Autonomous Aerial Assistance for Search and Rescue

Team F: Team Rescue Rangers
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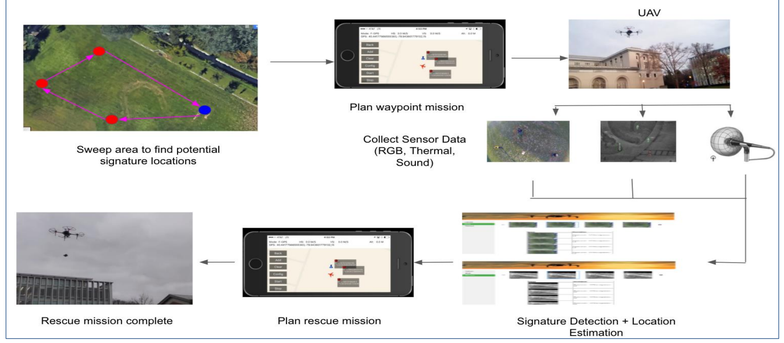
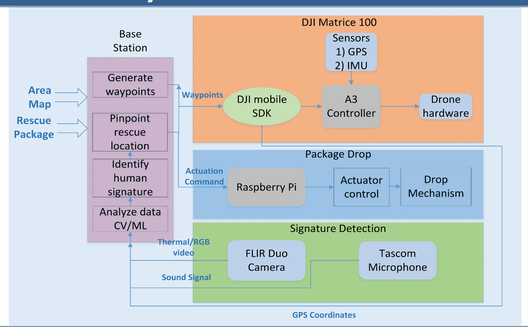
Motivation

Existing Search and Rescue Operations require skilled personnel and expensive equipment. They also pose a risk for the people involved.
Our objective is to **"develop an autonomous aerial system to make Search and Rescue operations – speedier, cheaper, and more reliable."** We develop a system that can pinpoint precise human signature locations in wilderness and drop a rescue package until further help arrives.

Use Case Scenario



System Architecture



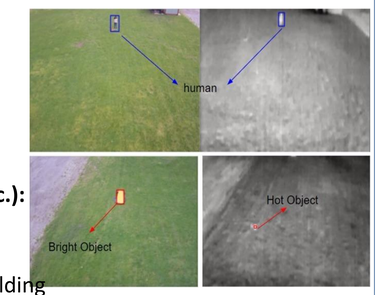
Autonomous Flight Subsystem

Waypoint Navigation
- Generate lawn-mower type sweep pattern
- Ensure maximum coverage of area
- Custom flight data logging implementation for signature detection and package drop

Implementation
- iOS app using DJI mobile SDK
- Validation using DJI simulator

Signature Detection and Analysis

Human detection using RGB+IR images:
- Extract Regions of Interest (ROIs) using edge detection and blob detection
- Fuse the ROIs from both images
- Use HOG+SVM for classifying humans; report humans only when matched ROIs in both images are classified as humans



Bright objects detection (hiking gear, etc.): Thresholding based on saturation and value; morphological operations

Hot objects detection: Adaptive thresholding

Sound detection: Use melody extraction technique for voice activity detection

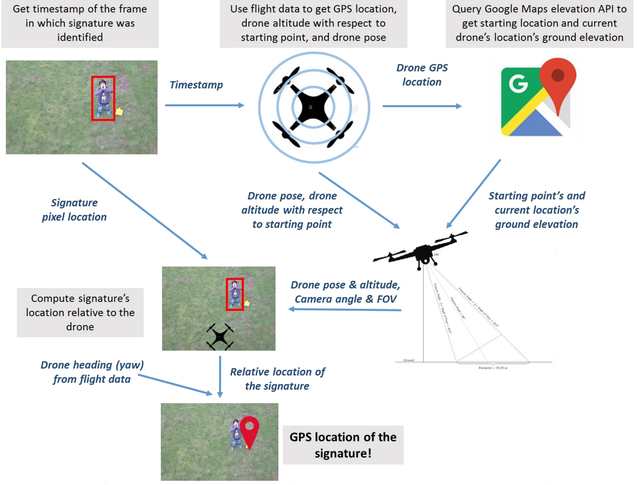
Signature GPS Location Estimation

For a single frame:

Get timestamp of the frame in which signature was identified

Use flight data to get GPS location, drone altitude with respect to starting point, and drone pose

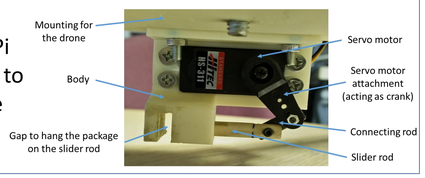
Query Google Maps elevation API to get starting location and current drone's location's ground elevation



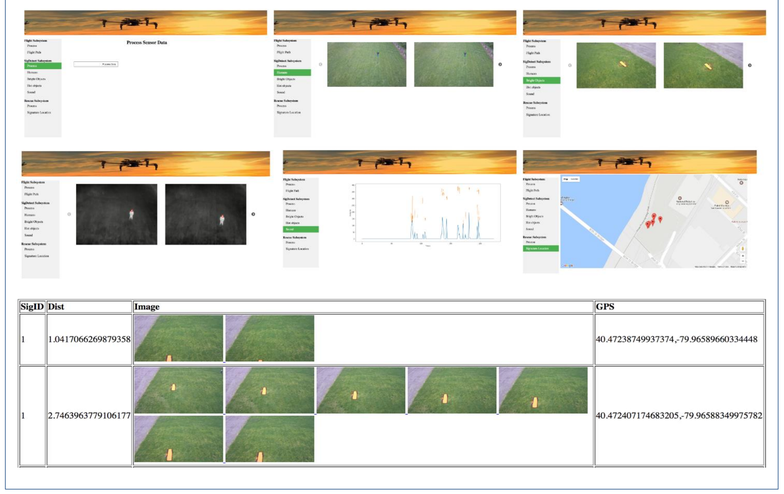
Cluster the locations reported for different frames based on distances:
- Clusters reported locations to give only a few relevant locations
- Separates true locations from false locations

Autonomous Package Drop

- Simple package drop mechanism actuated by onboard Raspberry-Pi
- Base station sends the command to drop when the drone reaches the rescue location



Backend Processing Console



SigID	Dist	Image	GPS
1	1.0417066269879358		40.47238749937374,-79.96589660334448
1	2.7463963779106177		40.472407174683205,-79.96588349975782

Results

Experimental setup: 7 signatures (2 humans, 2 bright objects, 2 hot objects, 1 sound source) in a 50m x 50m area
- **Signature detection algorithms:** Consistently able to detect all the planted signatures – report 250-300 frames, on an average
- **Location estimation algorithm:**
  - reports 15-20 clusters based on no. of false positives
  - Significantly large clusters for actual signature locations
  - Clusters reported for actual planted signatures within +/-5m
  - False positives are moved to separate clusters and have fewer frames
- **User Interface:** Makes it really easy for the user to choose the location for rescue based on detection quality (proportional to no. of frames and proper bounding boxes) and signature found
- **Package Drop:** Able to drop the rescue package within +/- 5m of the chosen rescue location

Conclusions

- HOG+SVM gives satisfactory performance in detecting upright human beings in aerial images with reasonable processing speed
- Fusing detection results from RGB and IR images helps eliminate a lot of false positives
- Clustering of reported locations proved to be an efficient way to identify true rescue locations

Future work

- Deep learning based signature detection approaches
- Onboard data processing and adaptive planning

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References

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2. A. Gaszczak, T. P. Breckon, and J. Han, "Real-time people and vehicle detection from UAV imagery," in Proceedings of the SPIE Conference Intelligent Robots and Computer Vision XXVIII: Algorithms and Techniques, 2011
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