# Biometric Coursework Report

## Body Shape Recognition

Qi Zhao
Email:qz1y18@soton.ac.uk

## ABSTRACT

In this paper, I describe the details of a recognition system which is based on body shape. The dataset used is part of the Large Southampton Gait Database [1]. In the paper, firstly I briefly introduce biometric. Then, I introduce the method to build feature vectors and classify data. Moreover, I have an analyzation and discussion of results. The code language I used is python.

## 1. INTRODUCTION

Biometrics technology is a combination of computer and optical, acoustic, biosensor and biostatistical principles, using the inherent physiological characteristics of the human body (such as fingerprints, faces, irises, etc.) and behavioral features (such as handwriting, Sound, gait, etc.) to identify individuals. In this system, it is based on body shape to recognize people.

## 2. METHOD

### 2.1 Feature Vector

In the system, I extract 7 types of features from the original images. They are the height of head, the width of head, the height of body, shoulder width, the age, the gender and the ethnicity. After extracting these features, I tried some different combinations of these features to train, and then compare their performance. The following section will introduce some details about how to extract these features from original images.

#### *2.1.1 The height and the width of head*

The height and the width of head means the axis of the people's head in the picture. In order to get this feature, firstly, I used Haar cascades face detector which is trained by OpenCV to detect the position of face. When I got the position, the first thing is cutting the head parts from images. Then transforming it from RGB space to YCrCb space. The next step is doing Gaussian blur to make human body smooth. Then, using OTSU optimal thresholding process the images to get a human body silhouette.

In order to get the height and width of head, I scan the image got above to make the edge of head touch the boundary of the image. Then we can get the height and width through measuring images' size. The change of images is shown in Figure 1.

**Figure 1. Change of images to get head features**

#### *2.1.2 The height of body*

The details of getting this feature is similar as getting features above. The most difference is that when I try to get the position of body, the full body detector OpenCV trained can't give me the correct position. Therefore, I used another detector named imageAI [2]. Except that, most of the process is as same as the process in previous section.

#### *2.1.3 Age, gender and ethnicity*

I get all of these three features through Face++ [3]. During the process, I found one same person on the front and side will get different results. In order to improve accuracy, I just throw away the result got from people on the side and use front people result replace it, because I think the front image is more precious to identify people's age, gender and ethnicity.

#### *2.1.4 Shoulder Width*

I get this feature through Face++ as well. Firstly, I use the API to get the positions of left shoulder and right shoulder. Then I just compute the distance between them as the shoulder width through equation (1).

$$Shoulder\ Width = (X_{left} - X_{right})^2 + (Y_{left} - Y_{right})^2 \quad (1)$$

Because it is difficult to get this feature when people are on the side, so I use the front images to replace the side images.

### 2.2 Model

In the task, I tried two kind of machine learning models to solve the problem. They are KNN and linear SVM. In the system, I take them from scikit-learn [4]. Firstly, I train them. Then, through comparing their performance and set the better one as the model of the system.

## 3. RESULTS

As I mentioned above, I tried 5 kind of combinations of features and two kind of machine learning models to solve the problem. And the accuracy of them is shown in Table 1.

**Table 1. Accuracy of different combinations**

| Features Combinations | Accuracy of KNN | Accuracy of SVM |
|---|---|---|
| Combination 1 | 0.681 | 0.681 |
| Combination 2 | 0.727 | 0.681 |
| Combination 3 | 0.091 | 0.091 |
| Combination 4 | 0.182 | 0.182 |
| Combination 5 | 0.409 | 0.364 |

Combination 1: head height and width + body height

Combination 2: Combination 1 + age, gender and ethnicity

Combination 3: Combination 2 + shoulder width

Combination 4: head height and width + age, gender and ethnicity

Combination 5: body height + age, gender and ethnicity

Through the table above, we can observe that when I use feature combination 2 and KNN, the accuracy is the highest. Then, I draw the ROC curve of this combination in Figure 2.

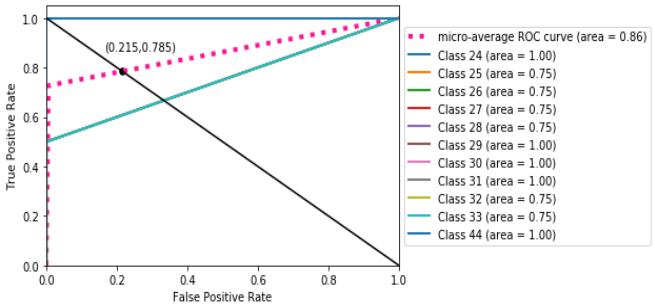


**Figure 2. ROC Curve with EER = 0.215**

I use micro-average ROC curve to assess the system. Because the number of test set is limited, so the curve is not smooth. Equal Error Rates means the value of false acceptance rate when false acceptance rate is equal to false rejection rate, the abscissa of the point of Intersection of ROC curve and straight line: y=1-x is EER value. Through Figure 1 we can get the EER =0.215. AUC means area under ROC curves. Through the right side of the picture we see AUC value is 0.86.

In addition, I also draw CMC Curve in Figure 3.

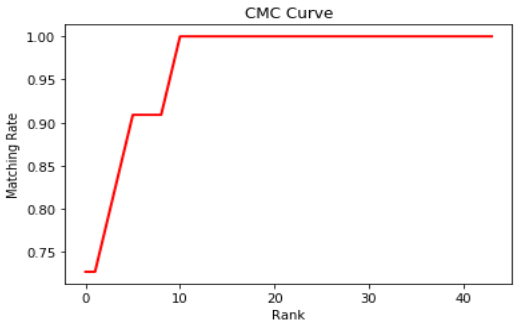


**Figure 3. CMC Curve**

Through Figure 3 we can see when rank =10, the matching rate is equal to 1.

Figure 4 shows a histogram of distances between the subjects.

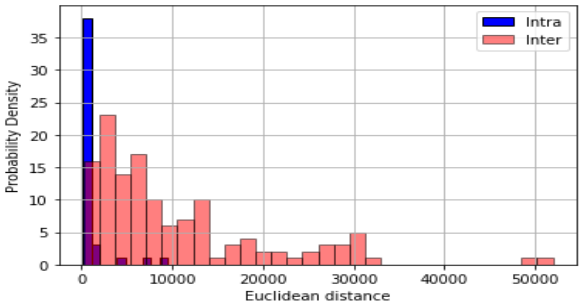


**Figure 4. Inter-class and Intra-class Variation**

Figure 4 shows that the center of the distribution of intra-class distance is about 800, while that of inter-class distance is about 2500.

# 4. DISCUSSION

## 4.1 Advantage and Disadvantage

Through the above introduction about the system, we know the it is a simple one., and its accuracy can get 0.727. Therefore, its advantages are easy to implement, speed is fast and having a good performance.

However, because it calls Face++ API, the system needs network. In addition, because the using of Haar cascades face detector, it can't work when the people's face rotate a strange angle. Moreover, based on the way of process images, it is limited by the background of people in images.

## 4.2 Future Direction

There are many directions to expand the system. Firstly, it can use a more powerful algorithm to detect the position of human face. In addition, some other new features can be added in to improve its performance. Furthermore, a better model can be used to solve the problem. Maybe some deep learning networks can get a better accuracy.

# 5. CONCLUSION

The system was trained by part of data in the Large Southampton Gait Database and got a good accuracy. Because of its internal limitations, it may not work in other kind of data.

# 6. REFERENCES


[1] JD Shutler, MG Grant, MS Nixon, JN Carter, On a large sequence-based human gait database, Proc. Applications and Science in Soft Computing, pp 339-346, 2004

[2] Moses Olafenwa, John Olafenwa, ImageAI. https://github.com/OlafenwaMoses/ImageAI

[3] https://www.faceplusplus.com

[4] https://scikit-learn.org