Institute Technical Summer Project

Team-Quad Cops

Team Members:

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➢ OBJECTIVE

The idea is to make a human detection hexacopter, based on the principle of thermal image processing, with on-board camera module that can be used to take consecutive photos.

➢ MOTIVATION

This hexacopter is designed keeping rescue missions in mind, for detection of humans in disaster hit areas like floods among others. Majority of the human detection methods currently in practice involve PIR sensing, which involve motion detection of humans. However this is comparatively difficult for a device that is continuously in motion. **So stationary images can be processed (with lesser accuracy) using thermal image sensing method.** A basic working model is aimed to be built, which can be enhanced for improved performance.

➢CONCEPTS AND TECHNICAL ASPECTS:

1. **ArduPilot Mega 2.6:**

Ardupilot Mega (APM) is a professional quality IMU autopilot that is based on the Arduino Mega platform. This autopilot can control fixed-wing aircraft, multi -rotor helicopters, as well as traditional helicopters. It is a full autopilot capable for autonomous stabilisation and way -point based navigation.We used an APM 2.6 board for our copter.

We followed this tutorial for configuring and understanding of the APM application:
https://www.youtube.com/watch?v=30cCs4aHdB0&list=PLYsWjANuAm4oswLMu9OU8yOm-9J6y30XW

2. Power Module:
A power module is connected for monitoring of the battery's voltage and current and triggering a return-to-launch when the voltage becomes low or the total power consumed during the flight approaches the battery's capacity. It also allows the autopilot firmware to more accurately compensate for the interference on the compass from other components
For the connections to APM 2.6 and details:
http://ardupilot.org/copter/docs/common-3dr-power-module.html
3. Electronic Speed Controllers:
ESCs or Electronic Speed Controllers basically take PWM output of the Ardupilot Mega Board and using that, control the motor and propellor rotation and speed.Pulse Width Modulation, or PWM, is a technique for getting analog results with digital means.

Digital control is used to create a square wave, a signal switched between on and off. This on-off pattern can simulate voltages in

between full on (5 Volts) and off (0 Volts) by changing the portion of the time the signal spends on versus the time that the signal spends off. The duration of "on time" is called the pulse width. To get varying analog values, you change, or modulate, that pulse width.
More on PWM:

https://www.arduino.cc/en/Tutorial/PWM

4. Raspberry Pi and R-Pi camera Module: Our primary objective with the R-Pi and R-Pi cam module was:
    1. Clicking Consecutive thermal images
    2. Transmitting these images to our PC for processing

5. QGroundControl:
Windows based Mission Planner, QGroundControl is used to provide full flight control and mission planning for any MAVLink drone. It provides configuration for Ardupilot or Pixhawk boards for ease of use as well as advanced automation.

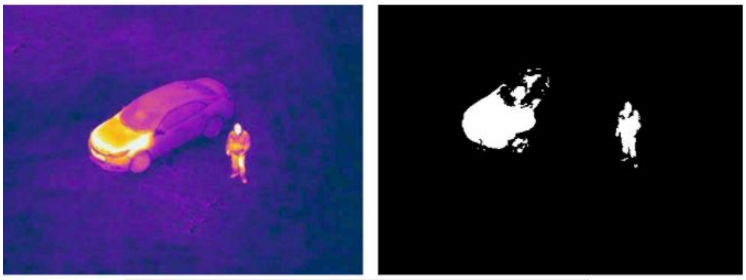
<u>Project Details and Problems faced:</u>

<u>Image Processing:</u>

<u>SURF detection Algorithm:</u>

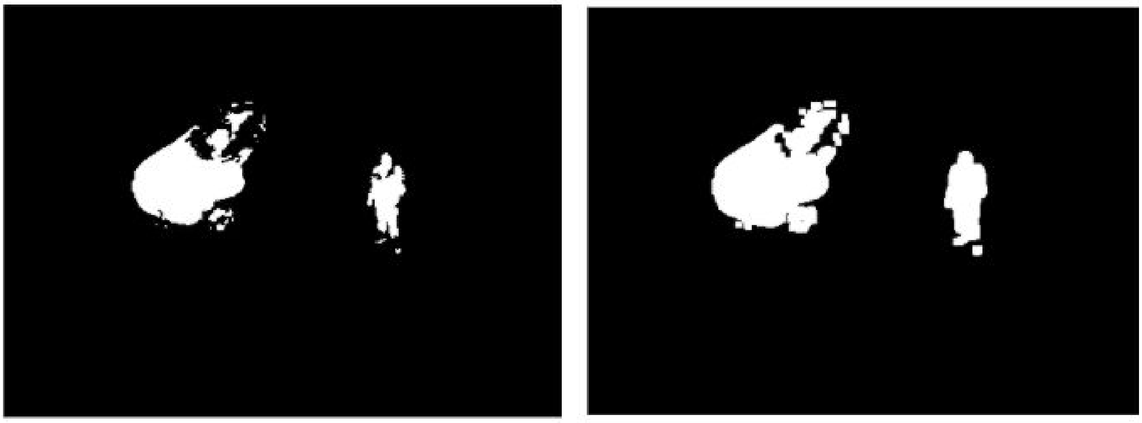
For the detection of Human contours in the image taken by an Infrared Thermal Camera, the following algorithm was used:

1. Binarize the image using appropriate thresholding methods.



Left image represents the obtained thermal image, while the right image represents the thresholded binary image using the parameters R>200 and G>100

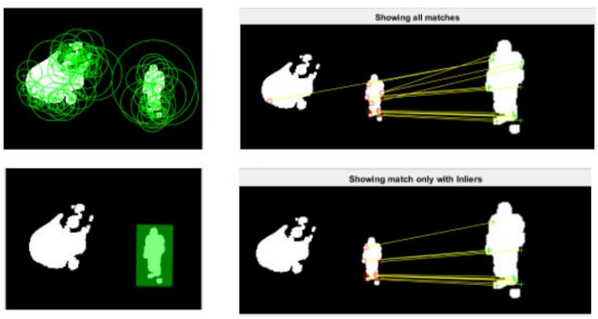
2. Now we apply adequate kernel filters like dilation and hole filling to obtain an image with easier to detect human contour.



Simple thresholded image v/s image obtained after applying kernel filters like dilation for easier shape detection

3. Using the SURFpoints function, identity points are produced in the input thermal image, and are matched with the present SURFpoints from the data set of human contours.

4. Once all the matches are made, Geometric Transform Estimator is used to detect the correctly in-lined and compatible matches.



First image shows the detection of all SURFpoints
Second image shows the matched points
Third image shows geometrically compatible inlined matches
Fourth image shows plotter area of human detection

Since we were not able to get an IR camera(out of budget), we tried to implement a prototype by adding a R-Pi camera Module. We also parallely worked upon Human detection using HOG descriptors in OpenCV to implement human detection using a normal camera module.

HOG Descriptor Algorithm

Histogram of Oriented Gradients(HOG) descriptor is a feature descriptor in computer vision and image processing for the purpose of object detection. How a feature descriptor works is that it tends to generalize similar object in different conditions. This method is similar to edge orientation histograms but uses overlapping local contrast normalization for improved accuracy.

For our person detection problem, we have used HOG with SVM(Support Vector Machines) approach. SVM is a machine learning algorithm that classifies object decision boundary such that examples of different categories are divided by as wide of a gap as possible(large margin classifier).

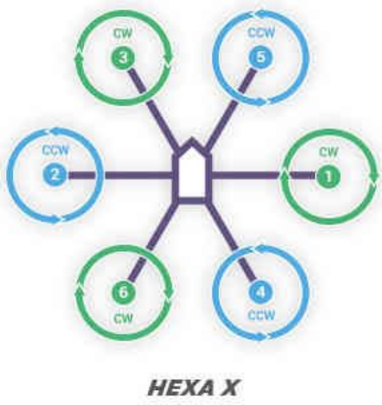
So for human detection, our feature descriptor uses global feature to detect the person itself rather than local features of the person. This means that the entire person is represented by a single feature vector. Essentially we divide our image into small regions called cells and for each pixel in a cell, we calculate a histogram of oriented gradients. For this gradient vector is calculated for each pixel value and its contribution to the histogram is taken as the magnitude of the gradient vector. After this , we normalize this histogram for better contrast and hence,

better accuracy.
The rest of the job is completed by our SVM that takes this histogram and classifies whether the image contains person or not.

Other Problems Faced and Solutions:

1. Connecting the APM to ESC by understanding PWM outputs and configuring and calibrating APMs

We followed this tutorial for configuring and understanding of the APM application:
https://www.youtube.com/watch?v=30cCs4aHdB0&list=PLYsWjANuAm4oswLMu9OU8yOm-9J6y30XW
The motor order diagram for the hexacopter is as follows:



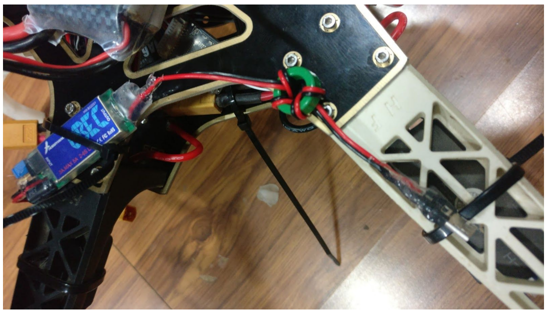
For connecting the APM PWM outputs to the ESCs for hexacopter, the following link was referred.
http://ardupilot.org/copter/docs/connect-escs-and-motors.html

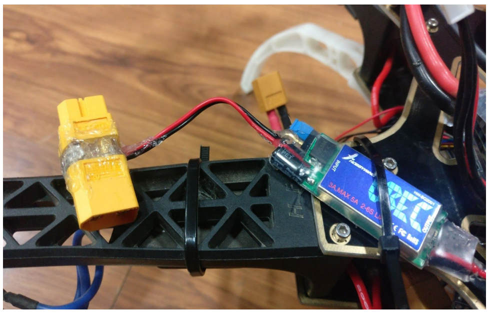
2. Binding the Transmitter and Receiver

Our Transmitter is a FlySky FS-i6 and the receiver is FS-iA6 2.4Ghz. The manual for FS-i6 is: https://imgmgr.banggood.com/images/upload/2014/04/FS-i6%20Maniac.PDF

3. How to connect the Raspberry Pi power to the PDB or the battery mounted

Raspberry Pi basically took a micro-USB 5V 2A power input, whereas we only had terminals of battery providing 3S (12.5V). So we connected QBEC voltage current regulator to the terminals and then soldered the two terminals to a micro-USB pin for connection to the Raspberry Pi.





4. Wireless transmission of images to the laptop for processing while in flight