Team F: Rescue Rangers

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1、Individual Progress

1.1、Overview

During the past few weeks, my primary role was exploring the human signature detection algorithm based on thermal images. I read several papers and collected some conclusions from them, which are relevant and helpful to our project.

Also, I applied the classification algorithm we had developed last semester on the thermal dataset. It turns out that the HOG+SVM method also has great performance on thermal images when they have good resolutions. I will try other classification method mentioned in the papers and compare the results with each other before the next PR.

1.2、Literature Study on Thermal Signature Detection

In paper[1], it proposes an approach for human detection in thermal imagery based on a cascaded classification technique combining additional multivariate Gaussian shape matching. In terms of the detail of the classifier, it uses a cascaded Haar classifier, which extracts Haar-like features and is trained using AdaBoost over a set of a few hundred positive object and negative object training images.

Also, it mentions a method of using mean-shift color clustering followed by edge detection with Canny edge detector [2] to extract shape contours, and uses Hu invariant moments as shape descriptors [3] to eliminate unlikely possibilities. This method could be regarded as an extension of the way we used to find potential human candidates last semester. A result of this method is shown below:

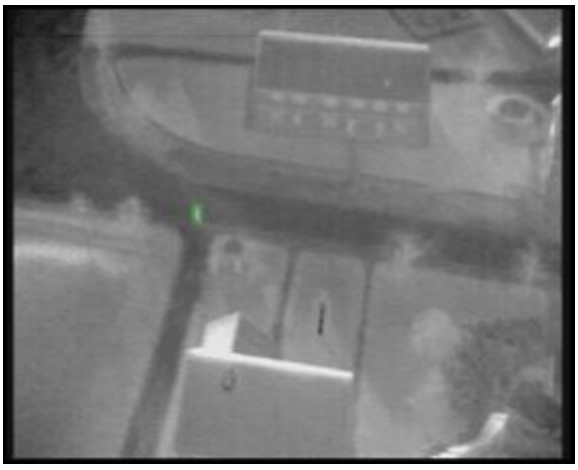

Figure1 highlighted contour matching the model

In paper[4], it compares the detection time per frame for different detector and tracker, and the accuracy of each algorithm, trained on INRIA dataset and the thermal dataset. The results are as below:

Detector	Time per Frame (sec)
HOG	0.1054
BPD	0.0384
LatentSVM	9.6057
LBP	0.074
Our Particle Filter Framework	Time per Frame (sec)
ViBe	0.0091
Particle Filter	0.0126
Rest (resizing, blobbing, etc.)	0.0023

Figure2 Comparison of detection time per frame

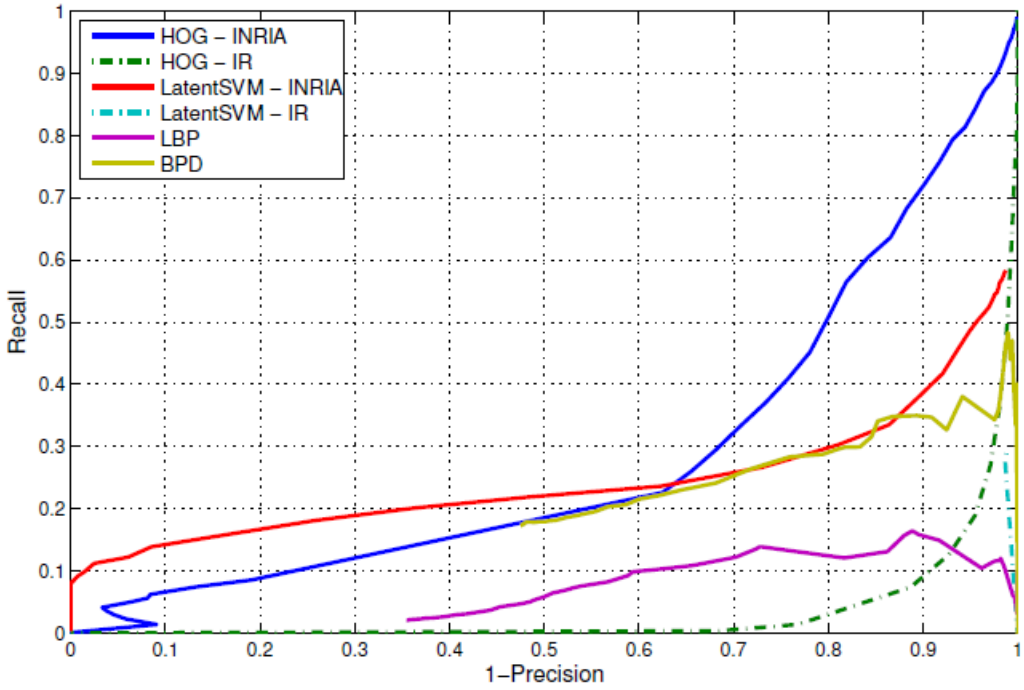

Figure3 Comparison of accuracy of each algorithm on "Sempach-7"

From the results above, we can have the following conclusion:

1. HOG trained on INRIA has the best performance for this test set "Sempach-7".
2. Latent SVM performs weak in terms of the detection speed.
3. HOG+SVM has overall the best performance considering both the detection time and the accuracy on thermal images.

1.3、Experiments on Thermal Signature Detection

I applied our HOG+SVM classifier developed last semester on thermal images to see whether it still has great performance or not. I created the dataset through public thermal images benchmarks, including OCTBVS Benchmark Dataset [5], and Thermal Infrared Dataset [6].

For this experiment, the training set has 4728 positive images and 5430 negative images, while the testing set has 850 positive images and 1060 negative images. The sample images for the positive image and the negative image are shown below:

Figure 3: positive image(64x32)

Figure 4: negative image(64x32)

The confusion matrix of the classification is:

```
confMat =

   922   138
    69   781
```

Consequently, the overall accuracy is 89%. The amazingly high accuracy demonstrates the performance of HOG+SVM on thermal images with relatively high resolution (64x32 in this case). However, in the real scenario, it is very likely that the human inside the image doesn't have as much pixels as in this experiment, probably only 300 pixel(20x15). We cannot guarantee that HOG+SVM will still excel other algorithms at that case because HOG actually extracts the gradient information of human shape, which is highly dependent on the resolution of the image.

2、Challenges

The main challenge I faced last week was to create the thermal dataset for testing the algorithm. Luckily, I can find enough positive images from the Thermal Infrared Dataset including 5578 images with humans, created by ETH. For the negative part, I had to randomly sample images with the size 64x32 from the background images both in Thermal Infrared Dataset and OCTBVS. After writing the script to randomly crop images, I created totally 6490 negative images. Finally, I split all the images into the training set and the testing set, and implemented our algorithm on them successfully.

3、TeamWork

When the new semester began, 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	Voice activity detection for sound sample
Sumit Saxena	Test Plan Parameters; Review signature detection algorithm based on RGB images
Juncheng Zhang	Explore signature detection algorithm on thermal images

Xiaoyang Liu	Review signature detection algorithm based on RGB images; Design FNN

The team worked with great coordination during execution of the entire task. We designed the test plan for data collection together and revised it in the past three weeks. Also, 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 are able to conduct our data collection plan and will collect valuable dataset including RGB images and thermal images similar to the real use case. After having them, we could test our algorithms on those images so that we will have a better idea about whether our algorithm would work in the real world.

Also, I plan to further work on thermal signature detection. I will implement cascaded Haar classifier trained by AdaBoost, and compare its result with the result from HOG+SVM.

5、Reference

[1]. 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.

[2]. J. Canny,"A computational approach to edge detection", IEEE Trans. Pattern Anal. Mach. Intell. 8(6), 679-698 (1986)

[3]. M.K. Hu,"Visual Pattern Recognition by Moment Invariants", IRE Transactions on Information Theory 8, 179-187 (1962)

[4]. J. Portmann, S. Lynen, M. Chli, and R. Siegwart. People detection and tracking from aerial thermal views. In Proceeding of IEEE International Conference on Robotics and Automation (ICRA), 2014

[5]. http://vcipl-okstate.org/pbvs/bench/

[6]. http://projects.asl.ethz.ch/datasets/doku.php?id=ir:iricra2014