Humane Investigative Poaching Prevention Operation (HIPPO)

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Introduction

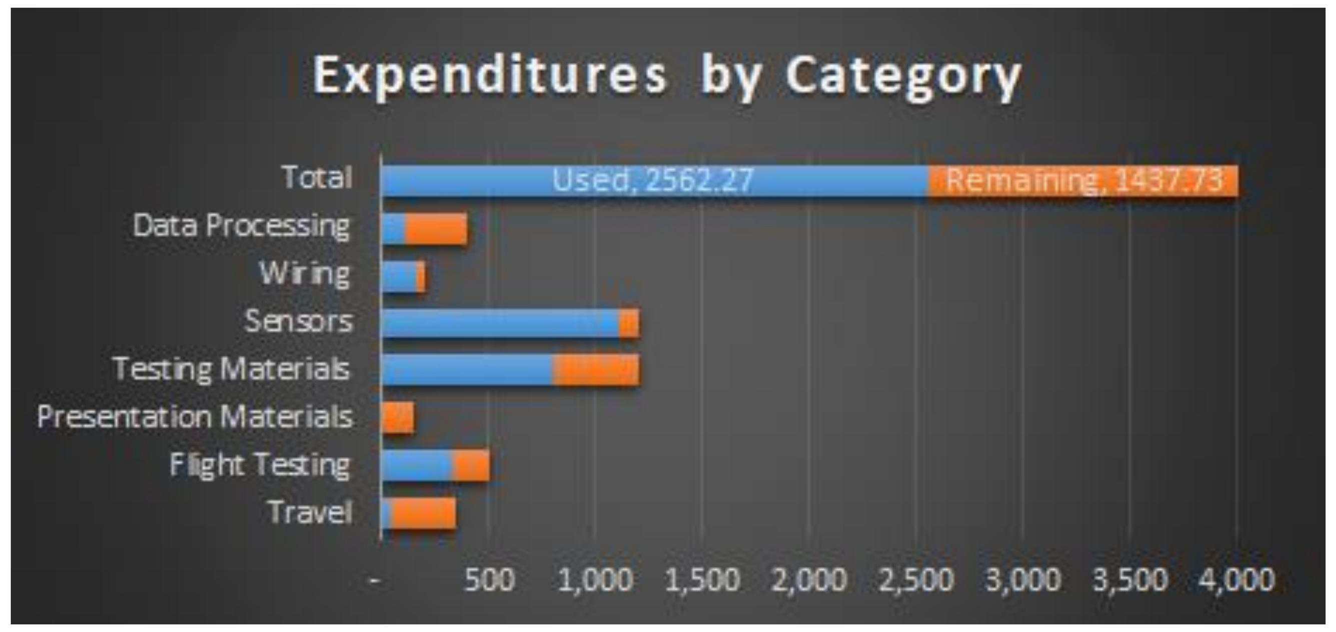
Problem Statement:
Poaching is devastating to populations of endangered animals. As such, there is a need to develop innovative ways of combating poaching. This project is intended to identify technologies to detect and track poachers from a fixed wing UAS so that appropriate authorities can be alerted and dispatched.

Motivation/Background:
Vulcan currently developing their own UAS for poacher patrolling with visual and IR sensors. There is a need to develop non-optical, poacher sensing technologies for use on a fixed wing UAS. Such a sensor should complement the traditional optical sensors to make a more successful system.

Customer Specifications:
Final product should return unambiguous poacher detection by comparing the data sets of an empty field with and without a simulated poacher. The sensing method used must be distinct from optical sensing. Sensor must be durable and ideally under 1 kg, and must not reduce the maximum UAS flight time below 5 hours.

Ethical and Environmental Impact of the Product:
Potential to save endangered wildlife, help preserve different animal species and stop poachers from committing crimes.

Budget



Trade Study

Several different sensors were considered for use. The final contenders were:

- Gunshot Detection
- Velodyne LiDar Puck
- Echodyne MESA-DAA
- Magnetometer
- Millimeter Wave
- Cell Phone Detection
- Artificial Light Detection

Multiple qualifications were considered for each sensor

- Mass
- Price
- Precision and Sensitivity
- Noise Susceptibility
- Power Usage
- Ease of Integration
- Durability
- Occurrence Likelihood
- Processing Power

Analysis

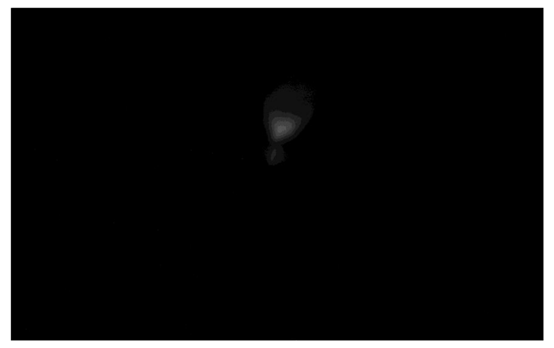
Key Analysis Components:

- Image Processing
- Optimizing Camera Performance
- Integration on UAS

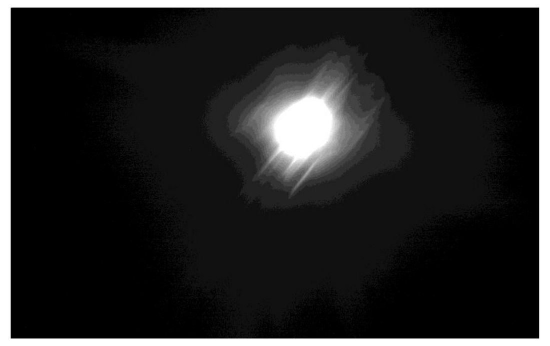
Analysis Tools and Process:

- Accelerometers, gyroscopes and GPS, built in to PixHawk for data collection
- Solidworks model for integration of sensor
- MATLAB for performing data analysis and image processing on pictures
- Several flight tests with Mission Planner

Verification of Results:
A signal to noise ratio of 5 and a signal size of 0.05% of total pixels were thresholds for human detection, the main customer design specification.



Flashlight reflected off ground



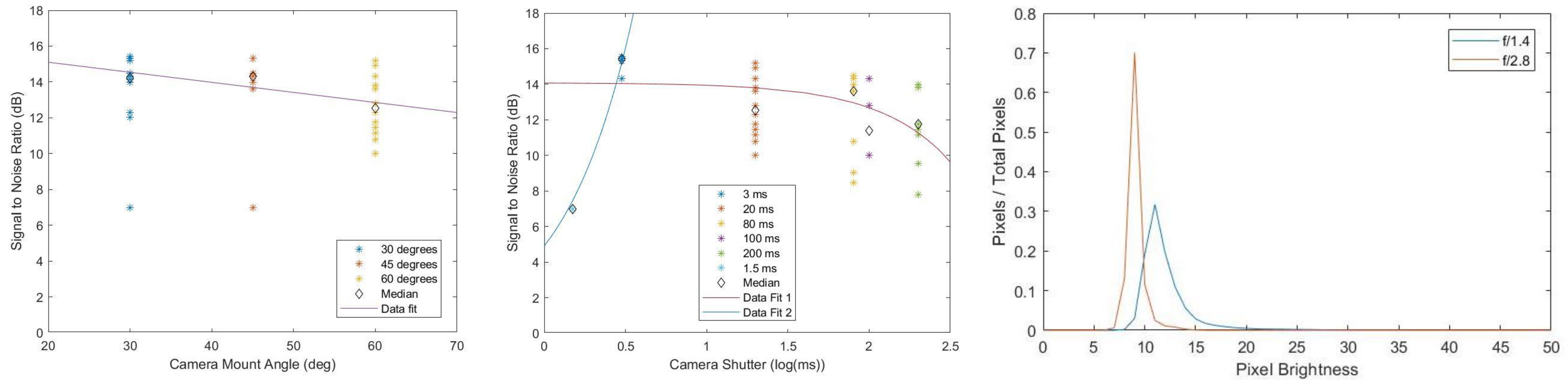
Flashlight directed at camera

Headlight reflected off ground

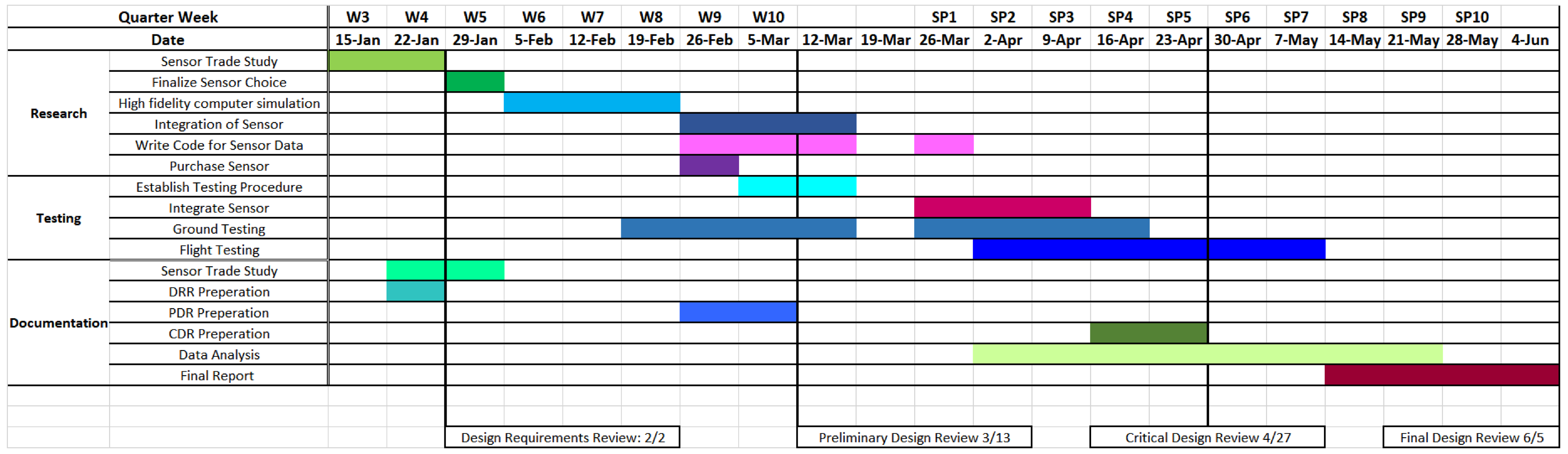
No light

Key Results

- Using a brighter exposure decreases the magnitude of the background noise, but increases the amount of noise in the image (decreasing the size of the signal). Thus, increasing the exposure will raise the signal to noise ratio, but when the size of the signal becomes negligibly small compared to the total image, the signal will no longer be detectable.
- Signal to noise ratio increases as shutter speed is increased while the signal is not fully saturated (up to approximately 3 ms), but decreases past that.
- An optimal EV for detection is approximately 9.35.
- Mount angle impacts both signal size and signal to noise ratio. Signal size weighted against ground area covered indicates that a 30 - 45 degree mount angle is ideal, as does analysis using signal to noise ratio.
- Based on environmental factors between Botswana and Washington, the signal to noise ratio is expected to differ less than one percent.
- Probability of detection using sensor package is estimated to be 97%



Project Timeline



Design Specifications

Project Goals

- Create data processing algorithm to successfully detect a light source in a photo.
- Integrate a sensor suite to detect light sources onto a UAS.
- Demonstrate successful detection of artificial light source during UAS night operation.

Deliverables

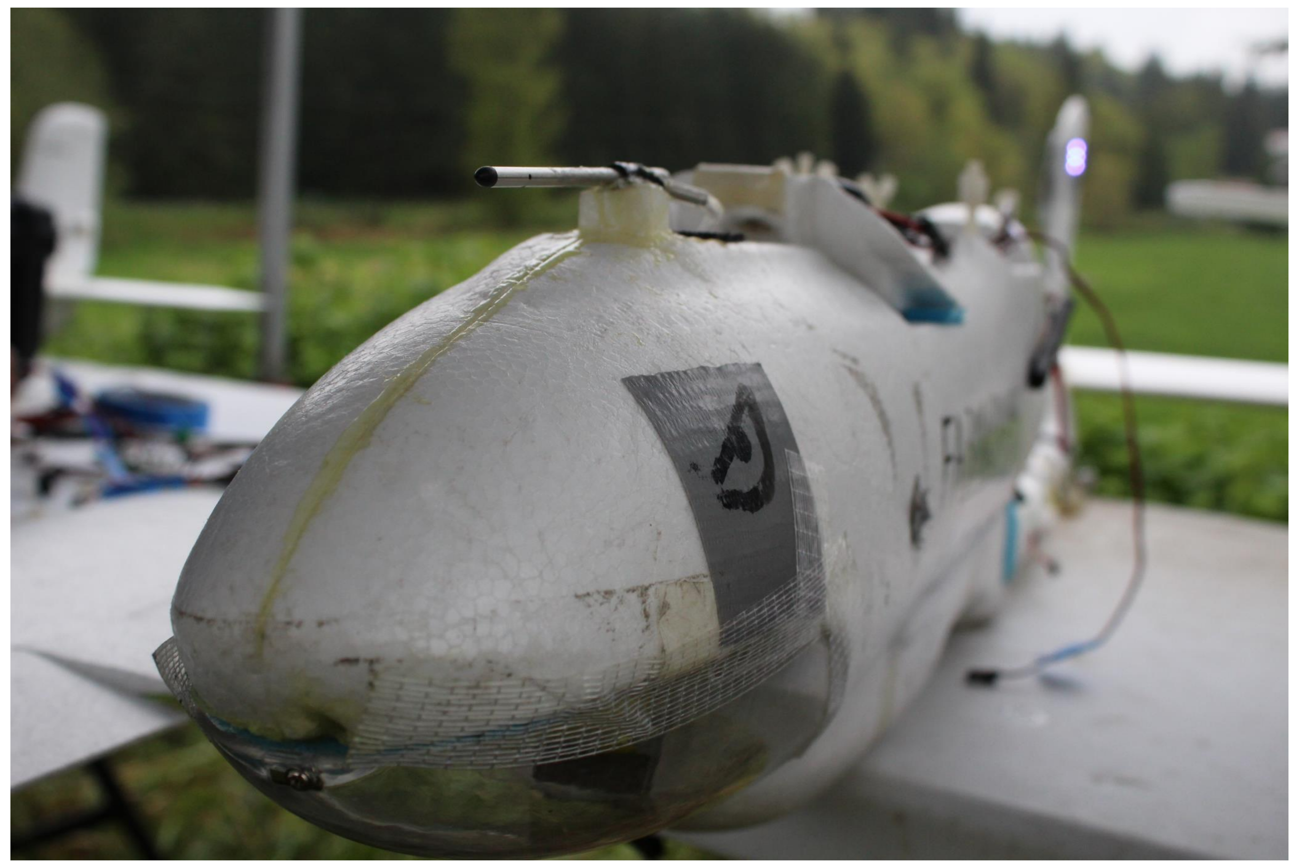
- Simulated poacher/no poacher data sets
- Detailed engineering report
- Analysis and data processing code

Specifications

- Unambiguous poacher detection comparing data sets
- Less than 1 kg payload
- Sensor should not reduce max flight time below 5 hour endurance goal

Sensor Package

- Final payload is 400 g
- Payload does not draw any power from UAS
- Provides unambiguous poacher detection



Fixed Wing UAS

Acknowledgements

Our deepest and most sincere gratitude goes to Vulcan, Inc. and especially Mr. Joel Reiter for their continued funding and guidance throughout this project.
Beyond that, we would like to thank our Advisor: Dr. Christopher Lum. His support has helped our group to achieve our goals and meet the project deadlines.
Finally, our gratitude goes to the Department of Aeronautics and Astronautics whose oversight of the Senior Capstone Project helps us, the students, to learn new skills and gain valuable experience in engineering and project management.

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