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Human Gait Recognition System Based On Principal Component Analysis [PCA]

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Abstract: ***This paper addresses about recognition of human being based on gait way of working. Gait recognition is usually referred to as a human identification/individual by the manor style or way of people walk in image sequences. The aim of this project is to implement the traditional gait recognition algorithm which will offers the possibility to identify people at a distance without any interaction or co-operation from the subject, This will be achieved when the human is observed parallel to camera under one condition of walking normal and walking patterns create a gait signature of individual which are transformed into silhouette and then using The principal component analysis (PCA) algorithm to identify the subject by matching with the one which has already registered in the database. However, in this case, the work of a novel method for the purpose of similarity computation rather than the traditional recognition where the overall recognition rate of percent was obtained.***

Keywords: Gait recognition, silhouette, gait signature, principal component analysis

1. Introduction

Human gait recognition is an important task in a variety of applications, such as access control, surveillance, etc. To distinguish different persons by the manner they walk is a natural task that people perform every day. In Psychological studies, have showed that gait signatures obtained from video can be used as a reliable cue to identify individuals in the way they walk. These findings inspired researchers in computer vision to extract potential gait signatures from images sequences to identify people. Human gait recognition is classified in one of the Biometric technology because this technology use of the physiological or human behavioral characteristics to authenticate the identities of people. The combination of human motion analysis and biometrics surveillance systems has become a very popular research direction. It is challenging, however, to find gait features in marker-less motion sequences, where the use of markers is avoided because it is intrusive and not suitable in general gait recognition settings. Ideally, the recognition features extracted from images should be invariant to factors other than gait, such as color, motion, landscape, shoes, texture, or type of clothing. The idea driven by the need for automated person identification systems for visual surveillance and monitoring applications in security environment such as Banks, Company/ Organization, airports, state house etc. the aims is to develop a surveillance technologies for successfully detecting and identifying human's beings in the way of walking gait. This project will discriminate an individual by gait compared with the past biometric features such as fingerprint, face recognition and iris recognition; gait has the advantage because it requires no subject in contact like fingerprint other than walking in a distance towards to the fixed camera.

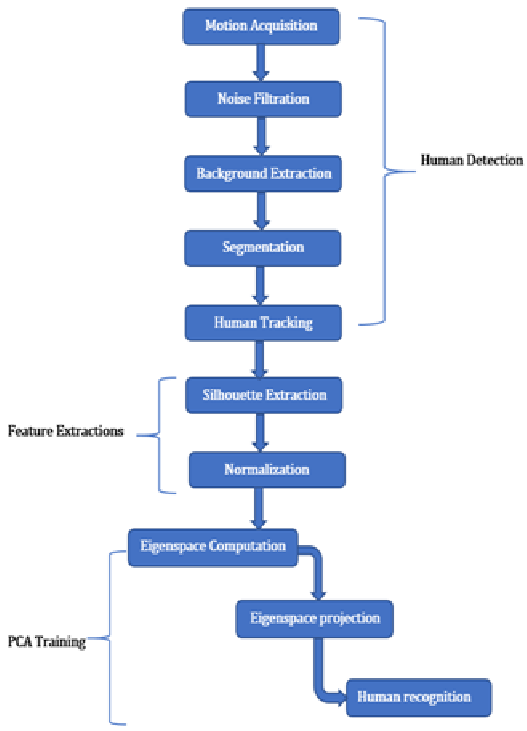

Figure 1: Human gait recognition model

1.1 Overview of the method

The overview of the proposed algorithm of this paper is shown in the figure 1above, it comprises of three major parts such as Human Detection, Feature Extractions and PCA Training. The first part Human detection detect the walking figure in terms of image sequences this performed from motion acquisition where we load walking figure then we remove noise from each sequence of an image of the walking figure we call it noise filtration after that a background extraction is performed to a motion segment that extract the foreground subjects from the gait sequence, ready for extracting gait features after the separation of the background and the moving region called silhouette of the walking figure is tracked through the corresponding method. The second part named feature extractions this is used to extract binary silhouette from every frame and silhouette image into normalized distance for the purpose of approximating the temporal changes of human gait pattern. The third part called PCA training in this we train by applying Principal Components Analysis in order to determine the particular person by using pattern classification techniques.

1.2 Contributions of this paper

The main contributions of this paper are as follows:

- We develop a method which is effective for gait based human identification by using Principal Component Analysis (PCA).
- Develop a program that is capable of performing recognition of individual in his or her gait that derived from a video sequence of a person walking. The program should be able to store the derived gait signature for comparison at a later stage.
- The previous biometric projects for human detections like iris detection, human face recognition, figure print both need appearance of subject (person) but gait recognition there is no need it is just the video sequence of walking gait captured by a fixed camera and detects the person.
- In an organization, instead of using finger print as a means of recording of employee's attendance you can use this biometric human gait recognition system, mount a fixed camera which is synchronized with the door system if the person who is passing through the door the system will recognize him/her and the door will open but this situation occurs if and only if the employee has already registered to the system database.
- This proposed method of human gait recognition is suitable to recognize walking gait pattern taken from different angles towards the fixed camera.
- The proposed method of human gait recognition is desirable because it has low cost of computation.

2. Literature Review

Literature presents a number of researches based on difference approaches for gait recognition. Of them, a few make use of Independent Component Analysis (ICA) for gait recognition. A concise description of those recent significant researches is presented below:

A simple method for gait recognition on the basis of human silhouettes using multiple feature representations and Independent Component Analysis (ICA) has been proposed by Jiwen Lu and Erhu Zhang [3].

M. Pushpa Ran and G. Arumugam [4]in this research, they propose an efficient human gait recognition system using modified Independent Component Analysis (MICA). The proposed gait recognition system characterizes gait in terms of a gait signature computed directly from the sequence of silhouettes. The system can be seen as a generic pattern recognizer composed of the three main modules namely, i)Human detection and tracking ii) Training using Modified ICA and iii) Human recognition. Initially, the moving objects (human) are segmented and tracked in each frame of the given video sequence (tracking module). Then, the person's identity is determined by training and testing using MICA on the extracted feature vectors (pattern recognition module).

Chen Wang, Junping Zhang Jian Pu [5] In this project, they propose a novel temporal template, called Chrono-Gait Image (CGI), to describe the spatio-temporal walking pattern for human identification by gait. The CGI temporal template encodes the temporal information among gait frames via color mapping to improve the recognition performance. Our method starts with the extraction of the contour in each gait image, followed by utilizing a color mapping function to encode each of gait contour images in the same gait sequence and compositing them to a single CGI. We also obtain the CGI-based real templates by generating CGI for each period of one gait sequence and utilize contour distortion to generate the CGI-based synthetic templates. In addition to independent recognition using either of individual templates, we combine the real and synthetic temporal templates for refining the performance of human recognition.

As we have seen the several researchers in their approaches has shown that it is conceivable to recognize people based on their gait compared with the other biometric features like fingerprint, face recognition and iris recognition.

3. Feature Extraction

The original human silhouette images are obtained from the database, it consists of walking subject's video sequences which is captured from a fixed camcorder. Background subtraction approach has been applied to segment out the subject from the background. The generated silhouette images have resolution of 378 x 269 (width x height).

There are several subjects in the database for the beginning of this project we train two males and one female but before training and recognition each frame image sequence containing a walking figure is converted into a temporal sequence for processing stage.

3.1 Human gait detection

This part is to track the moving of silhouettes of walking figure from extracted binary of foreground image in each frame we call skeletonization, the change detection algorithm is applied which is based on background subtraction. Video sequences walker captured from a fixed static camera and the Principal Component Analysis [PCA] method which stated above will perform well on our data set.

3.1.1 Background Subtraction

This is used for foreground detection first we use our fixed camera to observe moving object human gait or dynamic scenes here we use the Least Median of Squares method (LMedS)[11] to construct the background from the image sequences. The formula of calculating Background b_{xy} of N images as follows:

$$b_{xy} = \min_{p} med_t (I_{xy} - P)^2,$$

where P is the background brightness value to be determined for the pixel location (x, y), med represents the median value, and t represent the frame index ranging within 1 - N.

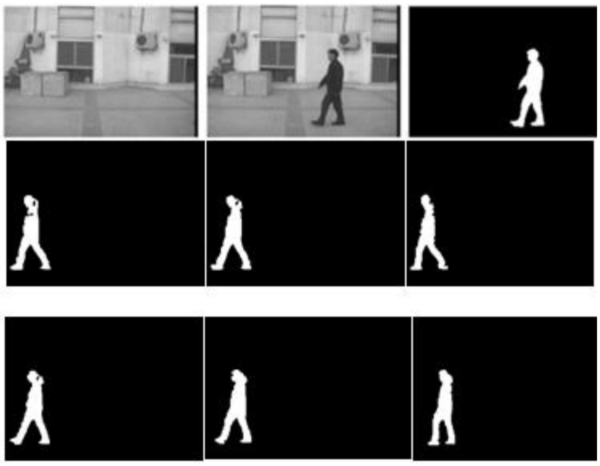

Figure 2: To show examples of moving silhouette extraction that the background image constructed by the Least Median of Squares method (LMedS)

3.2. Silhouette Extraction.

Background subtraction this method for identifying moving objects against a static background. It provides a set of pixels within the region of a moving object that may only be interested in the outline of that region. We refer to this outline as a silhouette. An examples of gait analysis that uses silhouettes is in Baumberg and Hogg [12] To make the proposed method to change the color and texture of clothes of the moving object we use only binary silhouette then we look for a computational efficiency to convert these 2D silhouette changes into a sequence of 1D signal. Then after moving silhouette of walking gait that has been tracking its outer contour can be obtained by computing its shape and centroid (x_c, y_c)then we calculate the distance signal by choosing centroid as a reference origin by unwrapping the outer contour counter clockwise.

S= {d1, d2, d3,…….,d_{Nb}} that contain of all distances d_i between pixel (x_i, y_i) and the centroid. Signal distance can be calculated by the following formula (d_i) [14]

$$d_i = \sqrt{(x_i - x_c)^2 + (y_i - y_c)^2}.$$

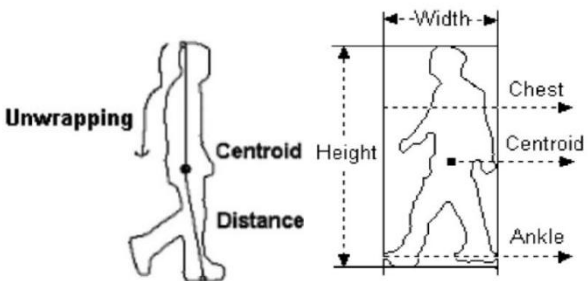

Figure 3: To show Silhouette representation

4. Training

This part including training which was done by neural network such as PCA training and Eigenspace projection.

4.1 PCA Training

In this part, we obtain some principal components to represent human gait features from the highest dimensional to low dimensional Eigenspace, also this was applied by P. Huang, C. Harris, and M. Nixon[13] as follows;

Given S classes for the training and each class represents a sequence of distance signals of one subjects human gait. Multiple sequences of each person can be freely added for training. Let $D_{i,j}$ be the $_j$th distance signal in class i and N_i the number of training samples is N_t= N_1 + N_2 + ... + N_s, and the whole training set can be represented by {$D_{1,1}$, $D_{1,2}$, ... , D_1,N_1, $D_{2,1}$, ..., D_s,N_s }. We can obtain the mean m_d and the global covariance matrix ∑ of such a data set by

$$m_d = \frac{1}{N_t} \sum_{i=1}^{s} \sum_{j=1}^{N_i} D_{i,j},$$

$$\sum = \frac{1}{N_t} \sum_{i=1}^{s} \sum_{j=1}^{N_i} (D_{i,j} - m_d)(D_{i,j} - m_d)^T.$$

4.2. Eigenspace Projection

In this part, we project Eigenspace by taking K<N the largest eigenvalues and their associated eigenvectors and then we transform in to matrix.

E= {e_1, e_2, ...e_k}^{T} $D_{i,j.}$ this illustrated by P. Huang, C. Harris, and M. Nixon, [13]. So, the sequential movement of human gait can be mapped into manifold trajectory in such a parametric Eigenspace. It is known that K is usually much smaller than the original dimensional data N, from that we can say Eigenspace analysis help to reduce the dimensionality of the input samples. So, for each sequence of training the projection centroid Ci in the Eigenspace is accordingly is given by averaging all of the single projections that corresponding to each frame in the sequence. According to A. Johnson and A. Bobick [15].

$$C_i = \frac{1}{N_i} \sum_{j=1}^{N_i} P_{i,j}.$$

5. Recognition

From the trained data sets in hand then we test the effectiveness of the proposed system of human gait recognition. Human gait recognition has been a traditional pattern classification problem which can be solved by calculating the similarities between instances in the training database and the test sample database. Human gait can be described as a kind of spatiotemporal motion pattern so we transform the input gait video moving object in sequence in to video Eigenspace by using PCA.

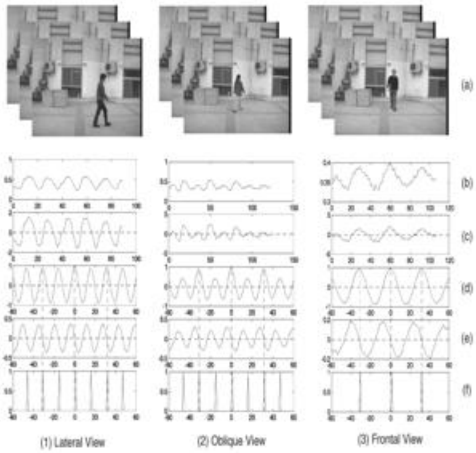

Figure 4: To shows Gait period analysis: (a) input sequences, (b) aspect ratio signals (c) signals after removing the background, (d) autocorrelation signals, (e) first-order derivative signals of autocorrelations, and (f) the positions of peaks.

5.1. Similarities and correlation

Gait is a kind of spatiotemporal motion pattern so we use Spatial-Temporal Correlation an extension of 2D image correlation to 3D correlation in the time domain according to H. Murase and R. Sakai [17] to better capture its spatial structural and temporal transitional characteristics.

For input two sequence signal I_1 (t) and $I_2(t)$ are respectively projected into a trajectory $P_1(t)$ and $P_2(t)$ in the Eigenspace by using [13]. The similarity measure between two such input vector sequence can be calculated by [17]

$$d^2 = \min_{ab} \sum_{t=1}^{T} ||P_1(t) - P_2'(at+b)||^2,$$

[18] Where $P'_2(at + b)$ is a dynamic time warping vector from $P_2(t)$ with respect to time stretching and shifting for an approximation of the temporal alignment between the two sequences. From the formula above selections of the parameters ‘a’ and ‘b’ depends on the relative stride frequency and phase difference within a stride of two steps respectively. Let f_1 and f_2 denote the frequencies of the two gait sequences, then $a=f_2/f_1$, by cropping a subsequence of length f2 from the second vector repeatedly and stretching it with ‘a’, we may obtain its correlation with $P_1(t)$. Then the average minimum of all prominent valleys of the correlation results determines their similarity. Human gait period analysis has been explored in previous work according to C. Ben Abdelkader, R. Culter, and L. Davis [19], which serves to determine the frequency and phase of each observed sequence so as to align sequences before matching, also he explored that width time signal of the bounding box of moving silhouette derived from an image sequence is used to analyze gait period because the silhouette width for frontal views is less informative, but the silhouette height as a function of time plays an analogous in periodicity.

Pictures to show silhouette in lateral, oblique and frontal and view

5.2. Classifier

Classification process in this paper carried by two simple different classification methods such as The Nearest Neighbor classifier (NN) and The Nearest neighbor with Exemplars (ENN).

The Nearest neighbor classifier achieves consistently high performance, without apriori assumptions about the distributions from which the training examples are drawn. It involves a training set of both positive and negative cases. A new sample is classified by calculating the distance to the nearest training case.

Let T represent a test sequence and R_i represent the $_i$th reference sequence. We may classify this test sequence into class c that can minimize the similarity distance between test sequence and all reference patterns by C. BenAbdelkader, R. Culter, H. Nanda, and L. Davis [16]

$$c = \arg\min_i d_i(T, R_i),$$

Where d is the similarity measure and the main purpose here is to evaluate the genuine discrinatory ability of the extracted feature in our method.

6. Experimental Simulation Results

In this section, we present the result and experiment carried out of the proposed algorithm of human gait recognition as follows:

6.1 Data Acquisition

The experimentation of the proposed human gait recognition system is performed with the images publicity available in the National Laboratory of Pattern Recognition (NLPR) gait database. This human gait database taken for study such as a digital camera (Panasonic NV-DX100EN) fixed on the tripod stand was used for capturing human gait sequence in an open-air environment. All the subjects walk along a straight line of the camera frontally, laterally and oblique (0^0, 45^0, 90^0 with the respect to the image plane) respectively.

The resulting Chinese National Laboratory of Pattern Recognition (NLPR) gait database [6] included 20 subjects and four sequences per view per subject. The properties of the images are: 24-bit full colour, capturing rate of 25 frames per second and the original resolution is 352 x 240. The database comprises a total of 240 sequences. The length of each sequence varies with the time each person takes to traverse the field of view. Some of those image samples are;

Figure 5: To show some images from National Laboratory of Pattern Recognition (NLPR)

6.2. Results

This subsection contains the results of the trained samples from the database NationalL gait we employed PCA training and the results after the simulation by using MATLAB software are depicted in the table below;

Trail	Tested dataset	Match ID	Time
1	00_1	1	26.2541
2	00_2	2	0.036601
3	00_3	3	30.505
4	00_4	4	35.104
5	45_1	5	41.5777
6	45_2	6	54.8304

Figure 6: To show some tested sample of dataset for human recognition

6.3. Simulation Tool

Software that we used to implement and simulation of human gait recognition is MATLAB 7.10.0 R2010a. MATLAB is a high-level language and interactive environment for numerical computation, visualization, and programming. The MATLAB application is built around the MATLAB language, and most use of MATLAB involves typing MATLAB code into the Command Window as an interactive mathematical shell, or executing text files containing MATLAB code and functions.

7. Conclusion and Future Works

Recently visual surveillance systems, human identification at a distance has gained more interest. The development of computer vision techniques helped us by studying biometric of human identification such as fingerprint, face recognition and iris detection but all these mentioned require the presence of subject but human gait we will find the possibility to identify people at a distance without any interaction or co-operation from the subject. So, gait is considered as the most valuable biometric feature for human recognition. Future work that has to be done is to provide the best approach of automatic human gait identification in any kind of environments, to reduce all challenges that I had faces to full fill this work like database we are planning to have much larger database so as to have more subjects, more sequences and more variations in conditions. Also, we plan to have multicamera for tracking system of moving subjects in multiple viewpoints without any obstacles.

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References

[1] D. Gavrila, “The Visual Analysis of Human Movement: A Survey,” Computer Vision and Image Understanding, Vol. 73, No. 1, pp. 82-98, 1999.
[2] L. Wang, W.M. Hu, and T.N. Tan, “Recent Developments in Human Motion Analysis”, Pattern Recognition, Vol. 36, No. 3, pp. 585-601, 2003.
[3] Jiwen Lu, Erhu Zhang, "Gait recognition for human identification based on ICA and fuzzy SVM through multiple views fusion", Pattern Recognition Letters, Vol. 28, pp. 2401–2411, 2007.
[4] M. Pushpa Ran and G. Arumugam, “An Efficient Gait Recognition System for Human Identification Using Modified ICA” Vol.2, No1, February 2010.
[5] Chen Wang, Junping Zhang Jian Pu, Xiaoru Yuan, and Liang Wang “Chrono-Gait Image: A Novel Temporal Template for Gait Recognition” ECCV 2010, Part I, LNCS 6311, pp. 257–270, 2010.
[6] Hu Ng, Hau-Lee Tong, Woo-Haw Tan “Human Identification Based on Extracted Gait Features” The Society of Digital Information and Wireless Communications, 2011 (ISSN: 2220-9085)
[7] Simon Haykin, “Neural networks and learning Machines” Third Edition ISBN 978-0013-147139-9 copyright © 2009 Pearson Education, Inc.
[8] Jiebo Luo, Xiaoou Tang, DongXu,” Computer Vision” 2011 ISBN 978-7-312-02750-5
[9] David A, Forsyth Jean Ponce “Computer Vision: A Modern Approach” Second Edition ISBN 978-7-121-16830-7copyright ©2012 Pearson Education, Inc.
[10] E.R. Davies” Computer & Machine Vision Theory Algorithms Practicalities” Fourth Edition ISBN: 978-0-12-386908-1 copyright ©2012 by Elsevier Inc.
[11] Y. Yang and M. Levine, “The Background Primal Sketch: An Approach for Tracking Moving Objects,” Machine Vision and Applications, vol. 5, pp. 17-34, 1992.
[12] Baumberg, A.M., Hogg, D.C.: Learning spatiotemporal models from training examples. In: British Machine Vision Conference, Birmingham (1995)
[13] P. Huang, C. Harris, and M. Nixon, “Human Gait Recognition in Canonical Space Using Temporal Templates,” IEE Proc. Vision Image and Signal Processing Conf., vol. 146, no. 2, pp. 93-100, 1999

[14] S. Niyogi and E. Adelson, “Analyzing and Recognizing Walking Figures in XYT,” Proc. IEEE CS Conf. Computer Vision and Pattern Recognition, pp. 469-474, 1994.
[15] A. Johnson and A. Bobick, “A Multiview Method for Gait Recognition Using Static Body Parameters,” Proc. Int’l Conf. Audio and Video-Based Biometric Person Authentication, pp. 301-311, 2001.
[16] C. BenAbdelkader, R. Culter, H. Nanda, and L. Davis, “EigenGait: Motion-Based Recognition of People Using Image Self-Similarity,” Proc. Int’l Conf. Audio-and Video-Based Biometric Person Authentication, pp. 284-294, 2001.
[17] H. Murase and R. Sakai, “Moving Object Recognition in Eigenspace Representation: Gait Analysis and Lip Reading,” Pattern Recognition Letters, vol. 17, pp. 155-162, 1996.
[18] Y. Yang and M. Levine, “The Background Primal Sketch: An Approach for Tracking Moving Objects,” Machine Vision and Applications, vol. 5, pp. 17-34, 1992.
[19] C. BenAbdelkader, R. Culter, and L. Davis, “Stride and Cadence as a Biometric in Automatic Person Identification and Verification,” Proc. Int’l Conf. Automatic Face and Gesture Recognition, 2002.

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