ISSN:0975-9646

Suvarna Shirke et al, / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 5 (4) , 2014, 4958-4961

Human Gait Recognition for Different Viewing Angles using PCA

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Abstract— **Human gait recognition is a developing biometric engineering now a days. It perceives the individual from its walk and above all from a distance without subject's co-operation. As human gait recognition system is influenced by diverse view variations effects. So, in this paper we have proposed a human gait recognition strategy for the images caught from distinctive viewing edges (0, 45, 90 degree). There are two phases in this proposed work: feature extraction and recognition. Principal Component Analysis is used for feature extraction and for similitude estimation Euclidean distance is used. Experiments are performed on CASIA A gait dataset.**

Keywords— **Euclidean Distance, Human Gait, Principal Component Analysis (PCA).**

I. Introduction

Human gait recognition system analyses an individual from its walking style from a distance. In Human gait recognition system there is no need of subject collaboration dissimilar to unique finger impression and palm print recognition. It is exceptionally hard to cover somebody's gait. However separated from these favourable circumstances here are few inconveniences of human gait recognition technique which are: human walk affected by liquor, attire style of an individual or if an individual has gone under the surgery or disorder may transform its walk. It is likewise conceivable that human brain research (individual is cheerful or miserable) additionally influence the persons walk. There are two routines for human gait recognition: model based and model free method.

A. Model Based Approach

Model based approach regularly utilizes a stick representation for modeling human. The individual model is fit to the individual in each one edge of the strolling grouping and parameters are measured with the obligations on the body model of strolling or walking succession [2]. Favorable element of model based methodology is it is vigorous to occlusion. Furthermore clamor, Disservice of model based methodology is it obliges high computational expense [3].

B. Model Based Approach

In model free approach distinctive sorts of features are concentrated like entire movement of human bodies, silhouette width vector on the other hand Fourier descriptors. It additionally concentrates on silhouette shape and the element data, which is utilized for example matching. Dynamic data is gathered by utilizing worldly arrangement Strategies [4] [5]. Model free approach is additionally called as holistic methodology, which dissect the movement of the walking subject and afterwards unique features are concentrated from the movement. The model free human gait recognition methodology comprises of discovery of subject, silhouette extraction, feature extraction and classification. This methodology obliges low computational expense. Disadvantage of this approach is that it is affected by background noise and changes in subject appearances. In this paper, we have used model free approach for gait recognition. We have proposed human gait recognition for different viewing angles (0, 45, 90 degree) using Principal Component Analysis (PCA). PCA is used for feature extraction; Euclidean distance is used for matching or for classification. In this paper section 2 covers the literature survey followed by the system design in section 3. Thereafter section 4 covers the experiments performed and section 5 gives the conclusion and future scope.

II. Literature Survey

Dong Xu et. al. [5] proposed a new patch distribution feature PDF. They displayed each Gait Energy Image (GEI) as a set of local augmented Gabor feature in connecting with Gabor features extracted from different scales and orientations (40D Gabor peculiarities removed from 5 diverse scales and 8 separate introductions) together with 2D x-y coordinate. As of late, Haifeng Hu [6] proposed combo of Enhanced Gabor (EG) and representation of GEI and regularized locally tensor discriminant analysis (RLTDA). To adapt to the variety EG remove the step characteristics which are portrayed spatial recurrence, spatial locality and orientations EG considers measurable property of walk peculiarities as well as nonlinear mapping to underline those paramount peculiarity focuses. Daigo Muramatsu et. al. [8] utilized GEI as gait feature. Shape arrangement is concentrated from standardized picture arrangements utilizing graph cut based calculation and background subtraction. Shape arrangement is standardized into 88*128 pixel estimated profile grouping lastly GEI is registered. For walk examination outline is the beginning stage however, a large portion of the work obliges form removed from background subtraction . Maodi Hu et. al. [9] apply optical flow motion feature which gives wealthier subtle elements than silhouette. Local binary pattern (LBP) is utilized for tracking and modeling and it is also used to describe texture information of optical flow and it is additionally used to portray composition data of optical stream. Daigo Muramatsu et. al. [10] generated silhouette image sequence by background subtraction and graph cut method. Yasushi Makhihara et. al. [11] assess silhouette by background subtraction and graph cut segmentation. A bounding box segment for silhouette sequence is computed and a size normalized silhouette sequence is generated by scaling height if boundary box and by registering silhouette centre.

Haruyuki Iwama et. al. [12] has used Gait energy image (GEI). Ryo Kawai et. al. [13] evaluates gait features which contain shape and motion with color information. In this spatio temporal histogram of oriented gradient (STHOG) features are employed as gait feature by containing shape and motion movers shape morphing (EMM) to extract the inner silhouette motion. Recently, Yasushi Makhihara et. al. [18] made the use of multiple gait features which are gait energy image (GEI), frequency domain feature (FDF), gait entropy image (GEnI), chrono-gait image (CGI), gait flow image (GFI) in simultaneousness with score level combination. GEI, FDF and GEnI are silhouette region-based gait features and CGI and GFI are silhouette contour based gait features and capture more dynamic components.

Negin K. Hosseini et. al. [27] has used a silhouette based method, to identify person in video by their gait. Gait cycle is represented by using averaged silhouette. To reduce the dimensionality of the features Principal Component Analysis has been used. Euclidean distance is used to measure the similarity of the averaged silhouettes. Experiments were performed on TUM-IITKGP Gait Database. Gyan C. et. al. [27] proposed a sub window extraction algorithm for feature extraction and back propagation algorithm for recognition. Here all the images they have taken are captured from different angles and images are enhanced by using clipping, filtering and histogram equalization. Experiments are performed on different datasets. In this the silhouette image are loaded and the upper-left and right, lower-left and right pixels for each row and each column are searched. By using this pixels sub-window from the silhouette image is extracted, then mean of the extracted sub-window is calculated. If the mean of the extracted window is zero then extracted sub-window will be considered as a background image and skipped, otherwise it can be considered as sub-window. The given algorithm is applied at each row and column for extracting the sub-window. Jinyan Chen and Jiansheng Liu [28] proposed average gait differential image (AGDI), which has advantage that as a feature image it can preserve both the kinetic and static information of walking. Comparing to gait energy image (GEI), AGDI is more fit to representation the variation of silhouettes during walking. Features are extracted by using two-dimensional principal component analysis (2DPCA).

III. Proposed Methodology

A. System Design

Human recognition is carried out by concentrating the outline of a walking individual in a feature. We have proposed a model free gait recognition technique. There are two phases our proposed gait recognition approach: Feature Extraction and Recognition. Fig. 1 represents an outline of the proposed technique, and these stages are depicted in points of interest by the accompanying segments. As we have utilized CASIA -A data set, which contains the binary silhouette so preprocessing step is avoided. Features like height and width of silhouette are concentrated throughout feature extraction in PCA. Euclidean distance is used to match the similarities between samples.

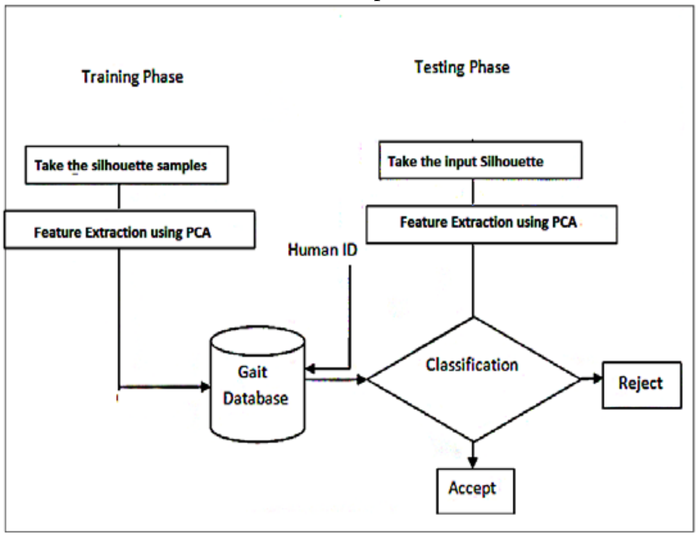

Figure 1: Proposed Gait Recognition System.

B. Feature Extraction

Principal Component Analysis (PCA) is linear technique and used for the feature extraction as well as for recognition in this paper. Principal Component Analysis does a linear mapping of high dimensional space to low dimensional space in such a way that first it centralizes the data by subtracting the mean, and then covariance is calculated followed by computing Eigen vectors of the covariance matrix. The largest calculated Eigen value is the principal component. This is used to reassemble a large fraction of the variance of the original data. Features extracted are height and the width of the silhouette.

1) PCA Description:

Principal Component Analysis (PCA, also known as Eigenfaces") is one of the most known global dimensionality reduction and recognition algorithm. The main idea is to decorrelate data in order to highlight differences and similarities by finding the principal directions (i.e. the eigenvectors) of the covariance matrix of a multidimensional data. For our experiments, we use the CASIA A database [4]. The Gallery Set contains N=10 subjects.

2) Training PCA:

To reduce the dimensionality of the feature space, PCA is given as:

$$[F] = T[f] \qquad (1)$$

Where T= $\{\gamma 1, \gamma 2, \gamma 3 \ldots . N-1\}$ are eigen vectors of covariance matrix, Cov ([f]).

Let N be the number of persons and n be the number of samples associated with each person, then average value of gait be the X for each person.

$$\sum_{i=1}^{N} X(i) - \sum_{k=1}^{n} X(i,i)k \quad (2)$$

Where i= 0 and j=0, i denotes the height and j denotes the width and i,j is the position of pixel in gait sample. If h is the height of the gait sample and w be the width of gait sample, we get the covariance matrix as follows.

$$cov(x) - [X]^T_{(N)*(h*w)}[X]_{(h*w)*(N)} \quad (3)$$

Let A be the covariance matrix and it is given as

$$[A]_{N*N} = X^T X \quad (4)$$

Since the covariance matrix and eigen values are related by the identity

$$A\gamma_i = \lambda_i \gamma_i \quad (5)$$

Therefore after obtaining all the eigen vectors

$$cov[f]T^T - T^T diag(\lambda_1, \lambda_2 ..., \lambda_{N-1}) \quad (6)$$

Therefore after obtaining all the eigen vectors,we obtain PCA using following

$$[PCA\ matrix]_{(h*w)*(N)} = [X]_{(h*w)*N}[Eigenvectors]_{N*N} \quad (7)$$

Where Eigen vectors are obtained by descending the eigen values of covariance matrix.

Finally we generate:

$$Omega_{N*N} = [X]_{(h*w)*(N)}[PCA]_{(N)*((h*w)} \quad (8)$$

Which is $X^T X$.

Where $X^T X$ [eigenvectors]

Finally we get the sorted eigenvalues of covariance matrix of eigenvector.

The mean image all the samples is computed and projected on gait space which has eigenvectors deriving from the Training Set. This step leads to a simple dot product which gives a weight vector.

C. Feature Extraction

1) Calculate Dot Product: The dot product is the first basic operation that must be done during the recognition step. A normalized image is projected onto the human gait Space. To decide the best match for query i.e. input gait sample for recognition

$$Omegainput_{1*N} = [Inputgait]_{(h*w)}[PCA]_{(h*w)*(N)} \quad (9)$$

For matching we find the cost of N persons as:

$$\sum_{i=1}^{N} cost(i) = \sum Omega\ Input - Omega(i,:) \quad (10)$$

2) Measure the Distance: Once the incoming probe image has been projected onto the gait Space, we have to see whether it is a known gait or not. To proceed, we compute the Euclidean Distance (ED) between the weight of the input image and weights of matrix for entire gait space.

$$\sum_{k=1}^{N} cost(i) = \sum (Omega\ Input(k) - Omega(i,k))^2 \quad (11)$$

3) Final Decision: At this stage, we have Euclidean distance for N persons. Since we work in verification mode (the subject's identity is claimed) and since the Probe Set contains persons who are registered in the database, we simply take the minimum Euclidean distance as the final decision rule:

Match = min(cost)

i = matched; [i = 1 to N]

Where i is nothing but the index. The palce whrere the cost is minimum is the best match. Assume the ID of the test image is the l (from 1 to P) and i is the index corresponding to the minimum SED, a subject is considered as a genuine if l=i, otherwise he is considered as an impostor.

IV. EXPERIMENTS

In the proposed work the algorithms are executed on MATLAB 7.7 and Intel I3 core processor is used with 4GB RAM. The dataset is derived from CASIA- A gait dataset.

A. *Training and Testing database*

Experiments are performed on CASIA A dataset. Dataset A contains 20 persons and for each person there are 12 image sequences, 4 sequences for each of the three directions. (Parallel, 45 degrees and 90 degrees to the image plane). The length of each sequence is not exactly alike for the variation of the walkers speed, but it must ranges from 37 to 127. The database includes 19139 Images. We have trained 10 subjects and each is having 10 samples, total 100 samples are trained. For testing 3 image samples per person has taken, and 10 false samples were taken, total 40 testing samples are there. The entire true samples are recognized correctly in both the approaches, so the TPR for PCA and DCT is 100%. There are 10 false samples, PCA has rejected 6 samples correctly but accepted 4 samples so, the FPR for PCA is 60%. FNR is 0% and TNR is 40%. The results are shown in the table 1 and 2. ROC curve for PCA is shown in figure 4, ROC curve is drawn against FPR verses TPR.

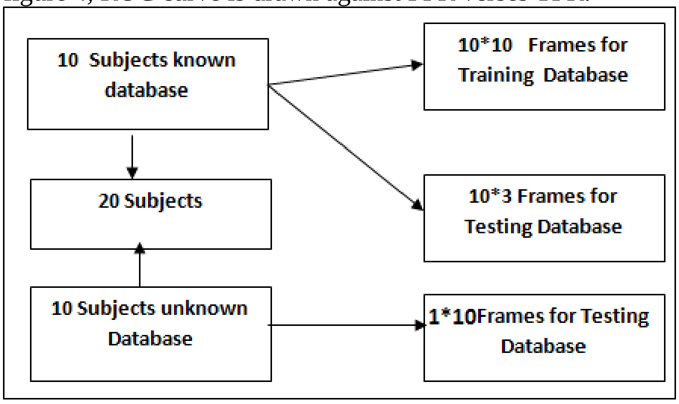

Figure 3: Design of Database for Training and Testing

TABLE I RESULT TABLE FOR PCA

No. of Persons	% PCA Accuracy
1	100
2	100
3	100
4	100
5	100
6	100
7	100
8	100
9	100
10	100
11(10 false samples)	60

TABLE II RESULT TABLE FOR PCA PARAMETERS

Parameters	Result
Feature extraction time	10 ms
Matching Time	134ms
Accuracy	90%
TPR	100%
FPR	60%

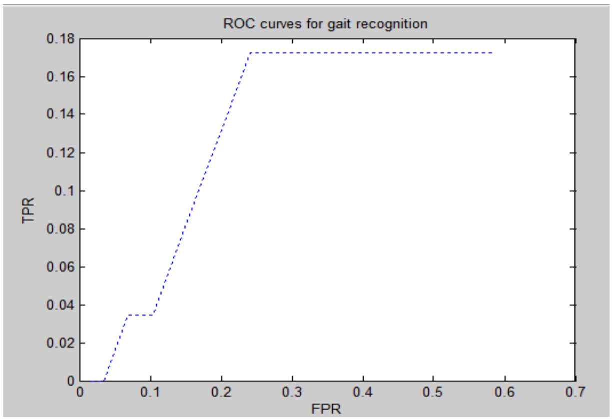

Figure 4: ROC curve for PCA

V. CONCLUSIONS

In this paper, Principal Component Analysis (PCA) is used for gait recognition. PCA is a linear feature extraction technique. CASIA -A gait dataset is used to perform the experiments with three different directions (0, 45 and 90 degree) image samples. PCA has performed well as it has given 90% accuracy. TPR is 100% and FPR is 60%. As we have worked on the still camera images, in future it may be possible to work with moving camera images.

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