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RESEARCH ARTICLE

GAIT RECOGNITION OF HUMAN USING SVM AND BPNN CLASSIFIERS

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ABSTRACT

Recognition of any individual is a task to identify people. Human identification using Gait is method to identify an individual by the way he walk or manner of moving on foot. Gait recognition is a type of biometric recognition and related to the behavioural characteristics of biometric recognition. Gait recognition is one kind of biometric technology that can be used to monitor people without their cooperation. Controlled environments such as banks, military installations and even airports need to be able to quickly detect threats and provide differing levels of access to different user groups. Gait shows a particular way or manner of moving on foot and gait recognition is the process of identifying an individual by the manner in which they walk. Gait is less unobtrusive biometric, which offers the possibility to identify people at a distance, without any interaction or co-operation from the subject; this is the property which makes it so attractive. In this thesis, firstly binary silhouette of a walking person is detected from each frame. Secondly, feature from each frame is extracted using image processing operation. Here center of mass, step size length, and cycle length are talking as key feature. At last BPNN and SVM technique is used for training and testing purpose. Here all experiments are done on gait database and input video.

Keywords: Silhouette extraction; Feature Extraction; Gait Recognition System; BPNN; SVM

1. INTRODUCTION

Biometrics is the unique features of a person. Biometric recognition refers to an automatic recognition of individual based on feature vectors derived from their physiological and/or behavioural characteristic. Biometric systems for human identification at a distance have ever been an increasing demand in various significant applications. Recognition/Identification [1] using gait becomes more attractive in such type of situations. Every individual has different features therefore biometric means unique feature of a person. Biometric characteristics are of two types physiological and behavioural [2].

Physiological characteristics are face, fingerprints, iris, palm print, DNA etc. And behavioural characteristics are voice and gait. As these physiological characteristics does not provide good results in low resolution and need user cooperation therefore recognition using Gait is more attractive. Recognition using gait means to identify a person by the way he move or walk. Gait recognition can also used for low resolution images. The definition of gait is "A particular way or manner of walking on foot". Human gait recognition works from the observation that an individual's walking style is unique and can be used for human identification. Depending on feature extraction, gait recognition methods are classified as appearance-based and model-based gait recognition. The appearance-based approaches suffer from changes in the appearance owing to the change of the viewing or walking directions. Model-based approaches [3] extract the motion of the human body by means of fitting their models to the input images. Model-based methods are view and scale invariant.

II. GAIT RECOGNITION SYSTEM

System will identify unauthorized individual and compare his gait with stored sequences and recognize him. Background subtraction is the common approach of gait recognition. Background subtraction [4] method is used to subtract moving objects and to obtain binary silhouette. Using background subtraction, pre-processing is done to reduce noise. Background subtraction techniques are also classified into two types: non- recursive methods and recursive methods. Non recursive technique uses sliding window approach for background subtraction. Recursive methods use single Gaussian method and Gaussian mixture model.

Gait recognition method contains two parts :

- Training part
- Testing part.

Figure1: The basic Gait Recognition System.

Gait is a person's manner of walking. By this verification process, the system can identify the registered person. There are three different systems which can be categories as knowledge based, object based and biometric based. Knowledge based system is using normally password and pin number. The object base is combination of knowledge based and object based such as smart card with pin code. But both password and smart card system can be steal or lost or forgotten to bring. To overcome these problems, the biometric based may have helped to solve the problems. It can be more reliable and is easy to interface with system. Nowadays biometric is the top research stages for the preventing purposes. Biometric gait recognition refers to verifying or identifying persons using their walking style.

The following is the flowchart of the Proposed Gait Recognition System:

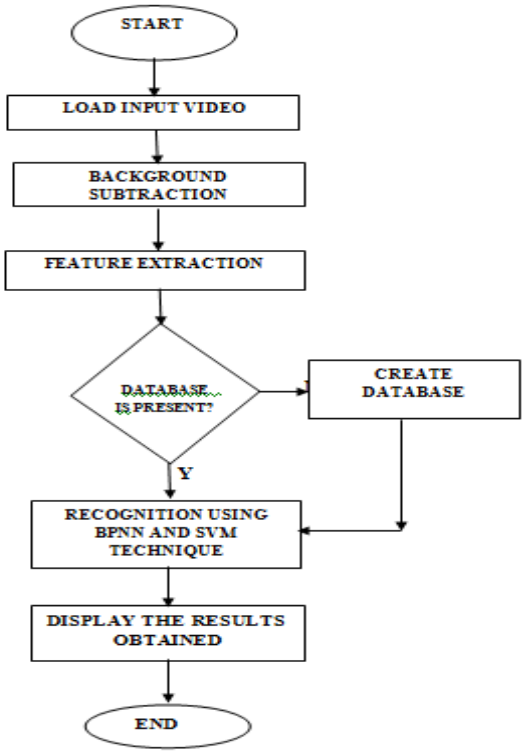

Figure2. The flowchart of the proposed gait recognition system

Human recognition based on gait is relatively recent compared to other approach such as fingerprint, iris, facial etc. The biometric gait recognition can be grouped into three categories which are known as motion vision (MV) based, floor sensor (FS) based and wearable sensor (WS) based. So this paper is going to focus on motion vision based system for surveillance.

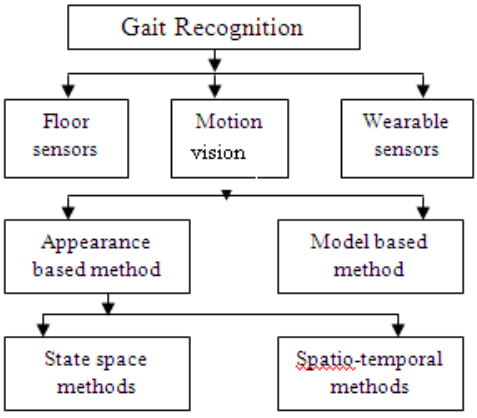

Figure3. The classification of gait recognition system

Model based approaches [3] are difficult to follow in low resolution images also they have high computational complexity. Advantage of this approach is the ability to derive gait signature from model parameter and free from the effect of different clothing. Features used in this approach are insensitive to background cluttering and noise. Model based gait recognition system includes motion of thigh and lower leg rotation that describes both walking and running. The use of double pendulum to describe the thigh and lower leg movement. Model based method construct human model to recover features describing gait dynamics such as stride and kinematics of joint angle [5].

Parameters used in this approach are height, distance between head and pelvis. Model free approach is easy to follow and has less computational complexity and this approach is best suited for real time systems. They used model free approach for gait recognition based on outermost contour [6]. Background subtraction-Identifying moving objects from a video sequence are a fundamental task in Gait recognition. A common approach is background subtraction in which moving objects from background in the scene are identified. Pixels in the current frame that deviate significantly from the stationary background are considered to be moving objects.

III. SILHOUETTE REPRESENTATION

An important cue in determining underlying motion of a walking figure is temporal changes of the walker's silhouette. To make the proposed method insensitive to changes of color and texture of clothes, we use only the binary silhouette [7].

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 the binary silhouette. In this paper, some of these limitations are overcome by taking combined features in the form of width and shape information of the binary silhouette of the person to be identified.

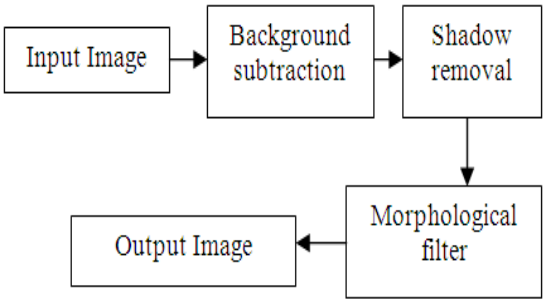

Figure4. Silhoutte Extraction

First step of the proposed method is the extraction of foreground objects i.e., human and other moving objects are extracted from input video sequences. Gaussian mixture model [8] is used for foreground object estimation in which an additional step of filtering by median filter is incorporated to remove noises. Moving target classification algorithm is used separate human being (i.e., pedestrian) from other foreground objects (viz., vehicles). Shape and boundary information is used for this moving target classification. 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. Hidden Maekov Model (HMM) [9] is used for recognizing persons on the basis of gait. Various parameters like distance between hand and distance between leg are calculated .Finally SVM and BPNN results are calculated which is far better in comparison to previous research paper.

IV. FEATURE EXTRACTION

Feature selection is a crucial step in gait recognition. The feature must be robust to operating conditions and should yield good discriminability across individuals. Each gait sequence is divided into cycles. Gait cycle is defined as person starts from rest, left foot forward, rest, right foot forward, rest. Figure 4 shows the stances during gait cycle. Gait cycle is determined by calculating sum of the foreground pixels. At rest positions this value is low. By calculating number of frames between two rest positions, gait cycle (period) is estimated.

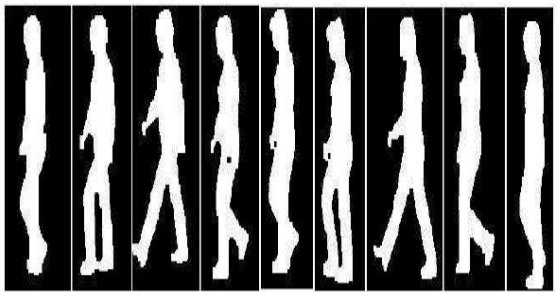

Figure 5: Stances during a gait cycle

In the proposed method, two types of features are extracted, the height and the width of the silhouette.

V. RECOGNITION

Once we obtain gait features, the next step is gait recognition. In this section, we introduce Neural Network. We give a brief description of the Neural Network method.

A. BACK PROPAGATION NEURAL NETWORK

A Neural networks are composed of interconnecting artificial neurons (programming constructs that mimic the properties of biological neurons). Neural networks [10] may either be used to gain an understanding of biological neural networks, or for solving artificial intelligence problems without necessarily creating a model of a real biological system. The real, biological nervous system is highly complex: neural network algorithms attempt to abstract this complexity and focus on what may hypothetically matter most from an information processing point of view.

Neural networks give effective results for solving multiple class classification problems. The neural network facilitates gait recognition because of their highly flexible and non linear modelling ability. Neural network has three types of layers: input layer, output layers and hidden layers. Hidden layer does intermediate computation before directing the input to output layer. Back propagation can also be considered as a generalization of delta rule. When back propagation network is cycled, an input pattern is propagated forward to the output units through the intervening input to hidden and hidden to output weights. Neural network have been widely used in image and signal processing.

This class of networks consists of multiple layers of computational units, usually interconnected in a feed-forward way. Each neuron in one layer has directed connections to the neurons of the subsequent layer. In many applications the units of these networks apply a sigmoid function as an activation function. The universal approximation theorem for neural networks states that every continuous function that maps intervals of real numbers to some output interval of real numbers can be approximated arbitrarily closely by a multi-layer preceptor with just one hidden layer. This result holds only for restricted classes of activation functions, e.g. for the sigmoid functions. Multi-layer networks [11] use a variety of learning techniques, the most popular being back-propagation. 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 fed 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 [12] a certain target function.

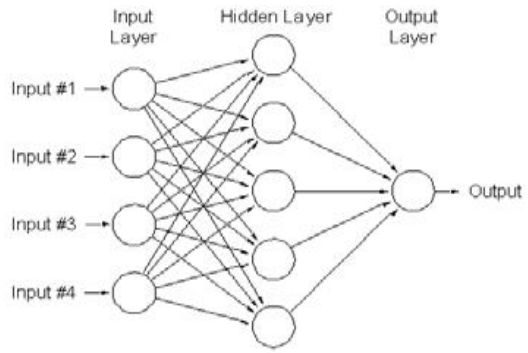

Figure 6: Basic layout of the Neural Networks

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[13] can only be applied on networks with differentiable activation functions.

Other advantages include:

1. Adaptive learning: An ability to learn how to do tasks based on the data given for training or initial experience.

2. Self-Organization: An BPNN can create its own organization or representation of the information it receives during learning time.

3. Real Time Operation: BPNN computations may be carried out in parallel, and special hardware devices are being designed and manufactured which take advantage of this capability.

Fault Tolerance [14] via Redundant Information Coding: Partial destruction of a network leads to the corresponding degradation of performance. However, some network capabilities may be retained even with major network damage.

B. SUPPORT VECTOR MACHINE (SVM)

The SVM classifier is widely used in bioinformatics (and other disciplines) due to its highly accurate, able to calculate and process the high-dimensional data such as gene expression and edibility in modelling diverse sources of data .SVMs belong to the general category of kernel methods. A kernel method is an algorithm that depends on the data only through dot-products. When this is the case, the dot product can be replaced by a kernel function which computes a dot product in some possibly high dimensional feature space. This has two advantages: First, the ability to generate non-linear decision boundaries using methods designed for linear classifiers. Second, the use of kernel functions allows the user to apply a classifier to data that have no obvious fixed-dimensional vector space representation. When training an SVM the practitioner needs to make a number of decisions: how to pre-process the data, what kernel to use, and finally, setting the parameters of the SVM and the kernel [12]. Uninformed choices may result in severely reduced performance. We aim to provide the user with an intuitive understanding of these choices and provide general usage guidelines. All the examples shown were generated using the PyML machine learning environment, which focuses on kernel methods and SVMs.

The approach of explicitly computing non-linear features does not scale well with the number of input features: when applying the mapping from the above example the dimensionality of the feature space F is quadratic in the dimensionality of the original space. This result in a quadratic increase in memory usage for storing the features and a quadratic increase in the time required to compute the discriminate function of the classifier. This quadratic complexity is feasible for low dimensional data; but when handling gene expression data that can have thousands of dimensions, quadratic complexity in the number of dimensions is not acceptable. Kernel methods solve this issue by avoiding the step of explicitly mapping the data to a high dimensional feature-space.

Gaussian kernel is defined by:

$$K(\mathbf{x_i}, \mathbf{x_j}) = \exp(-\frac{\left\|\mathbf{x_i} - \mathbf{x_j}\right\|^2}{2\sigma^2})$$

The theory of SVM is based on the idea of structural risk minimization [15]. In many applications, SVM has been introduced as a powerful tool for solving classification problems. Consequently, many researchers have used SVM on gait recognition. However, it is to be noted that SVM is fundamentally a two-class classifier.

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 in this high-dimension space. Maximizing the margin is a quadratic programming (QP) problem and can be solved from its dual problem by introducing Lagrangian multipliers. 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. 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, various methods have been proposed for combining multiple two class 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 [16] in which $k(k\text{-}1)=2$ classifiers are constructed and each one trains samples from two different classes. 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.

The following are the various outcomes of the proposed system.

Figure 7. The Basic GUI of the Proposed Gait Recognition System.

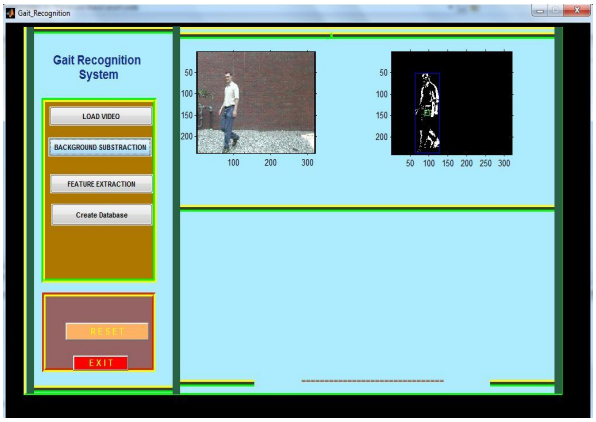

Figure 8. The input video is loaded and background substraction is performed.

Figure 9. All the parameters are been calculated.

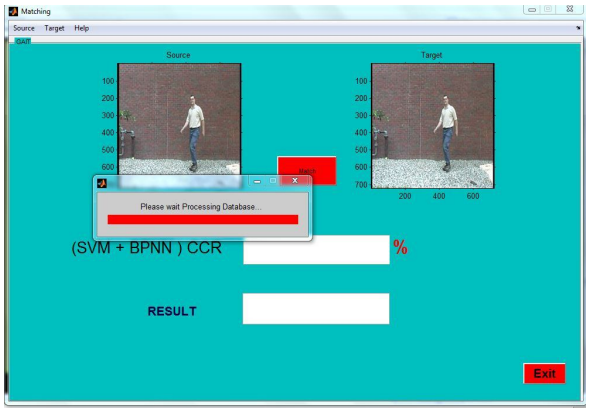

Figure 10. The source image and the target images have to be compared.

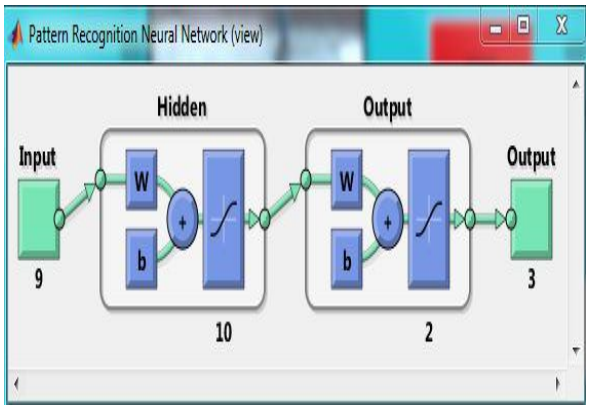

Figure 11. Neural Network Tool used for Pattern Recognition.

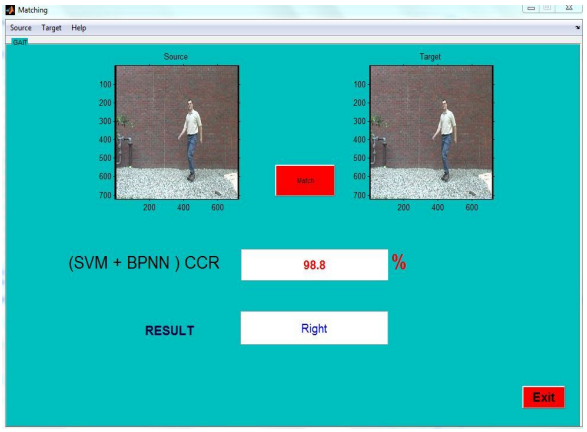

Figure 12. In this the input image and the output image are same therefore we obtained the CCR.

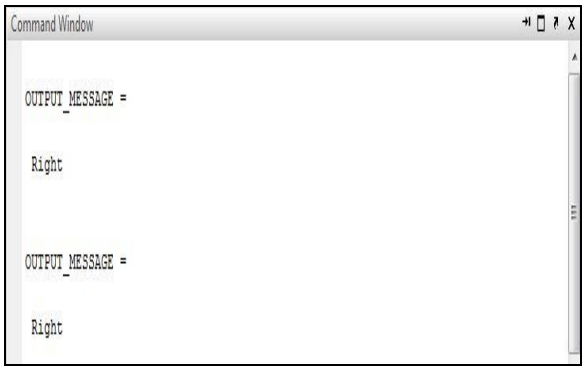

Figure13. The message will be displayed on the command window.

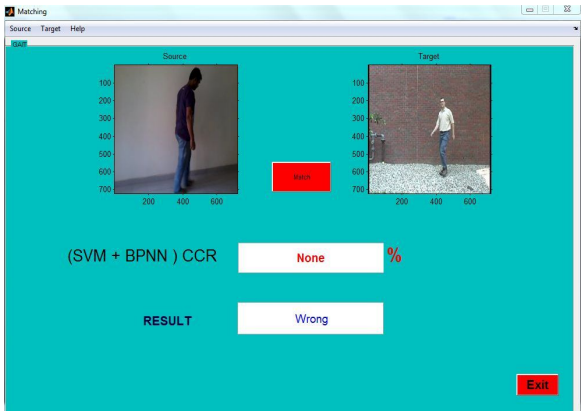

Figure14. The input image and the output image are not same, therefore it will display the message 'NONE'.

VI. CONCLUSION

With the increasing demands of visual surveillance systems, human identification at a distance has recently gained more interest. Gait is a potential behavioral feature and many allied studies have demonstrated that it has a rich potential as a biometric for recognition. This paper has described a simple but effective method for automatic person recognition from body silhouette and gait. The combination of a background subtraction procedure and a simple correspondence method is used to segment and track spatial silhouettes of a walking figure. Gait based recognition has been described in context of person authentication. Several existing techniques for gait recognition have been discussed. Intermediate results describe the effectiveness of proposed system. Results obtained in all intermediate steps have been discussed.

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