Jeffrey Lee & Oriol Resina
Face & Gesture Analysis
Project 4 - Face Recognition

Introduction

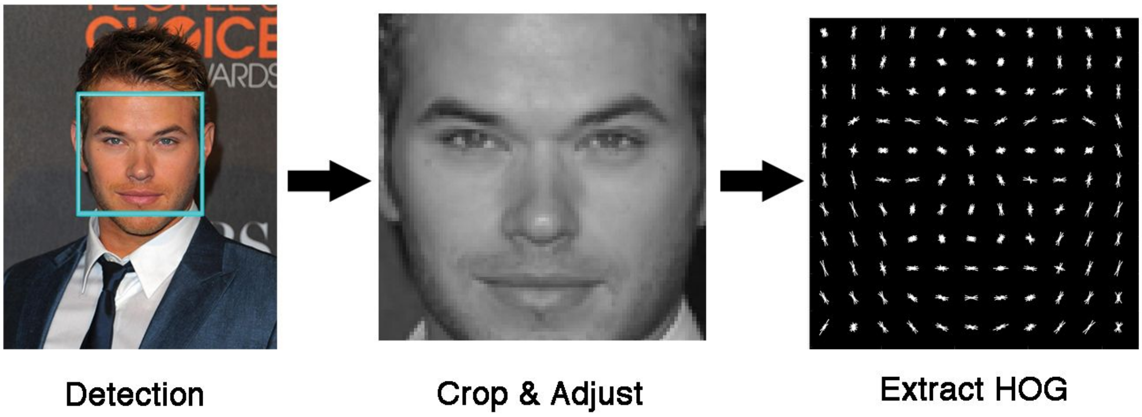
Face recognition is a difficult task that builds upon our previous face detection practice. For this challenge, we were asked to take a training set of 1200 images and prepare a face recognition model that could accurately identify a face from a separate set of test images. The training set contained 480 pictures with a known face ID from 1 to 80 for us to give our system to learn, and the remaining 720 pictures with unknown or no faces. By using 5-fold cross validation, we were able to train our system to have an F1 score of 37.09% and a recognition rate of 30.83%. Also, we added some images of famous actors and actresses to use in the face model and get a better performance of our project. With more time and a larger project size limit, we believe we could improve upon this even further.

Implementation

The first step we took to begin our facial recognition program was to prepare our files for training. It was important that every face was cropped, colored, and resized to the same dimensions to have the best results for our model. To do this, we looped through the training images and detected the face with our own detection algorithm, rather than using the facebox provided in training. This way, when we are testing, our detection will be the same as our training detection. If the face detector, we resorted to the given bounding box. After we found the face, we converted the image to grayscale, cropped the face, resized to 90x90, and saved the image.

Once our files were prepared, we went on to train our classifier. For our experiments, we used 5-fold cross validation to replicate a real testing environment. To create these tests, we separated the training images into chunks of 240, and counted the amount of faces in each segment. Then, we created 5 separate models, each including all of the faces in every segment but one. We tested several methods such as LBP and SURF to create a strong model, and found that extracting HOG features from each face with default cell size was our most effective option. We found that while we could conserve space in our model by increasing the cell size, the performance suffered as a result. We also attempted to normalize the images in an effort to improve performance, but again saw a negative impact on accuracy and removed the adjustment. After we extracted each image's HOG features, we paired the matrix with the ID's from each face and trained the model using an ECOC classifier.

Our facial recognition program was implemented very similarly to our classifier. We first detected a face in an image, then cropped, recolored, and resized it. Next, we would run it through an SVM classifier and detect the closest ID. If a recognition scored below our accepted match threshold, we would test the next face in the image, or assign the ID -1 if there were no other faces. If no faces were detected, it would again produce -1 as the ID.



After testing with our 5-fold cross validation system, we found the 12 most frequently missed ID’s and sourced five more training pictures for each of the subjects. We added the additional 60 images to our training data, and created one large classification model to use for testing. With the addition of more training data, we hope to cut down on some false negatives.

To test unknown images with our project, open the Basic Script file, update the necessary fields to your image database and testing .mat file, and run the script.

Results

In our 5-fold cross validation tests, we produced an F1 score of 37.09%. Included in this score was 148 true positive judgements, 550 true negatives, 483 false positives, and 18 false negatives. Our biggest weakness was the ability to judge between true and false positives. Every result from our classifier gave us a score of confidence in the prediction. After analyzing our results further, we found true positive results had scores ranging from -0.0000213 to -0.0202, with the largest score being the most confident. Conversely, we found false positives to have scores ranging from -0.0015 to -0.0237, which overlapped greatly with our true positive scores. Because of this, we were only able to remove the positive judgements that had scores below -0.0202, and could not account for a great amount of false positives.

With further experiments, we found that some segments of our 5-fold testing performed better than others. Our peak F1 score was using the first 4 partitions as training and the last as testing, which produced a score of 43.31%.

Finally, our program was able to process and classify 1200 pictures in 2210 seconds. This means that each picture had an average processing time of 1.84 seconds, well under the required 3 second limit.

Further Improvements

Our project was a great introduction to facial recognition, and we learned many different approaches to extracting details from face images and classifying them. We also found a limiting factor to be the project size limit of 100mb. Our current model sits at 99mb and stores HOG features of 540 90x90 facial images. As always, more training data would allow us to increase our performance for detection. Further, if we were able to increase the dimensions of our images, we would lose less data and gain accuracy as a result.

Additionally, some of our images held a lot of noise that was not relevant to recognition. If we had the time and space to implement a feature extraction on each detected face, it could be beneficial to only extract and judge HOG features from specific facial landmarks, such as the eyes, nose, and mouth.

Conclusion

In conclusion, we found that our face recognition model was capable of reasonable consistency given the constraints we worked with. Extracting HOG features allowed us to focus on the contours and edges of faces, and was able to properly identify 148 out of 480 faces in a 5-fold cross-validation test. If given more time, we would have been interested in using specific facial features to perform our classification with.

References

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