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Gait Biometric Recognition Using Direct Classification, TSVM, SVM and Neural Network

S. Senthil Kumar[1] and V.Kathiresan[2]
[1]Assistant Professor, Department of Commerce with Computer Applications,
[2] Head - Department of Computer Applications (PG) ,
Dr.SNS Rajalakshmi College of Arts And Science (Autonomous), Coimbatore, Tamil Nadu, India
E-mail: ssksnsmca@gmail.com
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***Abstract* - Gait recognition is the process of identifying an individual by the manner in which they walk. Using gait as a biometric is a relatively new area of study, within the realms of computer vision. It has been receiving growing interest within the computer vision community and a number of gait metrics have been developed. The term gait recognition to signify the identification of an individual from a video sequence of the subject walking. This does not mean that gait is limited to walking, it can also be applied to running or any means of movement on foot. While gait has several attractive properties as a biometric there are several confounding factors such as variations due to footwear, terrain, fatigue, injury, and passage of time. Examples of motion that are gaits include walking, running, jogging, and climbing stairs. Sitting down, picking up an object, and throwing and object are all coordinated motions, but they are not cyclic. Jumping jacks are coordinated and cyclic, but do not result in locomotion. The use of gait as a biometric for human identification is still young when compared to methods that use voice, finger prints, or faces.**
***Keywords*: Gait, biometrics, SVM, TSVM, NN**

I. INTRODUCTION

Human gait recognition works from the observation that an individual's walking style is unique and can be used for human identification. So as to recognize individual's walking characteristics, gait recognition includes visual cue extraction as well as classification. Many biometric technologies have emerged for identifying and verifying individuals by analyzing face, fingerprint, palm print, iris, gait or a combination of these traits [4].

II. ADVANTAGES OF GAIT

Gaits main advantage, unobtrusive identification at a distance, makes it a very attractive biometric. The ability to identify a possible threat from a distance, gives the user a time frame in which to react before the suspect becomes a possible threat. Another motivation is that video footage of suspects are readily available, as surveillance cameras are relatively low cost and installed in most buildings or locations requiring a security presence, the video just needs to be checked against that of the suspect. Gait as a biometric can be seen as advantageous over other forms of biometric identification techniques for the following reasons:

Unobtrusive – the gait of a person walking can be extracted without the user knowing they are being analyzed and without any cooperation from the user in the information gathering stage unlike fingerprinting or retina scans.

Distance recognition – the gait of an individual can be captured at a distance unlike other biometrics such as fingerprint recognition.

Reduced detail – gait recognition does not require images that have been captured to be of a very high quality unlike other biometrics such as face recognition, which can be easily affected by low resolution images.

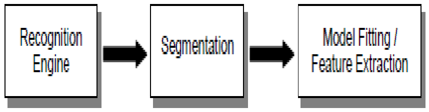
Difficult to conceal – the gait of an individual is difficult to disguise, by trying to do so the individual will probably appear more suspicious. With other biometric techniques such as face recognition, the individuals face can easily be altered or hidden.

III. GAIT RECOGNITION SCENARIO

Gait recognition can be used in a number of different scenarios. One example would be to analyze the video stream from surveillance cameras. If an individual walks by the camera whose gait has been previously recorded and they are a known threat, then the system will recognize them and the appropriate authorities can be automatically alerted and the person can be dealt with before they are allowed to become a threat. The threat has been successfully detected from a distance, creating a time buffer for authorities to take action. Such systems have a large amount of potential application domains, such as airports, banks and general high security area.

IV. METHODOLOGY OF GAIT RECOGNITION USING RECOGNITION ENGINE

1. Develop a program capable of performing recognition of individuals 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.
2. Automatic extraction of relevant gait feature points should be available from a video sequence in order to automate the classification process.



a. Fig.1 Gait Recognition process

Recognition Engine – develop the algorithms and functionality that can classify individuals based on extracted gait information.

Segmentation – extract the foreground subjects from the video sequence, ready for extracting gait features.

Feature Extraction – the segmented image map is used to extract the relevant gait features which will be used for classification.

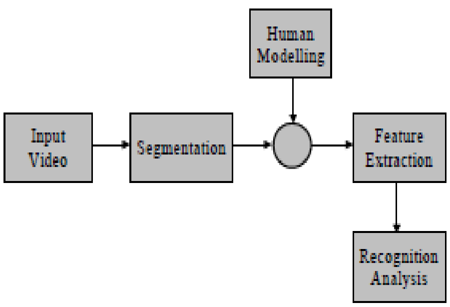


Fig.2 Overview of Gait Recognition process

The methodology is to first segment the foreground information (i.e. the subject) from the background. The features used to derive the gait signature must be extracted as accurately from the segmented object as possible. These parameters can then be analyzed and stored for recognition use at a later stage.

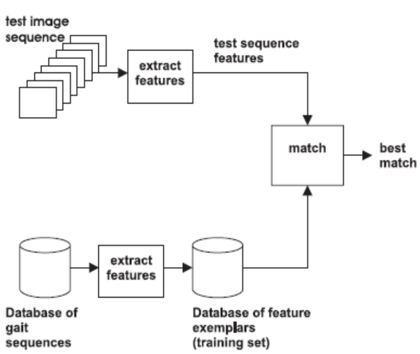


Fig.3 Testing performance of gait recognition and other biometric systems

The first is to estimate the rate of correct recognition, while the second is to compare the variations in a population versus the variations in measurements. Neither method is entirely satisfactory, but they both provide insights into performance.

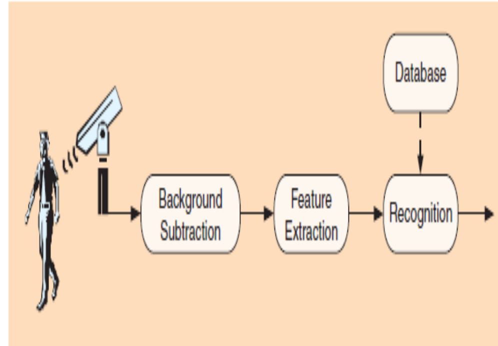


Fig.4 Block diagram of a gait recognition / authentication

Background Subtraction

In this approach moving objects from background in the scene are identified first. Then some of the background subtraction techniques are applied on it .A common approach is to perform background subtraction; which identifies moving objects from the portion of video frame that differs from the background model. The background subtraction generates binary images containing black and white (moving pixels) also known as binary silhouettes. The background subtraction is a class of techniques for segmenting out objects of interest in a scene for applications such as surveillance.

Feature Extraction

Feature extraction is a special form of dimensionality reduction. And when the input data is too large to be processed and it is suspected to be notoriously redundant (e.g. the same measurement in both feet) then the input data will be transformed into a reduced representation set of features (also named features vector). Then transforming the input data into the set of features is called feature extraction.

Recognition

This is the final step of human identification using gait. In this step input videos are compared with sequences stored in database.

V. GAIT BIOMETRIC USING DIRECT CLASSIFICATION AND TSVM & SVM

Direct gait classification methods do not pay attention to the temporal information of gait sequences. They are based on the single representation or key frames extracted from a sequence of gait frames. K-nearest neighbor classifier decides the class of test feature according to the number of the k closest training examples. The most common labeled class among the k closed training examples is chosen as the test feature's class. Collins et al. [5] extract key frames from a walking cycle to form a template, and then perform nearest neighbor classification to template scores. k-nearest neighbor rule is applied by Cunado et al. [6] to frequency information of the hip motion for classification.

Additionally, some authors use various discriminative classifiers. Support vector machine (SVM) is used by Xue et al. [7] for wavelet decomposed features from gait energy image (GEI). SVM is considered as a generalized linear classifier and is a supervised learning method. Instead of using a supervised learning classifier, Dadashi et al. [8] employ transductive support vector machine (TSVM) to perform semi-supervised classification on gait signature extracted by wavelet packets. The TSVM take high-dimensional features as input and effectively investigate correlational structures of gait features.

Support Vector Machine

The theory of SVM is based on the idea of structural risk minimization. In many applications SVM has been introduced as a powerful tool for solving classification problems. There are many researchers have used SVM on gait recognition. It is to be noted that SVM is fundamentally a classifier of two -tier. SVM first maps the training samples into a high dimension space (typically much higher than the original data space) and then finds a separating hyper plane that maximizes the margin between two classes. Maximizing the margin is a quadratic programming (QP) problem and can be solved from its dual problem by introducing Lagrangian multipliers of technique. Without any knowledge of the mapping the SVM can find the optimal hyper plane by using the dot product functions in original space that are called kernels of image. There are several kernels proposed by researchers. Here we use radial basis function (RBF). Once the optimal hyper plane is established we can directly use a decision function to classify testing samples. For solving multi-class problems and various methods have been proposed for combining multiple two classes SVMs in order to build a multi-class classifier such as “one-against-one” and “one-against rest” methods. In this paper we use the one against- one method in which k(k*1) =2 classifiers are constructed and each one trains samples. In classification we use a voting strategy: each two-class SVM is considered as a voter (i.e. k (k * 1) =2 voters in all)and then each testing sample is classified to the class with maximum number of votes.

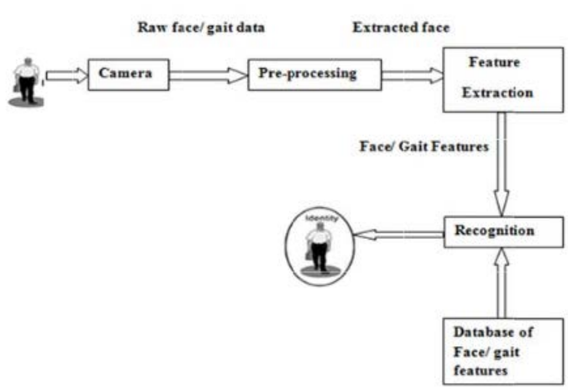


Fig.5 Gait recognition system using gait dataset and database image

VI. NEURAL NETWORK

An Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way biological nervous systems such as the brain and process information. Then key element of this paradigm is the novel structure of the information processing system. This is composed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems. The ANNs like people learn by example. And ANN is configured for a specific application such as pattern recognition or data classification through a learning process. The Learning in biological systems involves adjustments to the synaptic connections that exist between the neurons. Neural network simulations appear to be a recent development. This field was established before the advent of computers and has survived at least one major setback and several eras. The many important advances have been boosted by the use of inexpensive computer emulations. Therefore following an initial period of enthusiasm and the field survived a period of frustration and disrepute. And during this period when funding and professional support was minimal and important advances were made by relatively few researchers. These pioneers were able to develop convincing technology which surpassed the limitations identified by Minsky and Papert. Minsky and Papert, published a book (in 1969) in which they summed up a general feeling of frustration (against neural networks) among researchers and was thus accepted by most without further analysis. And currently the neural network field enjoys a resurgence of interest and a corresponding increase in funding. Then first artificial neuron was produced in 1943 by the neurophysiologist Warren McCulloch and the logician Walter Pits. And the technology available at that time did not allow them to do too much. Neural networks with their remarkable ability to derive meaning from complicated or imprecise data and can be used to extract patterns and detect trends that are too complex to be noticed by either humans or other computer techniques. And trained neural network can be thought of as an "expert" in the category of information it has been given to analyze.

VII. CONCLUSION

The future goals include evaluating gait features that support the tasks of people recognition and gender classification, and finding appearance based features that facilitate recognition of an expanded set of human action classes such as jogging, throwing a ball, etc.

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