**Motivation:** Autonomous aerial and underwater vehicles are finding growing applications in areas that require vision-based sensing, including reconnaissance, ortho-mosaicking and terrain modeling [1], and mapping of benthic sites of scientific and biological interest [2]. In mapping applications, the mosaicking of multiple images captured at low altitude maximizes resolution of the region of interest. In particular, in cases of limited lighting and visibility (e.g., in underwater imaging), maintaining an altitude of a few meters is required to produce sufficient detail in the captured images. Reconstructing the entire region of interest, registering adjacent frames, and minimizing seams and artifacts given variation in vehicle position, lighting, and terrain become key questions in practical algorithms for low-altitude aerial surveillance. More importantly, real-time registration of images marking the same point in a self-intersecting trajectory paves the way for motion-constrained vehicles to carry out benthic mapping [3], as the terrain-following system currently in use on some long-range autonomous underwater vehicles optimized for forward motion does not guarantee the image overlap necessary to produce benthic maps.

**Goals and Implementation:** The objective of the project is to take a first step in moving toward real-time localization using a single downward-facing camera attached to an unmanned aerial vehicle (UAV). The project aims to take images captured periodically throughout a trajectory designed for aerial surveillance and mosaic them together to form a high-resolution map of the region of interest. A quadrotor platform is currently available for use through the Aerospace Robotics Lab. To gather the required images, a GoPro will be mounted to the underside of the quadrotor and run on auto-capture mode throughout the duration of flight. For this project images will be post-processed, with the longer-term research goal of processing images on-board for real-time localization.

Project milestones are as follows:

1. Develop a mosaicked map of a small area of Stanford’s campus by applying mosaicking algorithms discussed in class. Doing so will require nonlinear transformations to minimize the fish-eye effect of the GoPro.
2. If necessary, apply image averaging and subtraction to remove the quadrotor shadow.
3. Adjust for uneven lighting across each photo to smooth the effect of seams through image averaging and subtraction or by applying the gain compensation and/or multi-band blending techniques discussed by Brown and Lowe [4].
4. If there is time, apply feature and image matching techniques discussed by Brown and Lowe [4] and/or combined metadata and image-based approaches discussed by Yahyanejad [5] to reduce distortion and improve processing time. Compare quality and runtime of results.
The minimum deliverable will be a mosaicked map of a small area of Stanford’s campus with at least one additional image processing operation applied. Please note that an Android phone will not be used in this project.

References:


