Team F: Rescue Rangers

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1、Individual Progress

1.1、Overview

During the past few weeks, my primary role was further developing the human signature detection algorithm based on thermal images. I tried to implement Haar-like features +AdaBoost for classification, and to use image segmentation methods to improve the accuracy of finding potential candidates in aerial images.

Also, I added the preprocessing part to the current thermal signature detection algorithm, so that it can detect human correctly in a given image. I tested the algorithm on some of images from Thermal Infrared Dataset[1], and analyzed the pros and cons of the current algorithm.

1.2、Exploration on Thermal Signature Detection

Initially, I tried to implement Haar Feature-based Cascade Classifiers using Matlab[2] or OpenCV[3]. However, after further study, it turns out to be difficult to design this classifier because the parameters of Haar features that you want to extract and stages of AdaBoost are not easy to be determined. Also, it might take a really long time to train this classifier given thousands of training example[4], and there is no guarantee that Haar Feature-based Cascade Classifier can outperform the current HOG+SVM classifier. As a result, I plan not to actually implement it until HOG+SVM classifier does not satisfy our requirement during our later development.

Furthermore, I explored different methods of image segmentation, including K-means clustering and mean-shift method to improve the result of preprocessing, i.e finding potential candidates in aerial images. The test image is shown below, and its resolution is 1920x1080.

Figure1 Test image of image segmentation

The K-means method takes 149 seconds(K=8), and the result is like:

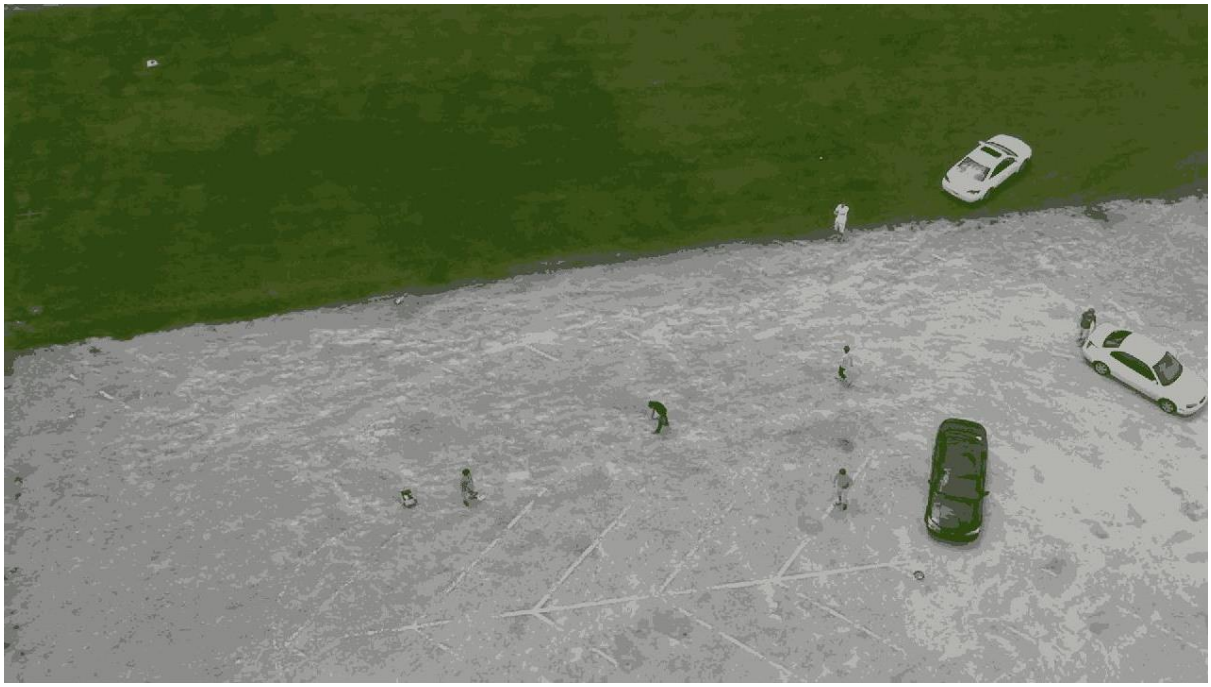

Figure2 Result of K-means segmentation

The mean-shift method takes 86 seconds(bandwidth=0.1), and the result is like:

Figure3 Result of mean-shift segmentation

From the results above, image segmentation does simplify the background of images, so that the edge detection can find human contours more easily. However, both methods take unrealistically long time, and some humans are merged into the background due to the clustering. Because of those, image segmentation is not applicable in our use case.

1.3、Experiments on Thermal Signature Detection

At last PR, I tested HOG+SVM on collected thermal images, whose resolutions are 64x32. However, in our real case, because of the limited resolution of the thermal camera that we will possibly use, the size of human inside thermal images would be smaller. In terms of making our algorithm more adaptive to real scenario, I down sampled images from both training set and testing test, so that their resolutions become 32x16, which are more similar to the real case. After down sampling, the classification accuracy drops from 89% to 86%.

Apart from that, I added the preprocessing part which we had developed for RGB-based algorithm, to the current thermal algorithm. Some testing images of our thermal signature detection algorithm are shown below:

Figure4(a) Result of thermal signature detection

Figure4(b) Result of thermal signature detection

From figures above, we can see that the current thermal signature detection can detect most human beings in aerial thermal images, while it has some false positives. Later, I plan to further improve the preprocessing part to make the whole algorithm more robust, and add the tracking part to prune false positives.

2、Challenges

The main challenge I faced last week was to integrate the preprocessing part to the whole thermal signature detection pipeline. The preprocessing of thermal images is actually to find all potential human candidates by edge detection and other image processing techniques, so that all candidates can be classified afterwards. Due to the different resolution of thermal images, several parameters of preprocessing part need to be modified. In addition, I added the Gaussian blur before edge detection, so that noise would not influence the performance of the edge detection. In the end, the integration has been successfully completed, and more improvement on the thermal signature detection algorithm will be conducted before the next PR.

3、TeamWork

After the previous progress review, our team discussed the plan for the next few weeks, and broke the work down as follows:

Table1 Work distribution form

Member	Work
Karthik Ramachandran	Improve the sound signature detection; Explore CNN on RGB-images
Sumit Saxena	Neural Network using Tensorflow; HSV thresholding to detect bright regions
Juncheng Zhang	Explore and improve signature detection algorithm on thermal images
Xiaoyang Liu	Test of revised RGB-based human detection algorithm

The team worked with great coordination during execution of the entire task. We worked on different signature detection algorithms separately, and each of us did a good job.

4、Future Plans

Before the next progress review, we plan to integrate RGB-based and thermal-based signature detection algorithms to improve the overall accuracy. Also, we will design the mounting for all the sensors, including visual camera, thermal camera and the microphone.

For my personal task, I plan to further improve the performance of thermal signature detection, by modifying the preprocessing part and combing the detection and tracking together for less false positives.

5、Reference

[1]. http://projects.asl.ethz.ch/datasets/doku.php?id=ir:iricra2014
[2]. https://www.mathworks.com/help/vision/ref/traincascadeobjectdetector.html
[3]. http://docs.opencv.org/trunk/d7/d8b/tutorial_py_face_detection.html
[4]. http://coding-robin.de/2013/07/22/train-your-own-opencv-haar-classifier.html