Individual Lab Report #7

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Team F: Rescue Rangers

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1. Individual Progress

1.1. Overview

During the past two weeks, I worked on the following tasks:

1. Develop a Feed-forward Neural Network using TensorFlow for image classification
2. Work on detecting presence of bright-colored objects in the images

1.2. Develop Feed-forward Neural Networks using TensorFlow

To improve the accuracy we were getting for human detection using HOG+SVM, we wanted to try neural networks for classification. Since TensorFlow is a powerful, yet flexible and easy-to-use tool for building neural networks, I used it to create neural networks.

Datasets used:

- **Training set:** 250 positive and 250 negative
- **Validation set:** 49 positive and 49 negative
- **Test set:** 108 positive and 108 negative

The data set used is the same as what Xiaoyang has used. Note that all the training, validation and test images are processed images. All the positive images are images cropped to the size of humans present and resized to a constant size. I tried various neural network configurations:

- 2 layer Neural Network:
    - Used ReLUs as activation functions
    - Tried many different values for number of hidden units, learning rate and number of iterations for training, and achieved accuracies in the range of 82-86%
    - For ex – Training with 100 hidden units, 0.2 learning rate, and for 1400 iterations gave an accuracy of 84.7%. The training is blazingly fast, it took only 10-20 seconds to train with these parameters.
- 3 layer Neural Network:
    - Used ReLUs as activation functions
    - Tried many different configurations for the hidden layers with 100 and 50, 50 and 25, and 100 and 25 hidden units in layers 1 and 2, respectively
    - The accuracy did not seem to increase much; remained around 85%

Some points to highlight:

- I also ran a logistic regression on the data set which also gave an accuracy of 84%. Most probably, the test set we have used has features similar to the training set. We will be better able to assess the accuracy of our models when we test them on our own data.
- We hope that the neural networks approach will perform much better when we have more training data. Use of convolutional neural networks, in case we are able to collect enough data, should make our human signature detection even better. I have the data pipeline setup in TensorFlow and will implement CNN soon.

1.3. Work on detecting presence of bright-colored objects in the images

Since we intend to use the tent and air mattresses, usually found in the hiking gear, and bright colored clothing also as human signatures, the objective of this task was to develop some simple algorithms to detect their bright colors in the images.

I implemented a simple 'HSV- thresholding' algorithm to obtain these bright regions of interest. For a given image, the algorithm creates a mask for bright objects by thresholding the image on 'Saturation', and 'Value' values in the HSV space. After some further processing of the mask to eliminate very small regions identified as regions of interest and to make the regions of interest continuous, the mask is applied to the RGB image to get the masked RGB image in which the bright regions are highlighted. Some results are shown in Figure 1.

Threshold values used: 0.6 for 'saturation' and 0.4 for 'value'.

Figure 1: *Extraction of bright regions from images using 'HSV thresholding'. The algorithm seems to work fine for most of the cases but loses its purpose when the object of interest is dull (illustrated in the right-most set)*

Caveats:

Since the threshold values have been set manually, we get some bright background regions also as regions of interest, as can be seen from Figure 1. The algorithm needs to be coupled with some information about the shape or size of the objects to look for, in order to produce better results.

2. Challenges:

I faced following challenges during my work:

1. Improving accuracy using Neural Networks:

   I tried a lot of different ways to further improve the accuracy – added regularization, introduced dropout, tried different configurations but couldn't improve the accuracy.

2. Approach for color-based segmentation for identifying bright objects:

   I was looking for a segmentation approach using which I could segment a given image into various segments based on brightness in various regions (without any specification of the number of clusters). But I was only able to find clustering approaches where you specify the number of clusters you want to create.

As a team, we were not able to collect data using NEA payload as our flight plan was canceled given the adverse weather conditions. Now, we will not be using NEA payload anymore and are in the process of securing sensors to mount on our drone.

3. Teamwork:

Work done by individual team members:

- Team:
  - RGB/thermal camera selection
- Juncheng Zhang:
  - Experiment with thermal signature detection algorithms
- Sumit Saxena:
  - Develop a feed-forward neural network using TensorFlow
  - Work on detecting presence of bright-colored objects in the images
- Karthik Ramachandran:
  - Test voice activity detection using the cardioid microphone
  - Work on developing a convolutional neural network
- Xiaoyang Liu:
  - Implement and test 'HOG + Feed-forward NN' for RGB image classification

All of us are fully involved in trying out different human signature detection algorithms to come up with the most suitable ones.

4. Future plans:

Following are the tasks I plan to work on until the next PR:

1. Independently develop a convolutional neural network
2. Work on improving the algorithm to detect bright-colored objects
3. Develop an algorithm to get GPS location of the signature based on GPS location of the drone when the image containing the signature was taken
4. Help in mechanical design/fabrication of the mountings