A Survey of Gait Recognition Techniques

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Abstract— **Gait method is used for the identification of an individual by examining the way person walks or move his feet. It is a biometric recognition system that acquires information like identification of person, person gender, age and ethnicity from the way person walks. As compare to the other biometric systems, gait recognition systems are able to obtain information from a distance, does not require user cooperation and high resolution pictures. Gait recognition has been a recent and progressive topic in computer systems during the last decade. In this paper some of the recent gate recognition methods are presented. Methods are discussed and produced results are compared.**

I. Introduction

The basic notion to identify a person through gait can be traced back to the experiments of Cutting and Kozlowski [1]. They used light point displays to recognize an acquaintance by looking at the lights attached to their joints while walking. Gait recognition has been further studied and advanced for identification. Gait recognition system involves the following steps:

(i) Background subtraction:

Background subtraction identifies the moving object from the background. Background subtraction generates binary images with black and white pixels also known as binary silhouettes.

(ii) Pre-processing

Pre-processing is applied for noise reduction and shadow removal. This involves application of morphological operators to filter noise.

(iii) Feature extraction

Feature extraction is done for reduced representation of input data. This input data is transformed into a set of features also known as feature vector. Feature extraction approaches are:

(A) Model Based: Model based approaches aim to model human body with geometric curves. These are difficult to implement because they usually include mapping from two to three dimension

(B).Holistic/Motion Based: These methods attempt to operate on moving silhouettes by analyzing their variations in shapes and distance vectors.

(iv) Recognition

This is the last stage of any gait recognition system. The extracted features are compared with the pre stored sequences in database using different types of classifiers.

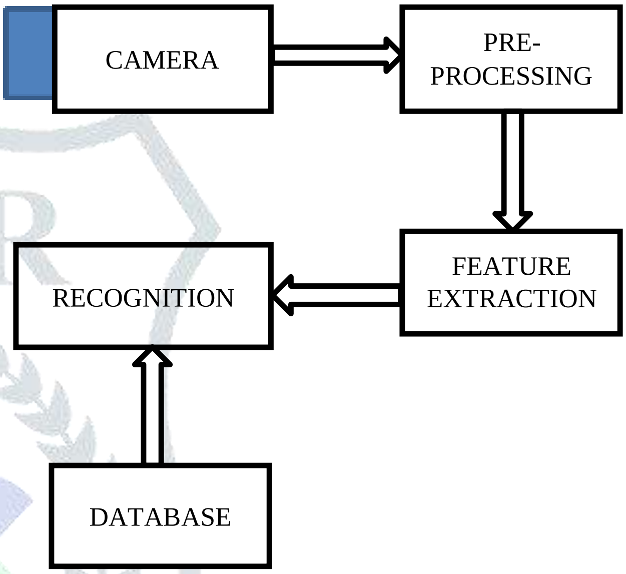

Figure 1: Basic block diagram of a typical gait recognition system

II. Literature Survey

The earliest attempts in gait recognition included extraction of human silhouette from an image. To do so, a human silhouette of an image was taken and then a description associated with the subject's identity was derived. The earliest effort towards automatic gait recognition was attempted by Niyogi and Adelson in 1994. In [2] the gait signature was derived from spatiotemporal pattern of the person's walking style. The head and legs movement have different patterns in XT dimensions. The bounding contours of the motion of the body were determined by processing these patterns and a five stick model was fitted. This fitted model was normalized for velocity to derive gait signature and then linear interpolation was used to derive the normalized gait vectors. A 26 sequence database of 5 different subjects was used and the correct classification rate based on the weighting vectors in a Euclidean distance that ranges between 60 to 80%.

Murase and Sakai has used a similar approach of spatio temporal image correlation [3]. To decrease the computational process and to increase the robustness of the system, the parametric eigen space approach is used. The generic object motion characterization method is used by tem for gait recognition. The approach included the extraction of silhouettes of images and then these images were projected into eigen space. Eigen value decomposition method is used in which the order of the eigenvectors represents the frequency of content. A database of 10 sequences for 7 subjects is taken to perform recognition. The result was a correct classification rate of 100% for 16 eigen vectors, 88%for 8 eigen vectors.

In 1998, Little and Boyd used optical means to derive gait signature [4][5]. The optical flow information was used to extract the frequency and phase features. A set of moving points were produced by the optical flow. The geometry of points used by using the given set of basic measures. The flow information was used to derive further information. Many irregularities in phase differences were shown by analyzing the periodic structure of the sequence. Gait signature are developed by calculating the difference in the phase between phase of the weighted points and centroid's vertical component. The experimentation of this on a limited database showed the correct classification rate of the subjects.

The approach used in [3] was later extended to include Canonical Analysis(CA) to enhance the capability for discrimination by Cunado, Nixon and Carter in 1997 [6]. This approach was further extended [7] to analyze flow rate instead of just silhouette for a better effect.

Based on silhouette methods, many techniques have been developed recently as they enable to obtain silhouette using background modeling and image subtraction methods. In 2002, Phillips and Sarkar introduced a simple method of gait recognition [8]. This approach includes the calculation of the mean co-variance values of each pixel in the whole sequence to find out the pixels in each frame are separated enough such that they may be considered foreground, manhalanobis distance is used [8]. After the foreground pixels are segmented for each sequence, the bounding box is drawn over the foreground silhouette after removing smaller regions. The resulting box is surmounted to a common size. A datasheet consisting of 74 video frames of various subjects walking was defined based on the parameters such as shoe type, type of surfaces and camera angles. A resemblance metrics between the training sequence and test sequence using their median values is used. This frame resemblance metrics includes the ratio of number of common pixels in two frames to the number of pixels combined in two frames.

In further extension to this, some experiments with this algorithm were performed. In this approach the parts of the silhouettes is removed to find out the area below knees for the successful recognition [9], which is an optimized version of [8] and produced better results.

Another simple approach was used by L. Lee and W. Grimson in 2002 [10]. This approach attempts to classify people by gait by using distinct boundary parts. Each silhouette is broken into seven regions specifically head, front and back, thighs and feet for each leg using centroid method. The features like centroid, aspect ratio, orientation are extracted by fitting an ellipse to these parts. The mean and standard deviation is also derived using Fourier analysis with previous feature vector as input. Hence two feature vectors are used for each sequence are produced for classification. The classification used is a simple 1 and the height of the silhouette is determined for a whole sequence.

A spatiotemporal approach was presented in [11] by Wang and Ning based on the unwrapping of human silhouette and eigen space transformation of distance signals are derived from the sequences of silhouettes. In this approach, the distance between each silhouette boundary pixel and centroid of the person is calculated and normalized with respect to length and magnitude to represent each gait sequence. Eigen values and Eigen vectors are calculated and a similarity measure is used to test the sequences. The similarity measure used can be either Euclidean distance method or spatial temporal correlation method. The experiments show that Euclidean distance produce better identification results than spatial temporal correlation.

In 2009, Liu and Zhu employed principal component analysis (PCA) to diminish the feature space by eliminating features that do not cause significant variations [12]. Hough transformation is used to locate certain features through voting. A single cycle is extracted by determining the period of gait for each sequence. Hough transform is done for images of each silhouettes and template image is computed for the entire sequence. Template images contain the information to find the straight lines in given silhouettes sequences. Later, PCA method is used to decrease the amount of features.

III. COMPARISON

The results of the discussed gait recognition approaches are indicated in table1

Table 1: Comparison of gait recognition approaches

RECOGNITION METHODS	CCR%
Phillips (2002)	78.75%
Lee (2002)	87.50%
Wang (2003)	82.50%
Liu (2009)	97%

On a single angle in Natural Language processing database, the schemes proposed in [10], [11], [12] exhibited the best performance. The performance of the algorithms used in these approaches depends heavily on the construction of the dataset.

IV. FUTURE SCOPE

Gait recognition is a particularly new area of research with a great future scope. A variety of promising methods have already been discussed in this paper. Currently, there are a number of factors which are being studied in this area. These include innate, practical and wider deployment factors. The innate factors are concerned with the covariate conditions that affect the performance of the gait recognition system. The practical factors include effects such as consequences of subject's speed, subject carrying a bag or wearing a coat and the variations in the angles of the viewpoint. With the increasing interest in gait recognition for authentication and medical purposes, there is a wider deployment capability. Further, greater realism in animation can be achieved through gait analysis but it further requires implementation of sophisticated strategies.

V. CONCLUSION

In a short span of time, gait recognition system has come a long way. From a limited database used in early approaches, gait recognition has progressed to large databases that are real time. Different covariate factors are also being included for study in the databases. This paper briefly reviewed the different approaches in gait recognition and their progress.

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