8 seniors prefer physical albums because they like the feeling of turning the pages when browsing through the album
- The elderly like to use photos to tell stories to their grandchildren, including their life when the photo was taken and how the person in the photo grew up.

Voice of our User

Designing for seniors is a challenge. To design a device that seniors would use and enjoy we must understand their needs.

**NEED FINDING:**

SIMPLE The device must be simple to use or they will reject it.

INTUITIVE It should be intuitive to them, mainly dealing with applications they are familiar with.

UNBREAKABLE We should produce a low maintenance product that is relatively unbreakable to prevent seniors from just storing it aside when it no longer works.
Executive Summary:

Today, there is a significant and growing divide between members of a family, especially between generations, and we attribute it to three main reasons. The first is physical separation—Quick and easy transport and communication technology today has allowed convenient travel, and work and study have pulled family members to different locations. Another issue is the lack of time for communication—Technology and modern life have brought with them distractions and longer working hours. Not only has the amount of time spent at home decreased, but also the proportion of that time spent on communication and family recreation rather than on housework. The third reason is the generation gap—the differences between generations in interests—whether they like gardening or cooking or watching sports or the news on TV, or playing Call of Duty—and also the differences in the platforms they use for communication and for keeping in touch with the world around them. All this has left a wide disconnect between generations that needs to be urgently addressed. Microsoft Research Asia has tasked our ME310 team of three students from Stanford University and four from USTC, China with tackling this problem.

We started our project by defining our target users. At one end of the spectrum is the younger generation, the digital natives. They grew up with the internet and are frequent, and perhaps obsessive, users of social networking services and instant messaging. They are very comfortable with computers and smart phones. The middle aged people, the digital immigrants, use computers more for work, than for fun. Communication on the computer is mostly by email. They do not use social networking services, and networking is done more over the phone or in person rather than over the internet. At the other end of the spectrum are the elderly users, who keep to older technology like the television, radio, and the phone. Communication mostly involves the phone or even snail mail. They are almost completely insulated from the digital world. This is an important target segment as they are a growing proportion of the population, especially in the developed world and in China.

We found that the few seniors who do use computers and the internet do so to view photos their family sends as attachments. We realized that photo sharing was a need that was not adequately met for most of the elderly. While they had albums of physical photos developed from expensive film, their grandchildren had thousands of photos that could be taken at a moment's notice and at no cost from their phones or digital cameras. We needed to find a way to give seniors access to these pictures. Present attempts to enter this problem space, like digital photo frames, have not been very successful, due to lack of control and difficulty of navigation through photos.

Our solution to the problem is the **Family Album**, which consists of a projector and a camera fixed above a notebook. The camera is used to detect the page number on the book, and the projector displays the appropriate image on the page. It is important to hide the technology, as we found that many seniors had an almost irrational fear of technology—some of them were afraid they would damage the expensive device or they would do something wrong, even with simple devices like a mobile phone. The solution we came up with was to use a lamp on a table as a hiding place for the devices. The album would be fixed under the lamp.
We further recognized that families today have multiple formats of photographs, in varying shapes and sizes, in digital and physical forms. It could be useful to the user if they could easily add photos to our album and get them automatically digitized. So we implemented a scanning feature where physical rectangular photographs kept on specially marked scan pages would be automatically digitized and mailed to the family. We built an automatically generated contents page that would alert the user to new photographs being sent. We also implemented an email input system where photos sent as attachments to a certain email id would automatically be downloaded and displayed on the album. We also built an app that allowed us to easily snap and send photos from a smart phone running Windows Phone OS or Android.

We tested this device with seniors in multiple senior centers near Palo Alto. The feedback was overwhelmingly positive, with users appreciating the ease of use and the intuitive interface. No one needed an explanation of how to use the device - everyone knows how to flip through a book. Some users found it magical, with one user believing that we were using 'magic paper' that would show the photo only under the light of the lamp. Users also told us the importance of having large and clear pictures, and there were mixed comments about the need to have a portable album, one that could be pulled closer to the eye to see the picture better.

In Spring quarter, we plan to work on improving multiple features of the device and go through multiple rounds of testing before setting on a final design. We need to work on improving the picture clarity, adjusting the brightness according to the ambient light. The physical album design needs to be improved to look better and make it easier to flip through pages. The best paper surface for projection needs to be chosen. We will refine and build further options for younger generations to send pictures to the album. Integration with albums from sites like facebook, Flickr, Google Plus etc. would be a necessary step. A challenge will be to find an intuitive interface that allows the seniors to organize pictures that are sent to them, and delete one they don't like. Perhaps we could give them the option to select photos they really like for printing.

By EXPE, we will have smoothed all the rough edges, and have a device that will be the best gift you could give your grandparents!
# Table 1: Bill of Materials

<table>
<thead>
<tr>
<th>Item</th>
<th>Vendor</th>
<th>Price</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamp</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lamp Base</td>
<td>Pottery Barn</td>
<td>$120</td>
<td>Received</td>
</tr>
<tr>
<td>Lamp Shade</td>
<td>Pottery Barn</td>
<td>$60</td>
<td>Received</td>
</tr>
<tr>
<td>Electronic Base</td>
<td>PRL</td>
<td>$20</td>
<td>Need to design</td>
</tr>
<tr>
<td>Album Base</td>
<td>PRL</td>
<td>$20</td>
<td>Need to design</td>
</tr>
<tr>
<td>Album</td>
<td>TAP Solutions</td>
<td>$120</td>
<td>Ordered: Will Receive by Tuesday</td>
</tr>
<tr>
<td>Paper</td>
<td>Envelopments</td>
<td>$30-$60</td>
<td>Need to find proper paper</td>
</tr>
<tr>
<td>Infra red ink</td>
<td>TBA</td>
<td>~30</td>
<td>Need to buy better ink</td>
</tr>
<tr>
<td>Electronics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Projector</td>
<td></td>
<td>$339</td>
<td>Received</td>
</tr>
<tr>
<td>Raspberry Pi</td>
<td>Amazon</td>
<td>$40</td>
<td>Received</td>
</tr>
<tr>
<td>Camera</td>
<td>LogiTech</td>
<td>$50</td>
<td>Received</td>
</tr>
<tr>
<td>Circular Light Bulb</td>
<td>TBA</td>
<td>~$20</td>
<td>Need to buy</td>
</tr>
<tr>
<td><strong>Total Price:</strong></td>
<td></td>
<td>~879</td>
<td></td>
</tr>
</tbody>
</table>

![Figure 1: Lamp Base and Shade](image)
## Table 2: Bill of Processes

<table>
<thead>
<tr>
<th>Item</th>
<th>Action Needed</th>
<th>Deadline</th>
<th>Person in Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lamp</strong></td>
<td><strong>Lamp Base</strong> Hollow out base to pass wires</td>
<td>26-Apr</td>
<td>Sara</td>
</tr>
<tr>
<td></td>
<td><strong>Lamp Shade/Light</strong> Design Inner shade to hide electronics and add new circular lamp</td>
<td>1-May</td>
<td>Sara</td>
</tr>
<tr>
<td></td>
<td><strong>Electronic Base</strong> Design and manufacture</td>
<td>1-May</td>
<td>Sara</td>
</tr>
<tr>
<td></td>
<td><strong>Album Base</strong> Design and manufacture</td>
<td>1-May</td>
<td>Sara</td>
</tr>
<tr>
<td><strong>Album</strong></td>
<td><strong>Album</strong> Print title and logos</td>
<td>2-May</td>
<td>Sara</td>
</tr>
<tr>
<td></td>
<td><strong>Album Pages</strong> Customize pages</td>
<td>6-May</td>
<td>Sara</td>
</tr>
<tr>
<td></td>
<td><strong>Infra red ink</strong> Print on pages</td>
<td>6-May</td>
<td>TBA</td>
</tr>
<tr>
<td><strong>Electronics</strong></td>
<td><strong>Raspberry Pi</strong> Get Stanford Network connected to Pi</td>
<td>25-Apr</td>
<td>Mishel</td>
</tr>
<tr>
<td></td>
<td><strong>Raspberry Pi</strong> Connect to all electronics and make sure it works properly (proper speed)</td>
<td>25-Apr</td>
<td>Mishel</td>
</tr>
<tr>
<td><strong>Software</strong></td>
<td><strong>Programming:</strong> Downloading photo from emails, organize photos sequence, display photos</td>
<td>25-Apr</td>
<td>Tony</td>
</tr>
<tr>
<td></td>
<td><strong>Image Processing</strong> Writing a fast program to link printed code (printed number or image) to page number</td>
<td>25-Apr</td>
<td>Shiquan</td>
</tr>
<tr>
<td></td>
<td><strong>Organizing Photos</strong> Write code to switch between one set of pictures to another</td>
<td>6-May</td>
<td>USTC Team</td>
</tr>
<tr>
<td></td>
<td><strong>Input Options-App</strong> Finalizing Windows app to send photos to album</td>
<td>5-May</td>
<td>USTC Team</td>
</tr>
<tr>
<td></td>
<td><strong>Input Options-Email</strong> Finalizing code for sending photos by email</td>
<td>5-May</td>
<td>Mishel</td>
</tr>
</tbody>
</table>
**User Testing:**

For best results, our device could be kept with a family over a long period of time for them to get used to the device and see how they use it over time. The device can be kept with seniors in China communicating with their children in USA. That would give us feedback from both the users owning the device, and users inputting their photos to enhance the experience of the album.

Since we are limited by time, we would prefer more users to test our device. This would allow us to get immediate feedback to iterate quickly. Since our design requirements are set, we do not need to interview Chinese people specifically, but can widen our users to seniors who have slight or no connection to modern technology.

Senior centers that will be visited for testing:

- Cubberley Community Center – Palo Alto: Wednesdays 9 am-12 pm
  - Group presentation for Chinese seniors on May 8
- Avenidas- Palo Alto: Monday-Friday 9 am-12 pm
Microsoft

Mission 3: Penultimate Design Review

Executive Summary:

Earth is a large planet but over the years technology had helped making two people on opposite sides of the planet just a click away. Over the last 100 years, great achievements have been made that alter our whole lives, whether they are in major procedures like complex heart surgery, or in daily activities like addictive texting. Within this 100 year period, there are sub-periods that can be depicted as the 20 year old, 50 year old, and 80 year old. Noting that this is a generalized image of the majority in each group, we find:

The 20 year old is the one who grew up with computers, phones, video chatting, and social networking—Digital Native.

The 50 year old is the one who learned how to use computers, phones, video chatting, and social networking later in his life—Digital Immigrant.

The 80 year old is the one who might have learned how to use basic forms of computers and phones, but mostly falls back on old fashioned methods of communication—Digital Foreigner.

So, if we place these three people in the same room, how will they communicate? The 50 year old may find common grounds of communication with both, but the 20 year old and 80 year old may have trouble communicating since they are so different. So, due to the generation gap, how will the 20 year olds in the world and 80 year olds communicate? Now assume we remove these three people from this room and place each one in a new location on Earth, how will they communicate due to physical separation? Adding a busy schedule to the younger side, how will lack of time affect communication?

Our mission is to bridge the gap between the Digital Natives (younger generation) and the Digital Foreigners (older generation) while providing a valuable and pleasurable experience for both sides and taking into consideration the effect of the generation gap, physical separation, and lack of time for communication.

Sponsored by Microsoft Research Asia, the Stanford and USTC teams have worked for 30 weeks on accomplishing this mission and providing a successful solution and device.

After extensive research, interviews, and discussions, we compiled a long list of issues that concern the elderly where there are opportunities for enhancement or creation. Some of the solutions that we thought of providing are simplified video chatting, method of saving the senior’s legacy, and physical feeling between two distant people. After trying to take on all these issues, we discovered that a simple great solution will be implemented and appreciated more than a complex average one. Seniors (Digital Foreigners) have clearly stated their value of
family photos and memories, so we decided to create a photo sharing solution that would relate to the seniors who receive the photos and the younger people who send them.

Present attempts to enter this problem space (Digital Photo Sharing), like digital photo frames, have not been very successful due to lack of control, difficulty of navigation through photos, and fear of complexity of the device by seniors. Our solution is the Family Album, a photo sharing device, which consists of a projector and a camera fixed above a blank paged-photo album. The camera is used to detect the page number/code on the book, and the projector displays the appropriate image on the page. It is important to hide the technology, as not to alert seniors, so we merged the electronics with a lamp that could be found in any home.

Photos are inputted into the album by either sending an email with the attached images that will be automatically downloaded and displayed on the album or by using the created application from a smart phone running Windows Phone OS or Android. The Family Album will alert the user of any new photos received by showing it on the contents page. Since there are a finite number of pages and infinite number of photos, we decided to combine the photos into several albums, flipping through the albums using a switch.

We tested our device with seniors in multiple senior centers near Palo Alto. The feedback was overwhelmingly positive, with users appreciating the ease of use and the intuitive interface. No one needed an explanation of how to use the device - everyone knows how to flip through an album. Some users found it magical, with one user believing that we were using 'magic paper' that would show the photo only under the light of the lamp. Users also told us the importance of having large and clear pictures, and there were mixed comments about the need to have a portable album, one that could be pulled closer to the eye to see the picture better.

We hope that our solution is successful and implemented by Microsoft.
Guiding Questions and Discussion:

Need: Many seniors are extremely uncomfortable with using computers and smartphones, and the few who do use it mainly to see pictures mailed to them by their family.

A lot of the communication between seniors and their families involves photo sharing, since they are worried about wasting their children’s time with realtime communication, and time zones often come in the way.

Question: Can we simplify the process of browsing pictures for seniors?

Our solution:

Album with photos under a lamp, something that fits well in a living room

Interface for the younger generation: Smartphone app, email id

Assumption:

- Seniors know how to use an album, and will not need to learn any new behaviours to use our Family Album.
- They will accept the device as something that belongs in the living room and not with the computer

Design Requirements:

Functional Requirements:

<table>
<thead>
<tr>
<th>Functional Requirements</th>
<th>Metrics</th>
<th>Rationale</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>The photo should be clear enough to see.</td>
<td>Resolution &gt; 72 ppi (older mac screens) Projector brightness&gt; 100 lumens.</td>
<td>Essential for photo rendering.</td>
<td>Pico Projector with resolution:1024x768 Brightness: 300 lumens</td>
</tr>
<tr>
<td>The transition between photos should be smooth enough.</td>
<td>New photo should appear at most 0.5s after the user puts down the new page</td>
<td>Avoid breaking the physical album metaphor; long delay ruins user experience.</td>
<td>Response time &lt; 100ms • Strip down linux to only essential components, block loading unnecessary kernel modules • Overclock RPi • Change from Python</td>
</tr>
<tr>
<td>Requirement</td>
<td>Description</td>
<td>Measurement</td>
<td>Notes</td>
</tr>
<tr>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>-------</td>
</tr>
</tbody>
</table>
| Motion of pages within normal limits (without damaging the page) does not affect the detection | Not only for system stability, but can also make the photo transition more natural | Criterion met | - Redundancy of the colour pattern for page number detection  
- Larger pattern |
| Impossible for user to block the light by head | The lamp should cover less than 25% of the area in the space above the album | Prevent occasionally blocking the light when approaching to the album to look more clearly | The lamp covers <10% area directly above the album. With the projector located near the center of the lamp support, the projecting angle is around 60deg. The album has been moved further away from the lamp |
| Sufficient Brightness | Image should remain clear under lamplight or sunlight from outside the window | Increase the usability and flexibility | Pico Projector with Brightness: 300 lumens |
| Easy Installation | Only one cable and connector allowed. Just like other conventional household appliances. | Easy for seniors to use and make it looks familiar. | Only one cable and connector allowed. Just like other conventional household appliances. A Wifi adapter can be set up somewhere else unobtrusively. |
| Change Album | Albums should be changeable so that the number of viewable photos is expanded and albums can be dedicated to people/events | So as to satisfy users’ needs on different albums. | Users can pull the string besides the lamp to change to another album |
| Good durability | The device should be able to work continuously for at least one year on average. | Minimum requirement for a design to become a qualified product. | - Robust Program and electrical wiring  
- Stable, difficult to knock over  
- Most of the ‘technology’ is hidden in a casing  
- Album pages difficult to tear, can
Physical Requirements:

<table>
<thead>
<tr>
<th>Physical Requirements</th>
<th>Metrics</th>
<th>Rationale</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>The projected photo should be in proper position and size.</td>
<td>In the middle of the page and cover 60% of the entire page area.</td>
<td>Makes it look natural, and big enough to see.</td>
<td>In the middle of the page and covers around 60% of the entire page area, depending on the aspect ratio</td>
</tr>
<tr>
<td>The album should look traditional and be familiar to seniors.</td>
<td>&gt;90% seniors can recognize it is a photo album with one glance.</td>
<td>Makes it familiar and comfortable for seniors to use.</td>
<td>A modified album with a dark color. Not tested with seniors yet.</td>
</tr>
<tr>
<td>Stability</td>
<td>With 10N force exerted on the album to lift it won’t cause the lamp to topple over.</td>
<td>To keep the device balanced in case seniors might try to pick up the album</td>
<td>Good connection between the lamp base and the album with two types of fixture.</td>
</tr>
<tr>
<td>Paper material should be carefully selected.</td>
<td>Rough enough to prevent glare or reflection; Strong enough to prevent warping, folding or curling of the page.</td>
<td>Important for user experience and product durability</td>
<td>The papers are without glare or reflection. Corners of the paper are reinforced by metal corners to prevent it from being warped.</td>
</tr>
<tr>
<td>The pages should be easy for flipping.</td>
<td>The edge of the pages should be closed to edge of the covers, the distance should &lt;0.5cm.</td>
<td>Pages hidden deep inside the covers are difficult to reach.</td>
<td>Corners of the paper are reinforced by metal corners to make flipping easier.</td>
</tr>
<tr>
<td>The lamp should be high enough above the album.</td>
<td>The distance between lamp cap bottom edge and album should &gt;50cm.</td>
<td>Make it looks more natural and comfortable for use.</td>
<td>The distance between lamp cap bottom edge and album is ###</td>
</tr>
<tr>
<td>Size should be small enough</td>
<td>Within 40cm<em>40cm</em>80cm</td>
<td>Easy to find a corner at home to accommodate it.</td>
<td>Total box size: ###</td>
</tr>
</tbody>
</table>
Latest Model:
User Testing:

We had a 20 minute presentation of our Family Album to seniors, mainly of Chinese origin, at Cubberley Community Center in Palo Alto on May 8, 2013. The two teammates, Shiquan Wang and Xuesen Li, presented in Chinese and English to relate to all the audience (50-100 seniors). Most of the seniors provided positive feedback regarding our product. They thought it was good way to see their grandchildren’s photos especially since most of them do not know how to use computers. Some of them even stated that they wanted to buy an album immediately after it enters the market. Seniors were grateful that we took the time to analyze their needs and listen to their concerns, and were very excited to express their opinions. However, some opinions were negative whereby seniors who know how to use computers and tablets showed no interest in our product.
Two Week Future Plan:

<table>
<thead>
<tr>
<th>Course Deadlines</th>
<th>23 Thu</th>
<th>24 Fri</th>
<th>25 Sat</th>
<th>26 Sun</th>
<th>27 Mon</th>
<th>28 Tue</th>
<th>29 Wed</th>
</tr>
</thead>
<tbody>
<tr>
<td>SGM, this document is due</td>
<td>EXPE brochure, poster draft due</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Team</strong></td>
<td>Yingwei, June arrive</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Hardware</strong></td>
<td>Buy acrylic, Laser-cut base and everything else</td>
<td>3d printing</td>
<td>3d printing</td>
<td>3d printing</td>
<td>Assemble everything</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Software</strong></td>
<td>Finalize smartphone app interface</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>EXPE prep</strong></td>
<td>Prepare material for the brochure, poster</td>
<td>Brochure design, layout</td>
<td>After assembling, take pictures for the brochure and poster</td>
<td>Cubberly community center Chinese seniors for testing - take videos</td>
<td>Finalize brochure</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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<tr>
<th>Course Deadlines</th>
<th>30 Thu</th>
<th>31 Fri</th>
<th>1 Sat</th>
<th>2 Sun</th>
<th>3 Mon</th>
<th>4 Tue</th>
<th>5 Wed</th>
<th>6 Thu</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXPE brochure, poster final copy due</td>
<td>EXPE presentation rehearsals</td>
<td>SUGAR EXPE</td>
<td><strong>EXPE</strong></td>
<td>Yunjun, Paul arrive</td>
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<td><strong>Team</strong></td>
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The Vision
Connecting seniors who do not use technology to their younger family members.

The Need
Creating a photo sharing experience that combines the connectivity and convenience of the digital world with the familiarity of a traditional album.

The Product
The family album is a digital photo album that is designed for seniors. It consists of a paper album fixed with a traditional lamp that can fit perfectly in the familiar environment of a living room. The user can flip through the pages of the album to browse through images without the training required with a new interface.
The Family Album is synced to the cloud, and photos can be added via an email interface or via the smartphone app. The app lets the user control what is displayed in the album.

**Lamp** keeps technology out of sight.

**Phone app & email** add and edit photos, captions and albums.

**Pull switch** to cycle through multiple albums.

**Flip through pages** to browse photos.

---

**The Response**

“" I wouldn't need to arrange a Skype session with my son in Australia or struggle with a computer to see my grandkids. ""

“" The album will go in my living room and not sit next to the computer. ""
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The Response
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“The album will go in my living room and not sit next to the computer.”

Get away from the screens. Get back to the Album. And get back home.

Our Team
Mishel Johns
Shiquan Wang
Tony Li
Sara Jaafar
Yingwei Li
Yikang Liu
Yunjun Wu
Jingxian Zhang
Microsoft Liaison: Jiawei Gu