Biometrics Recognition System Based on Body Shape

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***Abstract*—This biometric system is designed to identify subject, which concentrates on individuals here, based on their body shapes. The classification is implemented based on k-nearest neighbors (KNN) algorithm. The accuracy of identification is 73% and its EER is 4.76%. The development of accuracy is supported by better image segmentation and appropriate training features.**

***Index Terms*—Biometrics identification, Body shape, image segmentation, Shape descriptors**

I. Introduction

THE essential requirement of a biometrics system is to recognize subjects. According to type of training input set, there are two main categories of system: statical identification and dynamical identification [1]. In this project, a system is proposed for statical images, which are distinct from each other by discontinuous posture. Both training and testing images are provided by Large Southampton Gait Database [2].

The prime processes of this system are illustrated in Fig. 1. It represents that the entire system contains process of training and testing images and classification. The process has four stages: import and initialization, image segmentation, feature extraction and feature analysis, in which a process consists of several steps to attain desired output. Classification is implemented by KNN algorithm. These technical details will be discussed in corresponding sections.

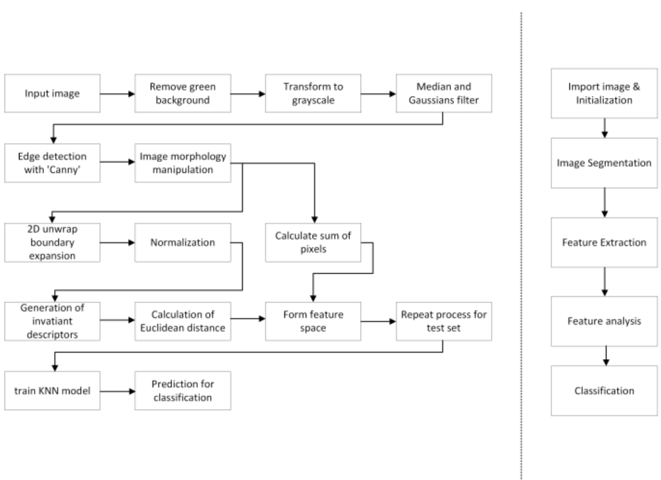


Fig. 1. Diagram of entire system.

II. Method

A. Import and Initialization

The first stage is to initialize image for further processing. To reduce the workload of system, the image is cropped by edge of green background. Then, the green background is filtered by mask so that only subjects will be remained in images. As the color is presented by RBG, which means three dimensions of data, the subtraction of green is accomplished in HSV space and the outputs are transformed into grayscale to reduce dimension of data.

To improve performance, two filters, median and Gaussians filter, are arranged to reduce noise. As the evaluation of them depends on ultimate accuracy, images will be respectively processed by both filters. The outputs of first stage are placed in Fig. 2. There are also several advanced image filter could be used, such as K Gaussians model. However, the following process may depend on the chosen filter and some of them are distinct from others. For instance, the mentioned K Gaussians is

Fig. 2. Initialized image with different filter.

not suitable for process based on conventional Gaussians filter, and it require much larger computation resource. To reduce the load of system with good performance, the two most classic filters are chosen.

B. Image Segmentation

In this stage, the output is expected to form an appropriate segmentation of subject contour. The image segmentation contains two parts: edge detection and image morphology manipulation. This approach refers to existing example of image segmentation in MATLAB [3].

The edge detection is used to extract edge information contained in outputs from previous stage and to present information as line structures. In this case, the detection method is 'Canny' method. The corresponding high and low thresholds are modified as [0.015, 0.030] for optimization.

Then, information will be amplified by image dilation. The dilated lines could be recognized as connecting or relative edges so that the information of target will become more distinct from other subjects. As a result of image fill, the silhouettes of subjects are formed based on edges. As the information is amplified before, an erosion step is place after to make silhouette fit its original image. The processed image is illustrated in Fig. 3.

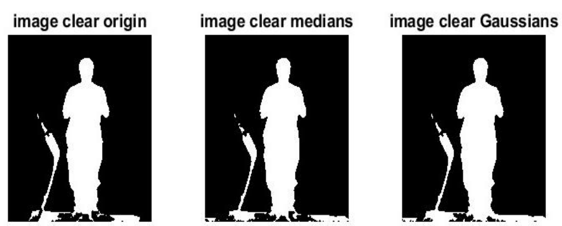


Fig. 3. An instance of extracted silhouette of image.

As shown in diagram, there are still some noise and subjects that is not target. In addition, the clothes wearing on target also influence the contour of silhouette. To remove effect from clothes, noise, and unexpected subjects, the output is cropped again to remain silhouette above shoulder and image opening operation is used to further filter noise points. An instance of output in this stage is placed in Fig. 4.

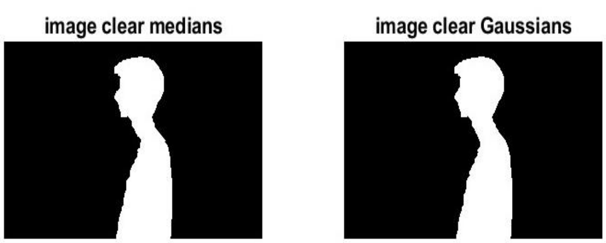


Fig. 4. Segmentation of silhouette above shoulder.

C. Feature Extraction

The features used in this project are area feature and boundary feature. The area feature is calculated by row in one image so that the height information of sample will be indirectly remained.

The boundary feature could be extracted by function directly. The extracted boundary is illustrated by Fig. 5. After that, the boundary is expanded and normalized, which is prepared for feature analysis.

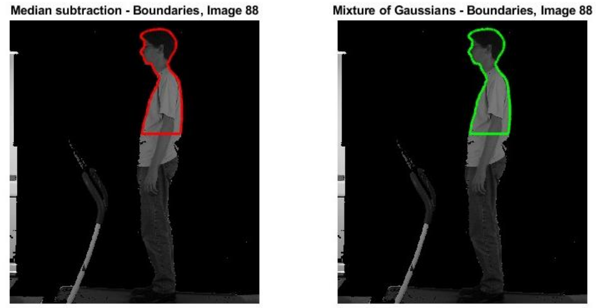


Fig. 5. Present of extracted boundary over original image.

D. Feature Analysis

In this stage, the output is expected to be distance between subjects, and the feature space will be generated. The Euclidean distance is chosen for it is a typical method to evaluate images. The process for Euclidean distance consists of:

a) Use normalized result to generate corresponding complex result.
b) Perform a Fourier Trigonometric expansion by complex result.
c) Define Translation Invariant Fourier Descriptors (TIFD) from Fourier coefficients.
d) Generate matrix of Euclidean distance between subjects.

In these processes, TIFD is chosen instead of absolute value descriptors for its theoretical better performance. The diagram

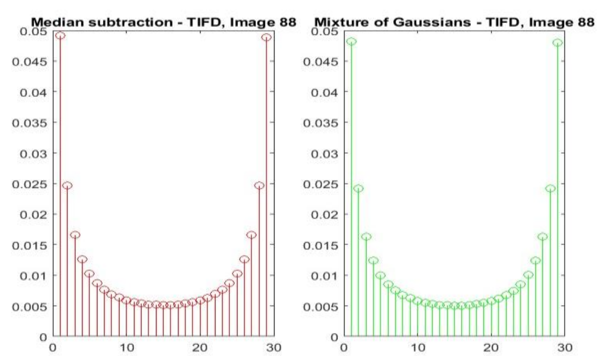


Fig. 6. Diagram of TIFD from a sample image.

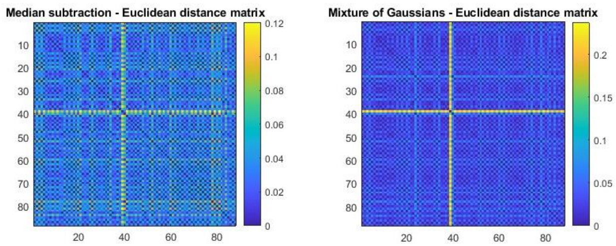


Fig. 7. Euclidean distance matrix of 88 training subjects.

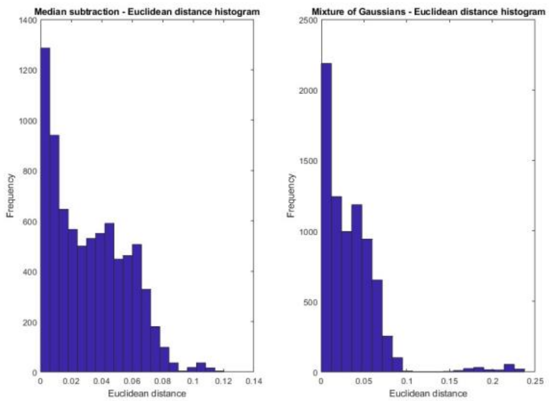


Fig. 8. The histogram of Euclidean distance.

of TIFD from one sample and Euclidean distance between 88 training subjects are respectively illustrated in Fig. 6. and 7. The histogram of Euclidean distance is placed in Fig. 8.

As all elements for feature space are prepared, the space will be generated as a combination of area features, Euclidean distance matrix, number of Fourier coefficients and label of images. Within that, information of one sample corresponding to training image is placed column by column. The process of testing set is same to that of training set, which will not be repeated here. Consequently, there should be two feature spaces from training and testing set before classification. The Fig. 9 illustrates Euclidean distance matrix between training and testing set.

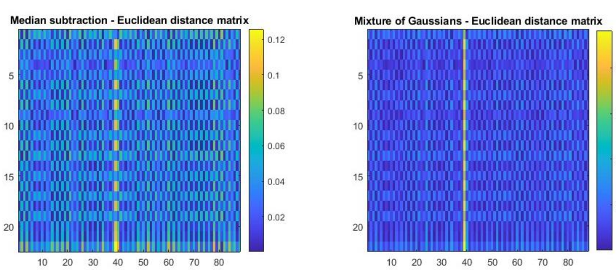
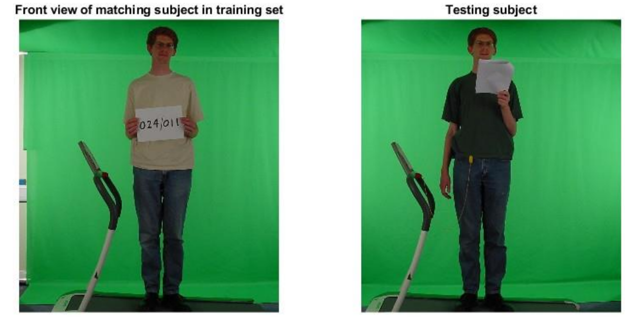


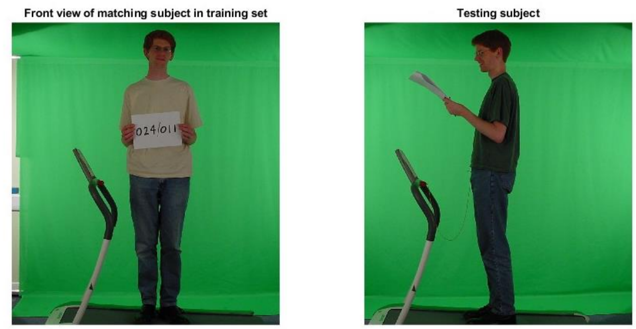
Fig. 9. Euclidean distance matrix between training and testing set.

E. Classification

The method of classification is KNN algorithm. The KNN algorithm works by finding the K nearest data points in the training dataset for a given input data point. Once the K nearest neighbors are found, the algorithm assigns the input data point to the class that has the majority of data points among the K nearest neighbors.



(a) Matching result of side view



(b) Matching result of front view

Fig. 10. Correct matching results of one sample.

Another choice of this stage, which is also easy to implement, is SVM model. However, by analyzing its fundamental and practically testing, its performance is not better than KNN algorithm. By comparing the other various algorithm, KNN is decided for its convenience and performance.

In this project, the labels of training set do not contain information of front or side views, which means the output of testing set classification will not indicate its view but only which sample it matches to. The identification of testing images will not categorize whether it is a front view image or side view image and will directly match the trained model. One of the matching results is presented by Fig. 10.

III. Results

A. Correct Classification Rates (CCR)

The general CCR of this system is regarded as 72.7%. Even though, in several tests, the correct identification is distributed between 16 – 18 from all 22 images, which means accuracy is distributed from 72.7% to 81.8%, while test accuracy from training images keeps in 100%. The 81.8% accuracy occurred quiet occasionally, and 72.7% appeared much more frequently. Therefore, it is more appropriate to regarded CCR as 72.7%.

Two phenomena need attraction, and corresponding discussion will be left to next section.

The primary thing is that all wrong identification happened in front view images, which means all subjects have been able to recognize through this system.

Another important issue is that combination of different filter in image initialization will bring different accuracy. The simple usage of median or Gaussians filter will both bring worse accuracy. The 72.7% CCR is produced by median filter for training set and Gaussians filter for testing set. But reversed arrangement will not bring such good performance.

B. Equal Error Rates (EER)

To evaluate the EER of this system, the essential step is to calculate the False Accept Rate (FAR) and False Reject Rate (FRR) of system. The definition of FAR and FRR is list below:

FAR: the percentage of times that the system incorrectly accepts an imposter.

FRR: the percentage of times that the system incorrectly rejects a genuine user.

The calculation of FAR and FRR is implemented by MATLAB program. The threshold is set to be a serial value to attain EER point. The Fig. 11 present the tend of FAR and FRR in the range of threshold, in which EER point (EER=4.76%) is highlighted.

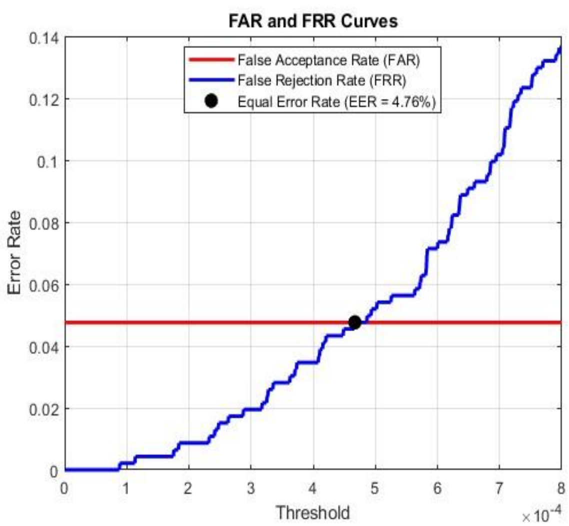


Fig. 11. Diagram of FAR, FRR and EER.

IV. Discussion

A. Identification of front view images

The wrong identification on front view image is mainly caused by two problems. The most possible one is that unclear image segmentation. It means not only failed segmentation, but also blurred boundaries. It leads to a vague representation in some place and could not be distinct from others.

Another problem is that some image is intrinsically similar to another one, which make their feature points close and hard to identify for test point. This issue is expected to cover by addition of feature vector or another state-of-art descriptors, which are used to provide ignored information in existing design.

B. Development and Optimization

The potential of this system is still large, especially in scalability and universality. Its optimization distributes on three directions: method of segmentation, choice of features, and classifier. And there is some information containing in main body of subjects possible to use. If the information could be extracted well, the performance could improve further.

In this case, a conventional method of image segmentation is used to release workload. To develop this system, more sophisticated segment technique could replace the used one. Feature space also have many issues to explore and reconsider some better feature that could not only contain more information but fewer space. There has been various learning method could replace KNN, such as Convolutional Neural Network (CNN) or Reinforcement Learning. An appropriate algorithm to improve the CCR is completely possible.

V. Conclusion

In this project, the main elements relative to CCR contain sharpness and fitness of boundary, information entropy in feature space, and performance of classifier. There is a balance need to maintain between sharpness of boundary and amount of noise.

Another issue is how to filter effect from unexpected subjects, such as clothes or connected items. Using color-based data is a sensible method, but the workload will also increase with more complex process. It leads to another balance between system complexity and information originate from data dimension.

References

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