Gait Recognition System for Human Identification Using Temporal Preserving Information

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Abstract:

Recognition of any individual is a task to identify people. Human recognition methods such as face, fingerprints, and iris generally require user’s cooperation, physical contact or close proximity. These methods are not able to recognize an individual at a distance therefore recognition using gait is relatively new biometric technique without these disadvantages. Gait Energy Image (GEI) is an efficient template for human identification by gait. However, such a template loses temporal information in a gait sequence, which is critical to the performance of gait recognition. To address this issue, we develop a novel temporal template, named Chrono-Gait Image (CGI). The proposed CGI template first extracts the contour in each gait frame, followed by encoding each of the gait contour images in the same gait sequence with a multichannel mapping function and compositing them to a single CGI.

Index Terms—Back propagation neural network (BPNN), Computer vision, gait recognition, biometric authentication, and pattern recognition

1. Introduction

In most of the metropolitan, identity cards and passports are used for authentication and verification of human beings. But now days, biometric identifications are most suitable for human recognition. Biometric means unique features of a person. Biometric identification aims to recognition of an individual from their physiological and behavioral characteristics. Different biometrics measures or vectors are used to identify an individual, physiological characteristics like fingerprints, palm geometry, DNA, iris, face recognition— they all are related to the body of person and other features such as voice, gait and they are related to the behavior of person. Gait is effective way of human recognition. Gait is unobtrusive and distance recognition. It overcomes all the disadvantages of physiological characteristics like- it needs user’s cooperation, also these physiological characteristics needs only high resolution images. Example: only few authorized doctors are allowed to go into operation
theater, in this scenario gait analysis technique is used as, gait sequences of those authorized doctors are stored in hospitals’ database, therefore whenever an unauthorized person tries to enter into room, then his gait sequences will not match with stored sequences and a system will generates an alarm to alert the authorities of department for any action.

BIOMETRIC authentication has broad applications in social security, individual identification in law enforcement, and access control in surveillance. Unlike other biometric features such as iris, faces, palm, and fingerprint, the advantages of gait include: 1) Gait can be collected in a noncontact able, noninvasive, and hidden manner; 2) gait is the only perceptible biometric at a distance. However, the performance of gait recognition suffers from some exterior factors such as clothing, shoes, briefcases, and environmental context. Furthermore, whether or not the spatiotemporal relationship between gait frames in a gait sequence is effectively represented also influences the performance of gait recognition systems. Although it is a challenging task, the nature of gait indicates that it is an irreplaceable biometric [1] and can benefit the remote biometric authentication [2].

Background subtraction, feature extraction and Recognition are three main parts of gait recognition system. Background subtraction is the first step of gait recognition system. In this process foreground objects in a particular scene are extracted and binary silhouette images will be obtained. Next is feature extraction process. In this step input data will be transformed into a reduced set of features. In this paper we are using model based approach of feature extraction. Final step of gait system is recognition. Here both the input and trained sequences in database are compared with each other.

Fig 1. From left to right: A gait sequence, gait energy image, and chrono-gait image.

Fig 2: Gait Recognition Scenario

2 Existing systems

To build a successful gait recognition system, feature extraction plays a crucial role. Currently, gait feature extraction methods can be roughly divided into two major categories: model-based and model-free approaches. Model-based approaches assume that the gait can be modeled with a
structure/motion model [3]. However, it is not easy to extract the underlying model from gait sequences [3], [4]. Model free approaches either keep temporal information in the recognition (and training) stage [5], [6], [7], [8], or convert a sequence of images into a single template [1], [9], [10], [11], [12]. Although some model-free approaches such as Gait Energy Image (GEI) [1] have attractively low computational cost, such a conversion may lose the temporal information of gait sequences.

3 Proposed System

3.1 Face Recognition Across Blur

Generally speaking, regular human walking always has a fixed cycle with a particular frequency because of the basic structure of human body. As a result, such walking is generally used in most of the current approaches of human identification by gait. However, some methods may neglect the influence of gait cycle information, e.g., GEI. Meanwhile, other methods require high computational cost to preserve such information. To address the issue, we propose to encode time-varying gait cycle information into a single chrono-gait image by using the multichannel technique. We also make several fundamental assumptions in this paper: 1) Most normal people have a similar gait gesture such as the stride length. 2) Each person has his/her unique gait behavior, such as the shape of the torso, the moving range of limbs, and so on. 3) Each channel of the multichannel method can be regarded as a function of time.

3.2 Preprocessing and Period Detection

To achieve a gait recognition system, some preprocesses, including background subtraction and foreground alignment, are required. Here, we assume that such preprocesses have been done to the original gait sequence. Concretely, we perform our gait recognition algorithm on the silhouette images.

3.3 Multichannel Mapping

To visualize time-varying information, several possible strategies can be considered in the visualization community. A representative way is to employ pseudo color to visualize such information for volume rendering [13]. In this method, Woodring and Shen proposed four integration functions: alpha compositing, first temporal hit, additive colors, and minimum/maximum intensity.

4 Related Work

Gait features are very important in improving the performance of gait recognition. Generally speaking, there are two different gait feature extraction methods. Model-based approaches are devoted to recovering the underlying mathematical construction of gait with a structure or motion model [3]. Wang et al. adopted procreates analysis to capture the mean shapes of the gait silhouettes [17]. However, it is time consuming and vulnerable to noise. Veres et al. [18] and Guo and Nixon [19] employed the analysis
of variance and mutual information, respectively, to discuss the effectiveness of features for gait recognition. Bouchrika and Nixon proposed a motion-based model by using the elliptic Fourier descriptors to extract crucial features from human joints [4]. Wang et al. [20] employed a condensation framework in which the structural-based and motion-based models are combined to refine the feature extraction. Chai et al. [21] divided the human body into three parts; then the variances of these parts are combined as the crucial gait features. Although the structure-based models can, to some degree, deal with occlusion and self-occlusion as well as rotation, the performance of the approaches suffers from the localization of the torso and it is not easy to extract the underlying model from gait sequences [3], [4]. Furthermore, it is necessary to understand the constraints of gait such as the dependency of neighboring joints and the limitation of motion to develop an effective motion-based model [3].

Many researchers had given their contribution in model based approach of gait recognition. In this model based gait recognition system both the motion of lower leg rotation and motion of tigh describes walking and running [1]. In our paper we are also proposing a model based approach as this approach can handles self occlusion, noise, scaling and rotation. Earliest model based approach of gait recognition system able to obtain gait signatures, when human walking as a pendulum and representing the tigh motion with combination of velocity Hough transform and Fourier representation [2]. Model based approaches can handle self occlusion, noise, scaling and rotation. [5] They used static body parameters without analyzing gait dynamics for gait recognition. Model-based approaches aim to explicitly model human body or motion, and they usually perform model matching in each frame of a walking sequence so that the parameters such as trajectories are measured on the model. Model based approaches are further divided into two main classes. First class, state space method and second is spatiotemporal method [6]. Latest model based gait recognition provides good recognition rates, when both motion model of thigh and lower leg rotation describes walking and running[3]. In model based approach moving person is divided in different regions and these different regions are fitted into seven ellipses and their aspect ratios, orientation, location used as features for gait representation [4]. First class takes in to account the sequence of static poses in gait motion and recognizes the motion by considering temporal verification of observation with respect to static poses [6], [7], [8]. Second class considers spatiotemporal method which specifies the spatiotemporal distribution brought about by gait motion in its perpetuity [6], [9], [10].

In model based approaches, the accuracy of reconstruction of human model depends on quality of extracted human silhouette [11]. In paper [12] three components based features are: area of each body component, the center of each body component and the orientation of each body component. Much of explicit features which characterize gait dynamics such as stride dimension and kinematic of joint angle are recovered by a
model fabricated by Model Based Approach [13]. In [14] they use gait energy for gait analysis. To improve recognition they used statistical feature extraction approach for learning effective feature. Many researchers used fuzzy principal component for gait recognition [15], [16], [13]. In [13] gait energy image is obtained by processing original gait sequences and then using fuzzy principal called fuzzy logic Eigen values and Eigen vectors are extracted then at last they use NN classifier for feature classification. Model based approaches extract the motion of human body by means of fitting their models to the input image. In gait recognition system using the extended features which incorporate spatial and temporal information and the combination of Eigen Space Transformation(EST) and Canonical Space Transformation (CST) for feature extraction was proposed. Advantages of this method are, EST and CST have been used to reduce data dimensionality with less computation time, and the use of extended features greatly increases the robustness and accuracy of recognition. But, it needs further improvement for large databases. Silhouette analysis based recognition system was proposed. In this, distance signal was the feature vector, which is obtained by calculating distance between each pixel and centroid of binary silhouette. In this paper some of these limitations are overcome by taking combined features in the form of width and shape information of binary silhouette of the person to be identified.

5 Human Recognition Using CGI

Now we can employ the proposed CGI temporal template for individual recognition by measuring the similarity between the gallery and probe templates. However, there are probably several disadvantages of doing so: 1) Since the gait sequences are sampled from similar physical conditions, the templates attained from such sequences may result in overfitting. 2) Due to the fact that the number of CGIs is small, it is a typical small sample size problem and thus cannot characterize the topology of essential gait space. 3) If we regard one pixel as one dimension, the dimensions of the original gait space are very high and the performance of gait recognition systems suffers from the problem of the curse of dimensionality. To solve these issues, we propose to generate CGI-based real templates and synthetic templates, projecting the templates into certain low-dimensional discrimination subspace with the dimension reduction method.

Specifically, we generate the real templates by referring to the multichannel image of each period as a temporal information preserving template. In other words, we average continuous four PGI's in one period. One advantage is that such a template keeps the similar gait temporal information as the CGI of the whole sequence owns. Furthermore, we generate synthetic templates to enhance the robustness to the exterior factors such as shadows. Similarly to Han and Bhanu [1], we cut the bottom 2-I rows from the CGI and resize to the original size using the nearest neighbor interpolation. If parameter i varies from 0 to K-1, then a total of K synthetic templates will be
generated from each CGI template. Some examples of real and synthetic templates are shown in Fig. 4. For visualization, we also set $k = 3$ in these figures.

To address the curse of dimensionality issue without losing the computational efficiency, we employ Principal Component Analysis and Linear Discriminant Analysis (PCA+LDA) [25] to project the real and synthetic templates in the gallery set into a low-dimensional subspace. With the projection matrix calculated by PCA+LDA, the real/synthetic templates in the probe set will be projected into a low-dimensional subspace.

Fig. 3. An example of generating a CGI temporal template.

Fig. 4. Examples of real templates (top) and synthetic templates (bottom) for a gait sequence.

5 (A) USF HumanID Gait Data Base
Feature extraction can be done by two methods: model-based and holistic approach. Here in this paper, we proposed the model-based approach of feature extraction. These methods used for processing are scaling, view invariant. This requires good quality video sequences. Parameters used in this methodology are features such as the height, the distance between head and pelvis, the maximum distance between pelvis and feet and the distance between feet and distance between hands. The silhouette of a walking person is divided into some regions (generally seven regions). After that, ellipses or rectangles are fit to each region and region feature vectors are determined. This includes averages of the centroid and the aspect ratio, where as holistic method
does not assume any model; they operate directly on binary silhouettes. In this paper combined features in the form of width and shape information of binary silhouette of a person to be identified. Width vector of outer contour of binary silhouette and MPEG-7 ART (Angular Radial Transform) coefficients are taken as the feature vector. These extracted feature vectors are used to recognizing individuals. Various parameters like distance between hand and distance between legs are calculated. In width vector of outer contour difference between left and right extremities of silhouettes gives the width vector. From the binarized silhouettes, the left and right boundaries are traced. The width along a given row is simply the difference between leftmost and rightmost boundary pixel of that row. MPEG-7 ART coefficients used as second feature vector in this paper. MPEG-based-region-based descriptors used to represent shapes. These descriptors take into account all pixels constituting the shape, both the boundary of interior pixels.

7 Recognition

After extracting feature from walking silhouettes. Recognition is the final step, using which input sequences are compared with stored sequences in database. For this step, we introduce a neural network technique. Most popular back propagation neural network is proposed in this paper. It is multilayer networks. Here, the output values are compared with the correct answer to compute the value of some predefined error-function. By various techniques, the error is then feed back through the network. Using this information, the algorithm adjusts the weights of each connection in order to reduce the value of the error function by some small amount. After repeating this process for a sufficiently large number of training cycles, the network will usually converge to some state where the error of the calculations is small. In this case, one would say that the network has learned a certain target function. To adjust weights properly, one applies a general method for non-linear optimization that is called gradient descent. For this, the derivative of the error function with respect to the network weights is calculated, and the weights are then changed such that the error decreases (thus going downhill on the surface of the error function). For this reason, back-propagation can only be applied on networks with differentiable activation functions. It is a supervised learning method, and is a generalization of the delta rule. Back propagation requires that the activation function used by the artificial neurons (or "nodes") be differentiable. It requires a dataset of the desired output for many inputs, making up the training set

8 Implementation Results

8.1 GUI was created.
8.2 database input video was selected.

8.3 background subtraction and various parameters of input video is calculated.

8.4 Now, input video is matched with database video and BPNN result is calculated, in this case input video is different to database video means not authentic user.
8.5 Here in this step all the previous steps are performed with different input video. Input video is matched with database video and BPNN result is calculated, in this case input video is same as database video and BPNN results are better. This shows our enhanced and better results than previous research.

9. Conclusions

In the future, we will explore how to enhance CGI’s robustness in more complex conditions, and investigate how to select a more general multichannel mapping function instead of the current linear mapping function. In addition, we will study how to make CGI effective when the gait sequence only contains few gait periods. We will also consider generalizing the proposed frameworks into other human-movement-related fields [31], [32] such as gesture recognition and abnormal behavior detection.

10. REFERENCES


