School of Civil and Environmental Engineering

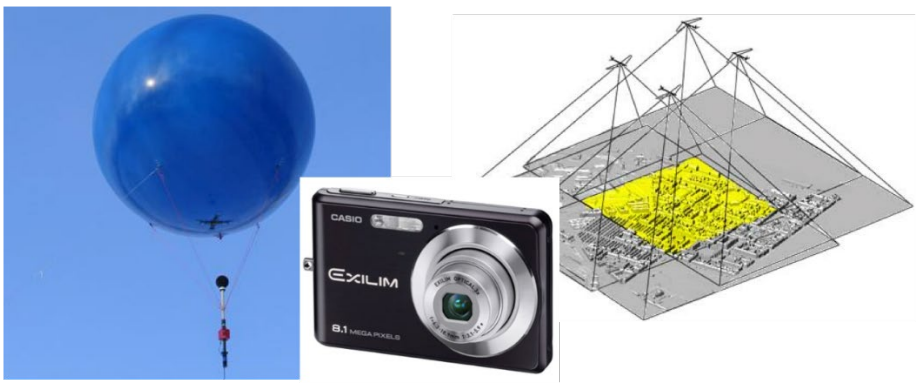
ENGG1000: Surveying and Geospatial Engineering
Mapping with Drones

Objective
In this project you will create your own drone (using a balloon), collect images with your drone, and create a 3D point cloud to develop a map for analysis.

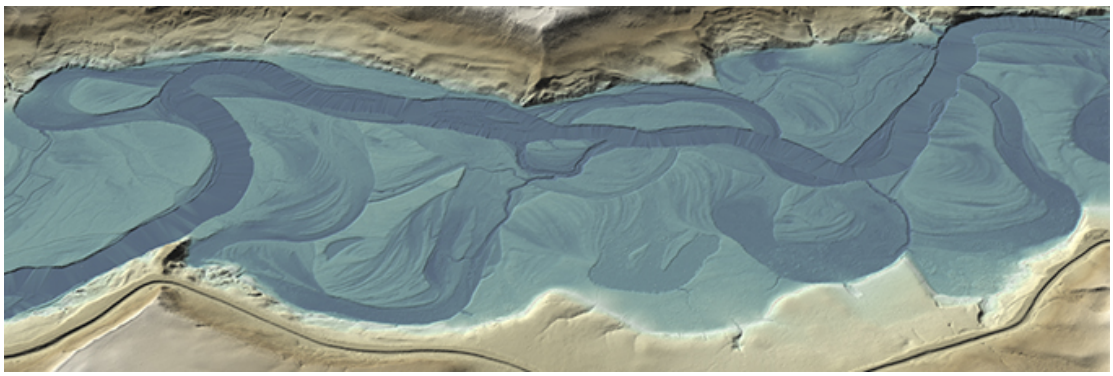
Background
Imaging systems range from simple hand-held cameras to sophisticated spectrometers on satellites. In the past decade, the design and implementation of unmanned aerial systems (UAS or drones) has exploded. Depending on the design, a drone can host a simple or sophisticated imaging sensor. The data from these sensors can be used to make topographic maps (even underwater), estimate vegetation biomass (carbon), quantify coastal erosion, estimate bushfire impacts, and so much more. The applications are limitless! Yet, almost all of this information starts with some type of a map that is developed with images from the imaging system.

Maps convey information in a graphical way. Features on maps are at scale, and can be used to navigate and measure features such as terrain (elevation), water bodies, or land or political boundaries. Map-making has a long history, and is perhaps one of the oldest means of non-verbal communication. Maps were traditionally created by collecting data in the field by cartographers, navigators or surveyors. Now we can make maps with drones!

The advent of low-cost digital cameras and sophisticated image processing software has made small area mapping viable for surveyors and engineers. Today's maps are typically pixel-based images, digital vector data (think roads), or 3D point clouds. The latter can be made using traditional photogrammetry techniques using multiple overlapping images. These images are then used to create 3D models that can be analysed for their geometric properties, such as calculating beach volume change or erosion from bushfires.



Example of a helium balloon carrying an out of pocket digital camera, along with graphic of multiple positions of the terrain to create a 3D map.


Using 3D point clouds to map a river (below water) and along banks. Credit: Quantum Spatial

Design Task Summary

Your task is to work within a small team to design and construct an imaging system comprising a helium balloon, to which a digital camera can be attached. This system is then manoeuvred across an area of campus of a few hundred square metres – the NE corner of the Physics Lawn, near the entrance to the Old Main Building. You will collect multiple digital images and using the "Pix4D" image processing software, you will produce a digital map.

Project Lectures

A series of lectures will be provided to complement the project as outlined in Table 1. **You will need to attend all lectures.**

Table 1: Lectures

Project-specific lectures	**ENGG1000 all project lectures**
Introduction to the project and to the principles of photogrammetry Modern mapping, remote sensing & imaging processing Coordinates, map products & applications	Teamwork & technical report writing Sustainable design and construction technologies and practices; societal and environmental ethics Engineering drawing (CAD)

Design Specifics

Design, execute and report on the various steps in the construction and operation of a low-cost helium balloon digital imaging system. There will be several aspects to this:

1. Design of the image acquisition system – comprising a tethered helium balloon carrying a digital camera.
2. Execution of the image data acquisition task – involving the moving of the balloon/camera system across the patch of campus to be mapped, ensuring that multiple images are taken with the appropriate amount of overlap.
3. Ingesting the images into the "Pix4D" image processing software to "stitch" together multiple images to produce a single 3D model of the ground.
4. Validation of the map product to determine its accuracy.

This project takes advantage of helium balloons, lightweight digital cameras, and sophisticated image processing software to demonstrate the feasibility of a low-cost system constructed from materials and technologies that are easily obtained. A comparison between your Do It Yourself imaging system with sophisticated mapping systems will demonstrate the progress and future opportunities in geospatial engineering.

Deliverables

The **Draft Report** is due Monday, Week 7.
The **Final Report** is due Monday, Week 11. **Testing** will be conducted in Week 11.

Deliverable 1: The Written Report

The primary deliverable is a group report that will include sections on:

- Principles of Photogrammetric Map-Making
- Design of image data acquisition system, based on a helium balloon
- Testing of photogrammetric map-making using terrestrial camera experiment
- Execution of balloon-based image acquisition
- Results of image processing using the "Pix4D" software
- A consideration of sustainability aspects related to the acquisition system you have designed and tested, and potential applications in sustainability.

Each of these will be marked against specific criteria, including quality of design, fieldwork, computations and CAD drawing; quality of appraisal; and quality of report (format, grammar, referencing, use of tables/figures, etc).

Deliverable 2: Test of Quality of Map Product

Each team will be required to evaluate the quality of their map product during the Week 11 Test Period. This will involve incorporating external information and the measurement tools within AutoCAD.