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Survey on Biometric Human Gait Recognition

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Abstract— Human Gait recognition is a distance based behavioral feature of biometric. It is relatively a new area being studied nowadays mainly because it is Unobtrusive . This paper presents a survey of different Methods used for recognition of a Person based on different Activities such as walking style. All methods are discussed individually and at the end Comparative study of different Methods is discussed.

Keywords— Biometrics, Gait Recognition, Axis of least Inertia, Interval valued Features, Surveillance, Silhouette detection, spatiotemporal correlation

I. INTRODUCTION

Biometrics refers to the metrics related to human characteristics and traits. Human Recognition Biometrics basically came into existence from real life Criminal and Forensic Applications. The term Biometrics is derived from a Greek word "Bio" means life and "metrics" means measure[8]. Thus, Biometrics is the science and Technology of measuring and analyzing biological data. Biometrics is classified into two categories as depicted in fig below :

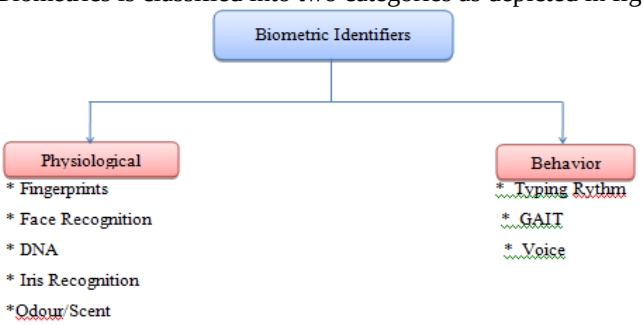

Fig. 1 Classification of Biometrics

Physiological characteristics are related to the shape of the body. Examples include, but are not limited to Fingerprints, Iris Recognition, Hand geometry, DNA, Face Recognition etc. ***Behavioral*** characteristics are related to the pattern of behavior of an individual and pay attention to the actions of a person. Examples include, but are not limited to Voice, Typing Rhythm and GAIT.

Gait refers to locomotion achieved through the movement of human limbs. Gait is one of the Biometric traits used to identify an individual by his/her walking style. Examples of motion that are gaits include walking, running, jogging, and climbing stairs. ***Gait Recognition*** is one of the biometric techniques which has become an area of focus in recent years in computer vision. Gait Recognition is a task to identify or verify an individuals by the way they walk . A desirable property is the ability to identify persons at a distance from a camera and this property is important for surveillance and other applications . Gait can be obtained from distance without the cooperation or knowledge of an individual, this makes it important for some early warnings or monitoring applications that has the need to perform recognition when the person is far away. Gait can be used in situations where other biometric traits such as face, iris and finger print information do not have sufficient resolution for recognition.

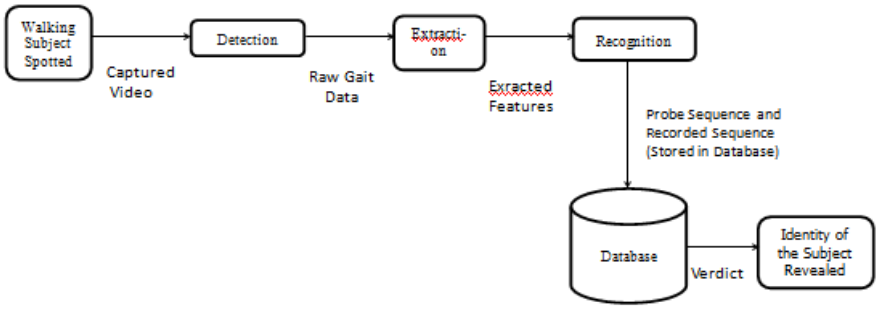

Fig : Gait Recognition Steps/Process

1*) Detection* : The first step in gait recognition is Detecting and Tracking humans from a video sequence, where an individual is actually spotted walking. The Systems usually work on the assumption that the video sequence which is to be processed is captured by a static camera, and the only moving object seen in the video sequence is the Person(Subject). Suppose, a video sequence is given from a static camera then, it detects and tracks the moving silhouettes. This process is comprised of two steps : 1) Foreground Modelling and 2) Human tracking using skeletonization operation.

2) *Extraction* : In this Step the Elements of interest of gait are collected from the individual. The background should be as simple as possible. An extra attention should be paid on the selection of an appropriate (side) viewpoint. Various moving Backgrounds and Lighting make unstable the extraction Techniques such as Optical Flow and Background Subtraction.

3) *Recognition* : In this Step, The Extracted samples are compared to the samples stored in a database. The identity of an individual having the most (and enough) similar gait sample is picked and stated as the recognition verdict.

Gait recognition system can be used in a number of scenarios. If an individual walks by the camera who's gait has been previously recorded and if he is stated as a threat, then the system will identify him and then after the concerned authorities will be automatically alerted. This kind of systems have strong application in airports, banks and other such areas, where high Security is of prime importance.

II. OVERVIEW

In Mohan Kumar et.al [1], a method is proposed for characterizing gait in terms of interval valued type symbolic features. In order to extract symbolic features for representation of gait, Axis of least inertia of a shape is used. This technique persue the capabability to capture various variations in gait due to change in cloth, carrying a bag and different instances of normal walking conditions in an efficient way. Three main phases are present in the proposed method viz., feature extraction, representation and similarity computation for recognition. The input in the proposed method is a sequence of binary silhouettes of one gait cycle. In this method it is assumed that the speed for any specific gait sequence is constant because length of all instances (change in viewing angle, change in cloth type, carrying a bag, change in walking surface) of a subject is constant. But, Speed can differ among reference and test sequences. As , the gait recognition widely depends on the shape of the body contour variations with respect to time, such variations are so captured by extracting features by keeping the axis of least inertia of a silhouette as a reference. The axis of least inertia is computed [6, 8] for each and every silhouette in a gait cycle. The axis of least inertia is unique to a particular silhouette and therefore it is used to extract features from a silhouette.

In Amit Kale et.al[2] suitable feature considered for gait recognition is width of silhouette. The width of silhouette is nothing but the horizontal distance between the leftmost and the rightmost foreground pixels of the silhouette. Experimental results showed that the side-view gave the optimal result to capture the characteristics of gait. By using the frontal-view the proposed method can recognize gait but the result is low accuracy as compared to the side-view. Two different approaches are used in order to gain observation vector : Indirect approach and Direct Approach. In, Indirect Approach the extracted features that have high-dimensions are transformed into Frame to Exemplar Distance(FED) vector that have low-dimensions. FED vector is capable of capturing Structure and dynamics of gait. This FED vector is fed to HMM(Hidden Markov Model) for training. In, Direct Approach the extraxted features are represented as vectors and are directly fed to HMM for training. In this manner the distance between exemplars and image features is found and compared for Reference and test image for Recognition.

In Tahir Amin et.al [3] a new gait signature based on the correlation analysis of the leg motion is proposed for gait recognition. The motion of two legs during walking process is one of the most important characteristics of gait. The results clarify that an important gait signature i.e leg motion, can be combined with other signature like Fourier descriptor features in order to gain better results i.e in terms of Recognition. The Proposed Method has three Steps :

1) Silhouette Preprocessing : It is necessary to improve the quality of the silhouettes and to reduce noise as lower half of the silhouettes is subject to critical quality and noise.

Morphological Closing Operations are used to smoothen the contours of the silhouettes. Morphological Closing operation is define as :

$$B' = B \bullet S = (B \oplus S) \ominus S$$

Where,

B = Binary silhouette before closing operation.

B'= Binary silhouette after closing operation.

S = Matrix of 0's and 1's called Structuring element.

$\oplus$ = Morphological Dilation operation.

$\ominus$ = Morphological Erosion operation

2) Extraction : Two types of Gait signatures are extraxted from silhouette – Correlation based and fourier descriptor. The shape of the silhouette can change during gait cycle and it can be calculated by Fourier descriptor(FD). FD is invariant to rotation and translation and it is robust to noise. So, FD features are used for gait recognition.
3) Recognition : The Test sequence features are compared to the features of reference sequence recorded before.

In Xiaxi Huang et.al[4], method for detection from side-view point for random walking paths of a subject is proposed for gait recognition. Process comprises of three steps: gait cycle determination, side-view partitioning and gait feature template construction.

1) Gait Cycle determination : Number of frames in one gait cycle is detected for every gait cycle.

2) Side-View Partitioning : After the number of frames in one gait cycle is determined, from sequence of gait , One gait cycle is selected that includes only side-view frames. Such cycle is selected because when we apply extraction method on it then it can give information about height of the subject just by detecting top and bottom edges of the silhouette.
3) Gait Feature Template Construction : It is better to use the features that considers all the frames in the cycle as whole. One such feature is Gait Energy Image(GEI) . It has two parts, Upper body part(head and torso) : it provides the information about the shape of the subject. Lower body part(Legs) : it provides the dynamic information about the subject. Then, GEI is divided horizontally into 3 trunks : Head, Torso and Legs.

Thenafter, the three trunks are shifted by their new centers separately, thus Shifted Energy Image is obtained.
After this the distance of SEI's are calculated for all the trunks and then combined to form single SEI feature. The new gait feature, the Shifted Energy image is used for various body-posture during random walking patterns. Thus, SEI features of Reference and Test images are compared fro recognition. As, SEI is used in this method , the name of the method is SEI.
In Nikolaos V. Boulgouris et.al[5], proposed method is Radon transform of binary silhouettes. The speed is considered to be constant for any particular gait sequence. First of all, input to the system is sequences of binary silhouettes that are obtained using background subtraction process. These, silhouettes are used to calculate walking cycle. Then after silhouettes are alligned and subjected to Radon Transform and thus Radon template is obtained. This, Radon template is subjected to LDA(Linear Discriminant Analysis) for extraction of the features. Then, these features are representated as single feature vector scribes entire gait sequence. Lastly, gait recognition is achieved by comparing it the feature vectors of reference sequences with the feature vectors of given test/ probe sequence.

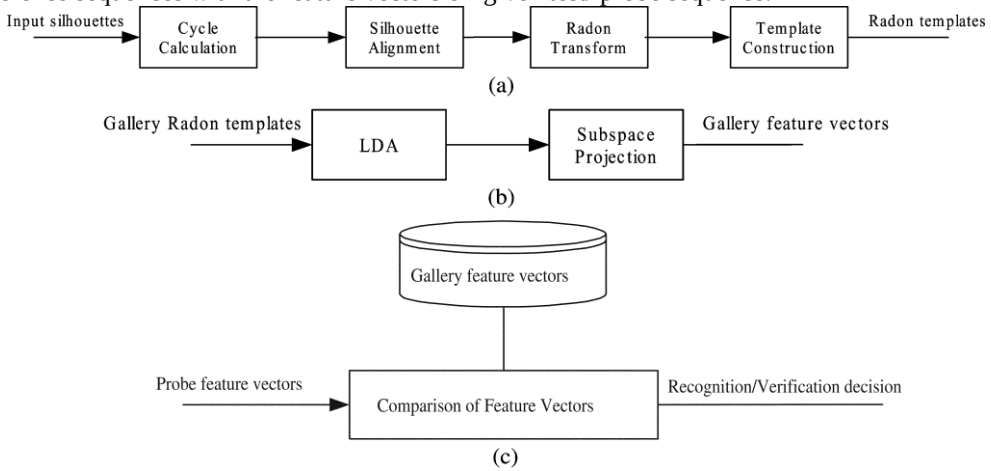

Fig. 2 (a) Construction of a Radon template; (b) Feature extraction using LDA; (c) recognition/verification.

In Sudeep Sarkar, P et.al[6], a baseline algorithm for gait recognition is proposed, which uses spatial-temporal correlation of silhouettes. 12 experiments were conducted on large data sets in order to test the effects of five covariates on performance. The five covariates considered are : change in viewing angle, change in shoe type, change in walking surface, carrying or not carrying a briefcase and elapsed time between sequences being compared. Two condition were selected for each covariate : 1) Two Camera angles viz., Left and Right. 2) Two Shoe Types viz., A and B. 3) Two Surfaces viz., Grass(G) and Concrete(C). 4) Not Carrying a Briefcase(NB) and Carrying a Briefcase(BF). 5) Two Different Dates, six months apart i.e Acquisition time viz., May(M) and November(N). Identification/Recognition rates for the 12 experiments range from 78% on the easiest experiment to 3% on the hardest. All five covariates had noteworthy effect on performance, but the walking surface and time difference had more noteworthy impact.
In Nor Shahidayah Razali et.al[7] this paper the method proposed for Gait Recognition is using Motion capture data. First of all the prototype of Gait motion capture system was developed and this prototype performed the processes such as : Normalization, Feature extraction, feature matching and identification. Normalization method is applied to make the data constant. Principal Component Analysis(PCA) method is used to reduce the dimensions of the data and to extract the features of lower limb gait data. By, using PCA, Principal components are obtained and these components are matched by using Euclidean Distance method between Reference data sequence and the test/probe data sequence.

TABLE I COMPARISION OF VARIOUS METHODS

Reference Paper	**Method**	**Recognition Rate**
[1]	Interval Valued Type	Good. Drawback : In this method we must find axis of Least Inertia for extracting features from the silhouettese.
[2]	HMM	Low. Drawback : This method cannot recognize gait with accuracy using frontal-view efficiently.

[3]	Correlation analysis of the leg motion.	Low. The motion of two legs during the human walking process is most important.
[4]	W-SEI	Good. Drawback : it only rely on energy.
[5]	Radon Transform	Low. Drawback : But every time we have to make feature vector.
[6]	Baseline Algorithm	Moderate. Using large data set this paper performs base line algorithm which uses spatial-temporal correlation of silhouettes for gait recognition.
[7]	Normalization, PCA, Euclidian Distance	Moderate This technique recognize a person by using Gait Motion capture Data.

III. CONCLUSION

In this paper different methods for Recognition of walking person at a distance are discussed on the basis of the survey conducted. It is observed that among various methods of Feature extraction methods, the method based on silhouette extraction is used extensively. Various methods discussed in this paper for recognition are Baseline Algorithm, HMM, Correlation analysis based method, Radon Transform, W-SEI(Weighted Shifted Energy Image), Interval Valued Type. are discussed. Last but not the least the comparative table of all the methods is provided including its Pros and cons.

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