Affordable Unmanned Aerial Systems, sensors, modular payloads, and algorithmic tools for ecological study

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Abstract: Ecological and conservation efforts are often complicated by the need to gather data in remote or inaccessible areas in unideal conditions. Researchers often cite the size, behavior or location of such populations as a major impediment to their population surveys. In military missions, unmanned aerial systems (UAS) have been instrumental in providing remote access and persistent presence. We will discuss an on-going design effort to develop affordable UAS designs, as well as sensors and modular payloads, aimed at supporting science and military missions.

source http://www.seaturtleinc.org/wp-content/uploads/2012/05/a9273edbc93df5f187263d5bde98907d-wpcf_190x126.jpg

Using UAS and machine vision to get accurate counts

Governments and conservation authorities rely on accurate population surveys to regulate and inform policy.

Population counts are generally obtained through sampling or estimation, since it is very difficult to get eyes on every member of a population.

Manual counting is laborious and time intensive; may require subsampling along transects and application of other estimation techniques.

Can UAS with modular payloads and machine vision techniques help?

Methods and Materials

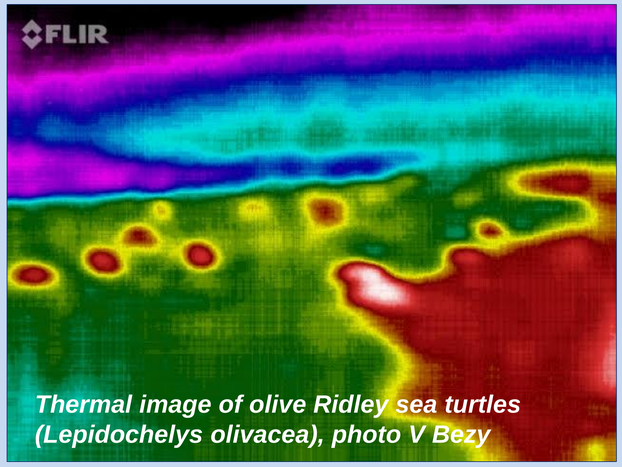
Fly sensors (payloads) over target area of interest

Analyze imagery using machine vision methods

- Visible light (4K, GoPro)
- Thermal / IR (FLIR)
- Active IR (mod GoPro/Runcam w/emitter)

Additional counts for ground truth

Collect additional environmental data (weather, wind and water, illumination, white balance, nav aids for registration)



Thermal image of olive Ridley sea turtles (Lepidochelys olivacea), photo V Bezy

```
while 1
  capture image from video
  convert to grayscale
  threshold to segment targets
  find moments >1000 and <2000
  select contours of proper size
end
```

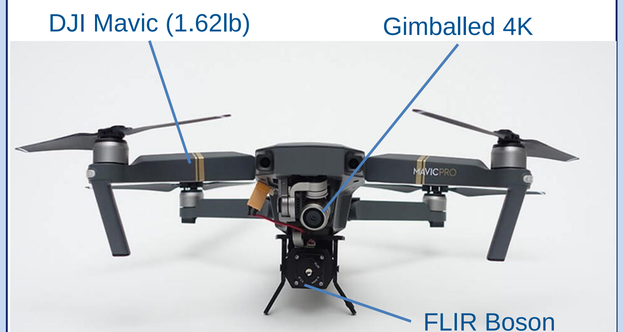
Blob Detection Pseudocode

OpenCV is an open source software library for computer vision in Python or C++

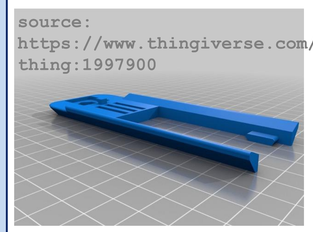
- Blob Detection
  - Shape (moments)
  - Color or brightness
- Machine Learning
  - Haar Cascade w training, validation sets
- Register and combine multi-spectral

Modular Payloads

Fixed wing (Flitetest derivative) spare also under development



source: https://rectrixdrones.com/



source: https://www.thingiverse.com/thing:1997900

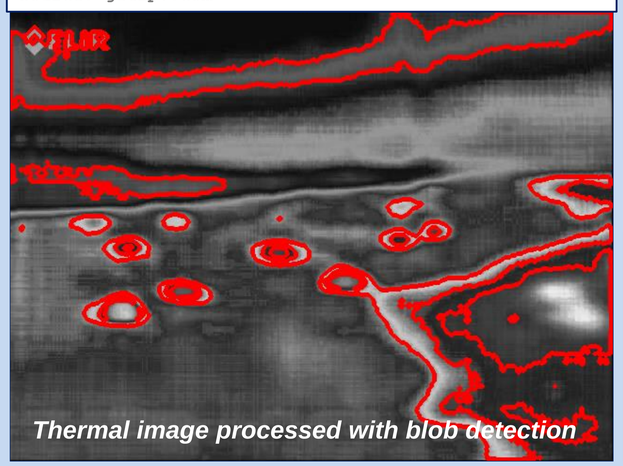
3D printed base mount for Mavic

FLIR Boson (7.5g, 4.9cm^3)

source: https://groupgets-files.s3.amazonaws.com/boson/Boson_2.4mm_f1.0_faceleft-small.png

CJLTech IR4+ emitter and Runcam camera

source: getfpv.com



Thermal image processed with blob detection

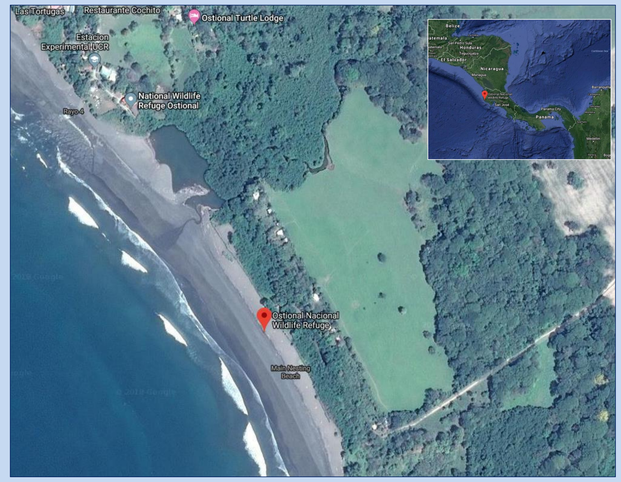
Deployment: March 2019

Planned field testing in Maryland, followed by deployment to Costa Rica in March 2019 to film olive Ridley *arribada*

- Ostional, Costa Rica
- Obtain aerial imagery of sea turtles nesting
- Third quarter lunar phase

Local field testing to develop training set for automatic turtle detection and counting.

Inflatable sea turtle training shapes (Intex Co; Long Beach, CA).



Satellite Images of Ostional Wildlife Refuge, Main Nesting Beach, Costa Rica. Source: Google Maps

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References

[1] Bézy, V.S., Girondot, M., and R.A. Valverde. 2016. A new method for estimating nest density at an arribada rookery in Ostional, Costa Rica. Journal of Herpetology. doi: 10.1670/14-152.

[2] Sykora-Bodie, S. T., Bezy, V., Johnston, D. W., Newton, E. and Lohmann, K. J. (2017). Quantifying nearshore sea turtle densities: applications of unmanned aerial systems for population assessments. Scientific Reports 7, 17690. doi:10.1038/s41598-017-17719-x.