Introduction

Parking is a huge pain spot for many drivers. Inefficient allocation of space, lack of knowledge about parking availability, and lack of visibility in regarding pedestrians, blind spots, and danger zones all greatly contribute to parking problems. Thus, we decided to design a Smart Parking System (SPS) to assist drivers in finding and paying for parking spots when and where they need them. The SPS has the capacity to become a one-stop driving and parking solutions provider for frustrated drivers.

Meet Tom

Tom is a 23-year-old associate at Sterling & Co, a major investment bank in NYC. Like many others in the city, he commutes to work each and every day, so he uses his car quite frequently. He often has trouble finding parking spots, which gets very frustrating. Tom frequently becomes stressed because poor traffic conditions hinder his ability to easily find parking. When Tom is running late, which seems to be a common phenomenon, parking issues could cause more serious problems, such as missing a flight or having to confront management about untimeliness.

Drivers such as Tom face increased stress levels, lose valuable time and experience decreased productivity due to parking woes. The following statistics, from a 2011 study conducted by IBM across 20 major international cities, highlight existing parking-related problems, which can be greatly reduced through using the SPS:

- Drivers in urban areas need nearly 20 minutes on average to find parking
- Between 30 to 45 percent of traffic in cities is caused by drivers looking for parking
- Sixty percent of drivers reported giving up on finding parking at least once in the calendar year
- Twenty seven percent of the drivers surveyed got into arguments with fellow motorists over parking spaces.
We thought it was important to account for both the lifestyles and problems faced by drivers in our design process. For instance, we chose to give users the option of interacting with the SPS through an app (desktop, smartphone, tablet) or in-car interface (navigation systems, dashboard, and windshield displays) because we know that most drivers will have access to a device that facilitates communication and an Internet data plan, and an increasing number of cars are being manufactured with the option of adding built-in displays or navigation systems. Furthermore, the need to make pre-meditated or on-the-go parking decisions is also accounted for by our dual interface options. The SPS algorithms will reserve a parking space once a user has selected it in order to minimize inconveniences that may arise between drives seeking the same spot.

**Technologies Driving the SPS**

There is a clear need for a technological solution such as the SPS in society, especially in densely populated urban locations, to improve the overall parking experience. Ideally, the SPS would be ubiquitous, such that it is integrated into every driver’s life, allowing for the standardization of the technology across all vehicles and providing a more uniform user experience.

The windshield would act as a display screen, leveraging augmented reality technology to superimpose driving directions on what the driver sees through the glass, so when the driver sees the directional arrows (e.g. for a right turn at a certain road), it appears overlayed on the road itself. This reduces the risks of detracting from the situational awareness of drivers that typical GPS-powered navigation systems currently cause, because the driver would then not need to divert their attention away from the road when taking a sideways glance to look at directions
from a display. Currently, this is more of a future technology, but development on similar
technology has already begun in research labs across the world.

To help mitigate the risks associated with using the technology and ensuring the safety of its users, the SPS has many built in safety features. Functionality-wise, the in-car portion of the SPS is very similar to an advanced in-car GPS. The driver cannot interact with the touchscreen to set a new destination or select and pay for a parking space when the vehicle is in motion. This feature reduces the risks associated with diverting the driver’s attention from driving caused by him/her interacting with the SPS. If the driver were to have a passenger with him (which could easily be sensed in any vehicle nowadays), some of these features may be enabled for passenger use.

On the other hand, both when the vehicle is in motion and stopped, the driver can interact with the SPS through a series of voice commands. When the car is in motion, the driver may query the SPS to do a more limited array of tasks revolving around finding a parking spot, such as “Find me the nearest parking spot to [destination] X”, or “Take me to [destination] Y”. This limitation of commands reduces the complexity of the actions the driver needs to take when driving, and reduces the distractions involved with using another system while driving. When the car is stationary, the driver has access to a larger host of verbal commands, such as querying for historical data about parking lots (like accident history, thefts, etc.) through commands like “show me the thefts that have occurred here over the last 6 months”. These added commands give the driver the opportunity to get a quick glimpse at whatever data they want to see.

One very important part of this system revolves around tracking whether a particular parking spot has been occupied or not at any given time. There are a variety of ways to approach sensing whether a particular parking stall has been occupied or not. First, with accurate enough
GPS systems, coordinates should be able to be triangulated with enough precision such that the parking spot can be determined. While we are not far from such precise systems, it may take a few more years of technological development before such a method of determining the status of each parking spot to be viable. Alternatively, license plate tracking technology or various sensors located around each parking stall could be implemented. The feasibility of using these various systems depends on how widespread the adoption of this system is at any given point. For example, if the penetration rate is extremely high, then using GPS data would likely be a comparatively more inexpensive way to approach this problem. On the other hand, if adoption of the technology is few and in between, employing sensors at each parking stall would be the most accurate - albeit not that cost effective - method of tracking occupancy data.

The SPS simplifies the parking experience, through directly handling payments for parking options. When the user chooses a parking spot, he/she also agrees to paying for the parking spot, removing the need to leave the car to pay for parking or go through additional steps.

Additionally, internet databases, maintaining historical data tracking everything from pricing trends to parking habits of users to the safety records of various parking spaces. This historical data would act as a data mine for both users and enterprises operating garages. For users, access to these databases would allow the SPS interface to display records of points like safety (i.e. accident records, thefts, high pedestrian zones, etc.), allowing them to make a more informed decision about where to park, and what to watch out for. On the flip side, tracking pricing and the spending habits of users allows operators of parking places to better price discriminate, helping them maximize their profits.
**Our Big Idea – The Smart Parking System**

Our Smart Parking System aims to optimize and distribute effective parking information to drivers. It does so through integration with traffic information systems, data mining, and global positioning systems. Assuming we can pull this off perfectly, we expect there to be no more problems caused by parking for drivers! The possibility of potentially creating a uniform system for all drivers to use that will allow for an equilibrium between supply and demand of parking is quite exciting and needs attention. Can you imagine the day when you have no problems finding parking near your favorite store at the mall and the experience is not only stress-free, but also convenient and timely? There exists a market opportunity now to take advantage of the problems faced by drivers while parking because no one has created a system as comprehensive as the SPS yet.

**Tom’s Story Revisited**

The SPS would be perfect for drivers like Tom. On this particular morning, he's woken up at 8:31 a.m. but has a meeting beginning promptly at nine. As Tom rushes to get ready he realizes that although he has just enough time to make the drive, he will be late because he has to find a parking spot. Fear not, Tom! There is still a way for Tom to get to his meeting on time! Tom pulls out his mobile phone, opens up his maps app of choice, and selects the SPS tab. We see here that he is brought to a screen where he can quickly either decide to search for parking near his workplace, home or other "on demand" location. He also has the option of setting more custom "favorite" locations such as his girlfriend Hillary's home. Tom is in a hurry right now, so he chooses his workplace, setting the start and end time for his requested reservation. The SPS generates four unique parking options-- each one located a different distance from Sterling & Co and charging a different amount of money -- for Tom to choose from, based on how pressed he is
for time and how much he's willing to pay. Tom has no time to spare, so he chooses the closest (and most expensive) spot. Without even having to re-enter his payment information (it has been previously saved by the SPS for quick and convenient parking reservations), Tom’s parking is paid for through his credit card, which has been connected to the SPS e-payment system.

Once a reservation is made, the SPS digitally marks the reserved spot as taken as well as physically denoting its occupation status with a red light near the parking space (to be discussed in more detail later). Certain limited parking spaces are available for rental; all others are standard parking spots. Once a spot has been "taken" the Smart Parking System will ensure that no other user can reserve or be directed to the spot. In fact, if you drive into a spot without the proper reservation, you will be warned about potential fining/towing. If your reservation is wrongfully taken by another and is no longer available, the SPS would redirect you to the next closest spot, charging you at a greatly reduced rate.

In Tom’s case, as expected because he is using the SPS, Tom effortlessly directed to his parking space, and manages to make it to his meeting on time, rushing through the door at 8:56am. His parking space will be locked down for him until the time he has specified for it to end, in this case, 8 hours and 19 minutes later. If he gets caught up at work and no one has reserved his spot after his reservation ends, Tom can extend his reservation. Today, Tom will not be extending his reservation though, because he and his girlfriend are going on a date to see Wicked on Broadway after work.

Once Tom picks up Hillary and they arrive in the parking garage, Tom verbally asks the SPS to direct him to the parking space closest to the ticket booths, since Hillary wore high heels today, and would strongly prefer to walk as little as possible. The SPS proceeds to give him vocal directions to the parking space, so he doesn't have to take his eyes off the road. However,
because he is driving with a passenger, Hillary, the SPS offers them the option of requesting for additional information. By enabling these features (either verbally or via touch) handicapped parking spaces in the area can be displayed in blue and free parking spots in green. In addition, areas historically associated with a high frequency of collisions, theft and heavy pedestrian crossings are highlighted in red.

With the adoption of augmented reality technology, the SPS can overlay visual navigation information on Tom’s view of the road. Often, current GPS navigation system users find it unpleasant to utilize both the auditory functions and visual directions located on their mobile phones or side displays concurrently. Such a phenomenon could certainly occur with the SPS, in which case this more visual method of conveying directions offers an advantageous alternative. Tom does not have to take his eyes off the road, as is the case with the utilization of a traditional GPS navigation screen, nor does he even have to listen for directions. Doing so may be a nuisance to him if he's conversing with Hillary or enjoying the radio. Tom's parking spot is secured as soon as the SPS begins directing him there. The stall is denoted as occupied by a red light. The free stalls, on the other hand, display a green light, intuitively suggesting to other drivers their availability.

Thanks to the SPS, Tom has had an amazing start and end to his work day. He and Hillary got to their movie on time and as he turns off his mobile phone for the first time in weeks while they settle into their theater seats, he feels relieved and happy that he bought the SPS because it has become a painkiller to his previous parking problems.

**Looking Beyond Tom’s Story**

Despite Tom’s great experience with the SPS, for the SPS to be truly successful it must be widely implemented. In order to reach critical mass and ensure ubiquity of the SPS,
agreement must be reached between the SPS, municipal councils (for public parking spaces) and parking lot operators (for private parking spaces). While this is expected to significant amounts of time, we believe that our comprehensive, insightful argument would win even the most stubborn of parking lot owners over. To better facilitate and encourage adoption of this technology, some functionality of the SPS (including reservation of, and turn by turn to parking spots) could be enabled as an add on to all existing mapping frameworks (like Google Maps, Apple Maps, etc.).

Because operators using the SPS have access real-time data about drivers needs with regards to parking, they could put more cars into lots, ensuring that full capacity is reached when there is sufficient demand while charging at different price points to maximize profits. We know that this is an extremely pertinent concern to the parking lot industry, as the International Parking Institute (IPI) estimates that $25-30 billion in gross parking revenues were generated nationally last year. The SPS presents the opportunity to achieve an optimal equilibrium through data mining processes that allow for potentially increased revenues; we are confident that parking lot providers will be interested in participating in the SPS system. Economically, friction theory explains why there might be times when a mismatch of information (or lack of it) between parking lot providers and drivers causes either an oversupply or excessive demand of parking spaces. This mismatch of parking capacity and consumer awareness leads to either two outcomes, both of which are undesirable: empty parking lots or frustrated drivers-- both of which parking lot owners would like to avoid.

The Smart Parking System also allows parking lot owners to differentiate between drivers who often have different parking needs, and thus, are willing to pay different prices. Price discrimination could be applied to a parking lot through integration with the SPS. Through the
use of this technology, parking lot operators will be able to automatically charge a premium price to drivers who are willing to pay more for a shorter walk or safer parking spot. They’ll consequently see an increase in total revenues as they will now be charging two separate segments of the market two distinct prices, leading to maximized revenues for each segment. The prospect of an increase in revenues will then activate the competitive trait amongst the players in the parking lot industry, ensuring that when one signs on, they will all feel the need to do so in order to avoid losing a part of their revenue stream. As the amount of partnerships SPS has with parking lot providers grows, SPS’ contribution to solving driver’s parking problem will increase.
Works Cited

