COLLEGE OF ENGINEERING

Mechanical, Industrial, and Manufacturing Engineering

AERO.07

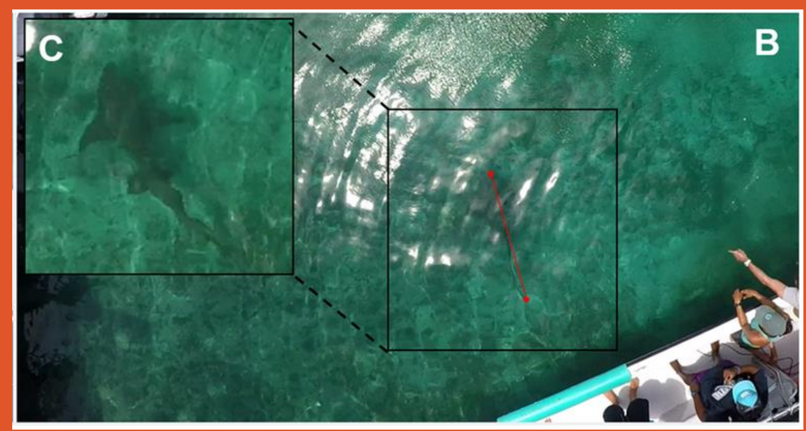

Figure 1. *Measuring a nurse shark with a stereo-video system prototype.*

STEREO-VIDEO EQUIPPED DRONE FOR MEASURING MARINE MEGAFAUNA

Design and Engineering R&D Lab

Team Members: Fischer Hill, Elliott Chimienti, Azara Tilt

Advisors: *Dr. Susan Piacenza and Dr. Joseph Piacenza*

BACKGROUND

The purpose of this project is to design a stereo-video camera (SVC) equipped drone, used for measuring the size of ocean wildlife, such as nurse sharks and turtles. Knowing an animal's morphology is valuable data for ecological studies and can help to infer other information, such as food consumption, body mass, and population health. Although solutions exist to measure the size of marine megafauna, an SVC system can reduce the impact on wildlife while collecting data quickly and accurately.

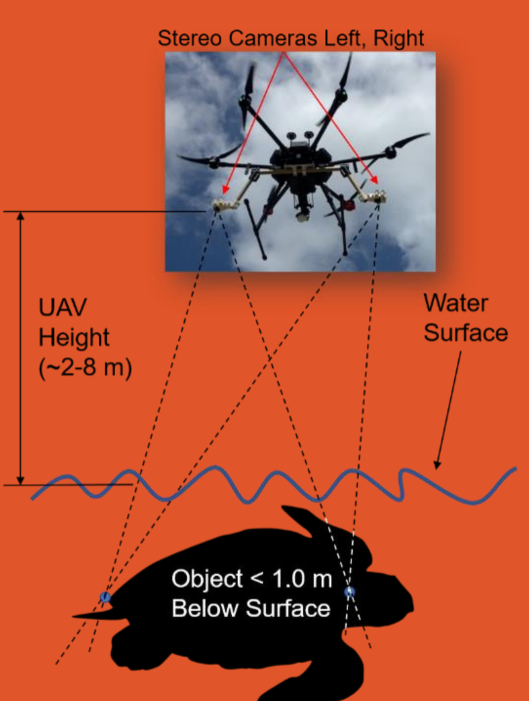

Figure 2. *Using stereo-vision footage and triangulation to measure objects.*

DESIGN REQUIREMENTS

- Lightweight.
- Flight time > 15 minutes.
- Accuracy > 95% (<50 mm error at 5-meter range).
- Stability – Land in 15 mph wind and all user inputs.
- Python based post processing software.
- Portable (fits in carry on bag).
- Calibration time < 15 minutes.
- Object measurement speed < 15 seconds.
- Cost < Budget.
- Robust (3 ft crash survival).

Oregon State University

INITIAL TESTING

The team set out to determine the maximum weight the drone could carry in flight, the ideal separation distance between the cameras (known as the baseline), as well as the effect of range on accuracy. A design which allowed for enough camera separation for accurate measurements while having a minimal effect on flight stability was required. Testing showed that accuracy increased with increasing baseline, decreased with increasing range, and SVC would need to weight less than 300 grams (Fig. 3).

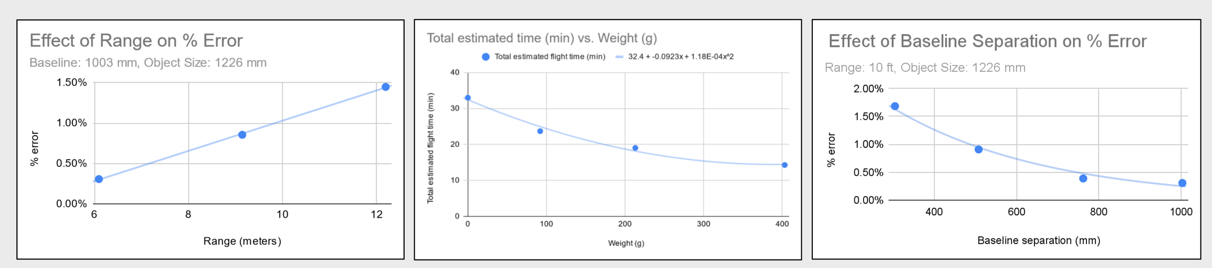

Figure 3. *Effect of weight on drone battery life, effect of range on accuracy, and effect of baseline on accuracy.*

DESIGN PROCESS

An initial prototype was constructed as a test platform to inform the final design and support software development. The initial prototype was stable but introduced vibration in the cameras, resulting in low accuracy in the field.

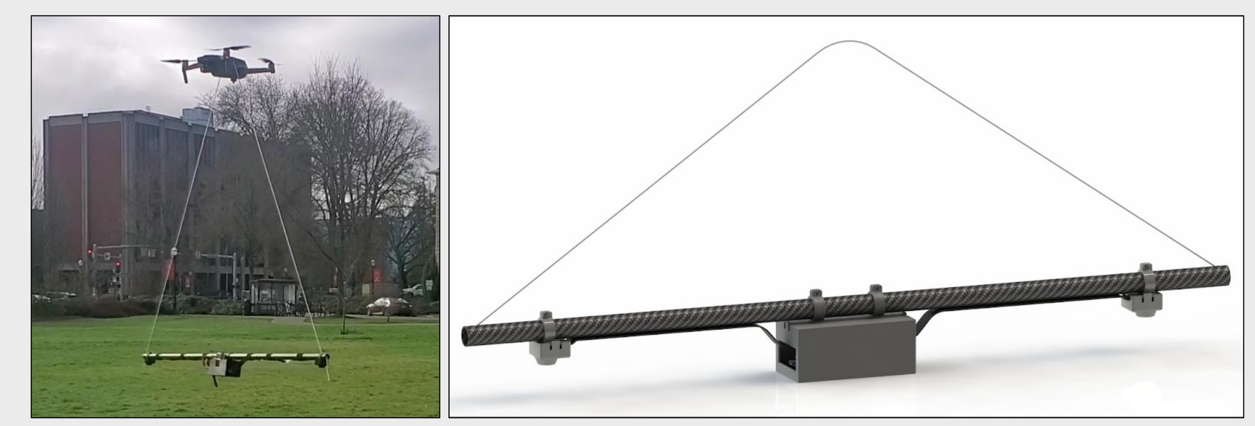

Figure 4. *Initial prototype for testing the effect of changing design parameters.*

HARDWARE

The final SVC system is mounted rigidly to a Mavic Air 2 drone. The cameras are mounted to the legs of the drone, housed in a 3D printed enclosure. The computer module, Raspberry Pi, external battery, and DC to DC converter are mounted to the top of the drone with a GoPro mount, also housed in a 3D printed enclosure. The design is lightweight, compact, and easy to use. The cameras can be detached easily with a snap feature, and the computer enclosure is attached with a GoPro mounting feature that is easily removed.

Figure 5. *SVC final design with cameras mounted to the drone legs.*

SOFTWARE

The post processing software contains a table for collected data, video player, and popup windows that allow for easy calibration. The popup window has image importing for single or stereo camera calibration, and input boxes for checkerboard parameters. After a successful calibration, the user can import footage and select points for a measurement. The software has video playback and scrubbing functionality, as well as zooming capabilities. Once all measurement points have been selected, the table is populated, and the data can be exported.

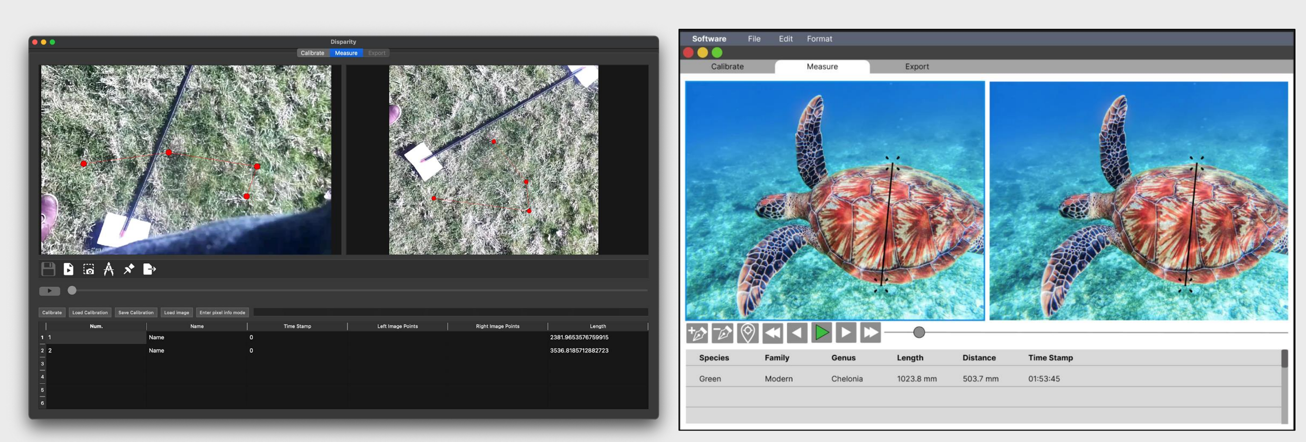

Figure 6. *Post processing software - graphical user interface*

RESULTS

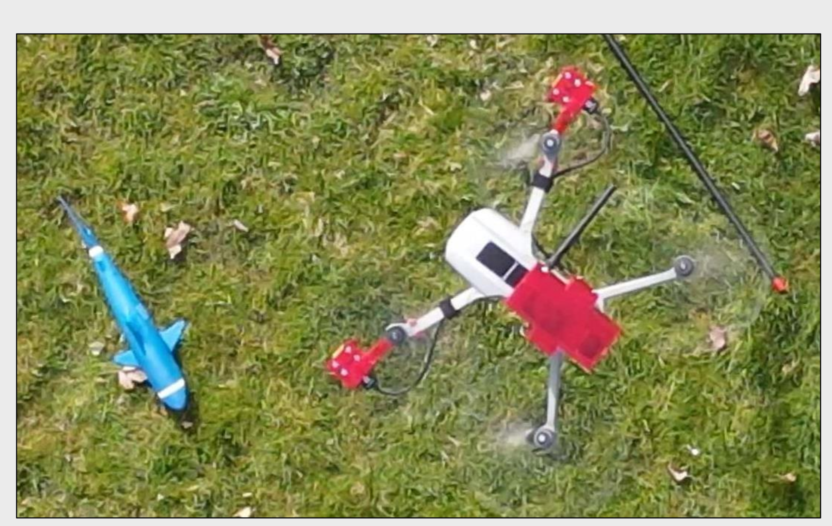

Figure 7. *Drone mounted SVC system measuring objects below.*

The final design achieved a flight time of more than 15 minutes, at a weight of around 300 grams. The design is portable, compact, and easy to use. The python post processing software achieved a calibration time of 10 minutes. In ideal conditions, the error was less than 1% at a 5-meter range. Testing in the field resulted in approximately 6% error at 6-meter range. The solution was low cost, well below the team's budget.

Figure 8. *Drone mounted SVC system in flight.*

FUTURE WORK

Hardware

- Lightweight computer module and camera enclosures.
- Reduce camera vibration and increase accuracy.
- Add features such as on/off switch, indicator lights, and polarized lenses.
- Implement optical zoom to improve range.
- Make enclosures impervious to heat and water.

Software

- Add video filters to reduce visual background noise and increase visibility of target.
- Implement artificial intelligence to automate animal recognition and measurement.

ACKNOWLEDGMENTS

- **Dr. Joseph Piacenza and Dr. Susan Piacenza** for inspiring this project and contributing their expertise on ecological research, and stereo-vision.
- **John Faller** for his work on the initial software design and stereo-vision expertise.
- **Professor John Greeven** for his guidance and support.
- **The OSU Advantage Accelerator staff** for their expertise on commercialization.
- **Clara Bird** with the Geospatial Ecology of Marine Megafauna (GEMM) lab at OSU for her time and expertise on drones and morphology.
- **The OSU student volunteers** that contributed to our design ideation and testing, for their creativity and time.

lete.