International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-2 Issue-4, September 2013

# Biometric Identification on The Basis of BPNN Classifier with Other Novel Techniques Used For Gait Analysis

**Ira Gaba, Paramjit Kaur**

***Abstract*— Gait is the manner of the limb movement or the manner of moving a foot of an individual and recognition of an individual is the task to identify a people. Gait recognition is the biometric process by which an individual can be identify by manner they walk. The advantage of gait over other biometric traits such as face ,iris ,and fingerprint etc is that it is non-invasive and less unobtrusive biometric, which offers to identify people at the distance, without any interaction from the subject or at low resolution. In this paper, firstly the input video is converted into frame then, binary silhouette of a walking person is detected from each frame. Secondly, feature from each frame is extracted using image processing operation. Here distance between head and feet, distance between both hands, length of one hand, length of leg etc using hanavan's model are taking as key feature. And then CBIR method is also used. At last BPNN+MDA and BPNN+LDA techniques are used for training and testing purpose. Here all experiments are done on gait database and input video. Therefore, by using the combination of BPNN with LDA and MDA, in this paper, it obtains the better accuracy results.***

***Index Terms*— BPNN, CBIR, Feature Extraction, Gait Recognition, LDA, MDA, PCA, Silhouette Extraction.**

## I. INTRODUCTION

Biometric system is mainly used to prevent the unauthorized access. Gait recognition is an effective biometric for human identification, by the manner of walking by this a registered/authorized person can be verified. There are three different systems which are knowledge based, object based and biometric based[1]. Knowledge based system uses password which were set as a string that included integers or special characters and were used for authentication and these passwords can easily be cracked. Object based system is the combination of knowledge based and object based such as ATM card, Credit card with a given pin code. But both the knowledge based and object based system can be steal or lost or forgotten. Therefore to curb this problem biometric based system can solve the above problem. Biometric is a field of technology that uses automated methods for identifying and verifying a person based on physiological and behavioral traits[2]. Today, in the banks, metropolitan public transport stations, and other real time applications, authentication and verification are always required. In such applications Biometrics Identification are more attractive. Biometric recognition refers to an automatic recognition of individual based on feature vectors derived from their physiological and behavioral characteristic. The physiological are related to the body such as face, fingerprint, DNA and iris. And the behavioral is related to the behavior of the person such as voice and gait. As these physiological characteristics does not provide good results in low resolution and need user cooperation therefore Gait recognition is more attractive.
Individual biometrical identification system is achieved with methods such as fingerprints, face, hand geometry, iris, voice, signature, and gait [3], but all of them, excluding gait, needs to be captured only by physical contact or at a close distance from the recording sensor [4].

**Revised Manuscript Received on 30 September 2013.**
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## II. LITERATURE REVIEW

Many researchers had given their contribution in model based approach and model free approach of gait recognition. In the Proposed Gait Recognition System, model based approach is used. In this model based gait recognition system both the motion of lower leg rotation and motion of tigh describes walking and running[5]. Model based approaches can handle self occlusion, noise, scaling and rotation[6].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. By using this model approach, various parameters can be calculated easily, which provides the better efficiency. In model based approaches, the accuracy of reconstruction of human model depends on quality of extracted human silhouette. In paper [7] three components based features are: area of each body component, the center of each body component and the orientation of each body component.
In paper[8], the height , width, center of mass of the silhouette is calculated, which further help in calculating the various parameters for the gait recognition system.
Many researchers have developed Gait Recognition System on the based of the model free approach, and the Model based approach, 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.


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## III. GAIT RECOGNITION SYSTEM

The Gait Recognition System is which that identify the gait of the authorized individual by comparing it with the stored sequence in the database.

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. And to obtain the various parameters hanavan's model is used. After that for the matching purpose CBIR technique is used. Final step of gait system is recognition. Here both the input and trained sequences in database are compared with each other.

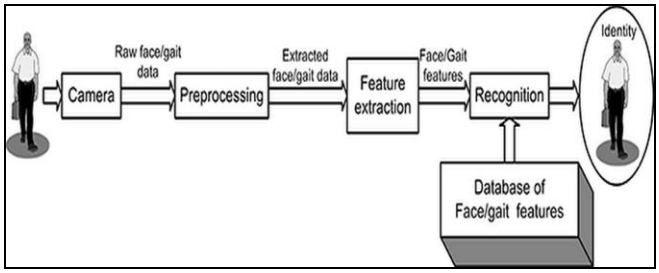


**Fig.1. Gait Recognition System**

## IV. PROPOSED GAIT RECOGNITION SYSTEM

The proposed Gait Recognition System is the one which consists of the following steps which is further shown with the help of the flow chart. There are various processes are carried out to obtain the better and accurate output. In this the basics step of gait recognition system is carried out like background subtraction, feature extraction and then recognition, whereas the matching is performed by the help of CBIR and the recognition is carried out with the help of BPNN classifier and further it is combined with the LDA and MDA techniques, so as to get the better accuracy results.

In this system we uses the approach of Model Based system, the main advantages of the model-based approach are that it can reliably handle occlusion (especially self-occlusion), noise, scale and rotation well, as opposed to silhouette-based approaches.

This section describes how to convert the input video into the form of frames and after that background subtraction is applied over that so as to remove the unwanted data or information.

Background subtraction is a process of extracting the foreground object in a particular location[9]. After that features are extracted by using hanavan's model , by using this model various features can be extracted like distance between distance between head and feet, distance between both hands, length of one hand, length of leg etc. And finally the individual is finally recognized by comparing the obtained characteristics with the ones previously stored in the database. The recognition part is also one of the most important step of the gait analysis.

The following figure provides the basic structure of the proposed gait recognition system.

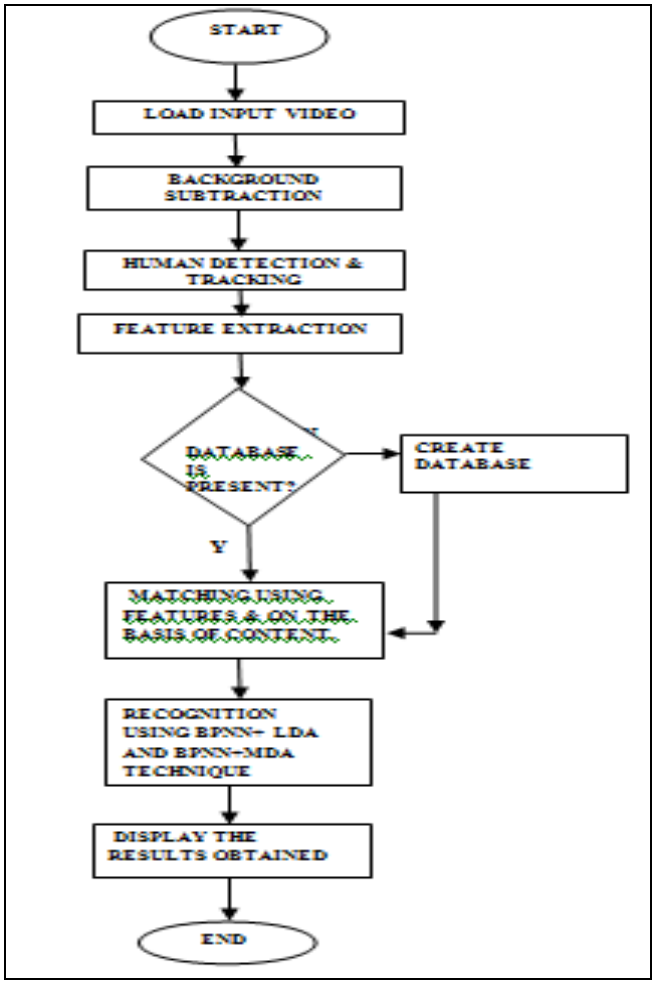


**Fig.2. The Proposed Gait Recognition System**

1) Input video: capture an input video for gait identification. First input video will be converted into frames known as video sequences, and those frames are used for further gait Recognition process.

2) Background Subtraction:
After converting video into frames, next is background subtraction. Identifying moving objects from a video sequence is a fundamental and critical task in many computer-vision applications. A common approach is to perform background subtraction, which identifies moving objects from the portion of a video frame that differs significantly from a background model. Gaussian mixture model is used for foreground object estimation.
Gaussian mixture model: GMM is an adaptive model which uses a mixture of normal distributions to model a multi-modal background image sequences. Each surface which comes into the view of a given pixel is represented by one of set of states k ∈ {1.2....K}. Where the number of surfaces k is an assumed constant. The process which generates the state at each frame time t = 1, 2, 3…. is simply modeled by a set of k parameters wk = p(k), k ∈ {1, 2, ...,K} each representing the priori probability of surface k appearing in the pixel view. The pixel value process X is assumed to be modeled by a mixture of K Gaussian densities with parameters sets, one for each state k.


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$$f_{x/k}(X/K, \theta_k) = \frac{1}{(2\pi)^{\frac{n}{2}} |\sum k|^{\frac{1}{2}}} e^{-\frac{1}{2}(X-\mu_k)^T \sum_k^{-1}(X-\mu_k)}$$

By applying the Background Subtraction, the un-required data can be removed. After this step, the silhouette can be extracted. Silhouette is defined as a region of pixels of the walking person.[10]. Background subtraction is the relatively simple and new approach to find the silhouette from an image. Moving object is extracted by background subtraction. Silhouette extraction mainly focuses on 'segmenting the human body'. The goal is to obtain the binary image of the silhouette that is nearly match the actual silhouette of the walking person. As shown in the figure3.

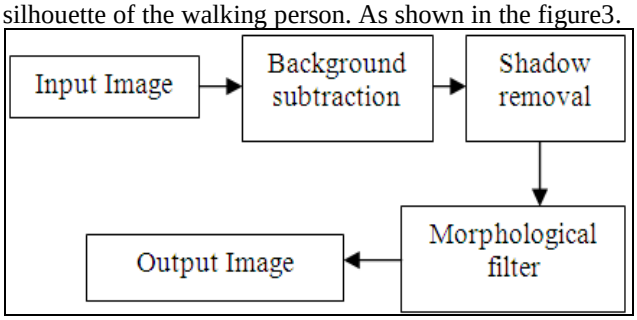


**Fig.3 The Silhouette Extraction**

**3) Human detection and tracking:** Human detection and tracking is one of the important steps in gait analysis. Tracking is a process of locating moving object. Tracking algorithm is adopted which is based on background subtraction and silhouette correlation to extract and track moving silhouettes of a walking figure from the background image in each frame.

Object tracking is used for determining the position and other relevant information of moving objects in images sequences or to track moving object frame to frame. Idea of tracking is, when we subtract two subsequent frames, part of images which does not change (background) gets subtracted to give zero intensity(black).

**4) Feature Extractions:**

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. 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.

In this further various parameters can be calculated on the basis of the Hanavan's model. A outer rectangle[8] can be drawn so that the height and the width of the silhouette can be measured on applying the following methods.

Upper left and right points, and bottom left and right points can provide their position (x, y) given in pixels. At each time instant *t*, both left points –*LP*– and right points –*RP*– share the same position on axis x, as upper points –*UP*– and bottom points –*BP*– do on axis y.

By this the height of the silhouette can be calculated

$$H = \frac{\sum_{j=1}^{N_H} [y_{UP}(t) - y_{BP}(t)]_i}{N_H}$$

where $N_H$ represents the total quantity of data gathered for height feature. The measurement values not only specify the person height but also the change on tiptoe position in the gait cycle.

Bundle rectangle mean width –*W*– is the representative width value for a person. It is obtained by averaging the difference between right and left points on axis *x* at each time instant *t*, as given by

$$W = \frac{\sum_{i=1}^{N_W} [x_{RP}(t) - x_{LP}(t)]_i}{N_W}$$

Where $N_W$ represents the total quantity of data gathered for width feature.

Now height of the particular silhouette can be calculated, now by using the Hanavan's model various parameters can be calculated. The parameters that we are using in the proposed model are like distance between head and feet, distance between both the hands, length of one leg, distance between right hand and left leg, and distance between left hand and right leg.


**Fig.4. various parameters can be calculated for the different silhouettes.**

**5) Recognition and matching of trained database:** Recognition is the final step of gait-based person identification. Here, input test video sequences are compared with the trained sequence in the database.

The matching is carried out by using the CBIR technique[11]. Content-based image retrieval, a technique which uses visual contents to search images from large scale image databases. Content-based image retrieval, uses the visual contents of an image such as *color*, *shape*, *texture*, and *spatial layout* to represent and index the image.

For the recognition part, we introduce a neural network technique. Most popular back propagation neural network is proposed in this paper. It is multilayer networks. Further it is combined with the LDA and MDA techniques also, so as to get the better accuracy results.



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Here, the output values are compared with the correct answer to compute the value of some predefined error-function. 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. And this method is also known as the Delta Rule.

For learning rule, consider the simple case of a neuron *k* constituting the only computational node in the output layer of a feed-forward neural network. Neuron *k* is driven by a *signal vector* x(n) produced by one or more layers of hidden neurons, which themselves driven by an input vector applied to the source nodes(i.e. input layer) of the neural network. The argument *n* denotes discrete time, the time step of an iterative process involved in adjusting the synaptic weights of neuron *k*. The *output signal* of neuron *k* is denoted by $y_k(n)$. This output signal, representing the only output of the neural network, is compared to desired response or target output, denoted by $d_k(n)$. An *error signal* $e_k(n)$. We thus have

$$e_k(n) = d_k(n) - y_k(n)$$

The error signal $e_k(n)$ actuates a *control mechanism*, the purpose of which is to apply a sequence of corrective adjustments to the synaptic weights of neuron k. The corrective adjustments are designed to make the output signal $y_k(n)$ come closer to the desired response $d_k(n)$ in a step-by-step manner. This objective is achieved by minimizing a *cost function E(n)*, defined in terms of the error signal $e_k(n)$ as

$$E(n) = \frac{1}{2} e_k^2(n)$$

The minimization of the cost function *E(n)* leads to a learning rule commonly referred to as a *delta rule*.

*Linear Discriminant Analysis (LDA)*

LDA is a technique which is used for the feature extraction and dimension reduction. It has been used in many applications involving high-dimensional data such as image retrieval and recognition[12]. The LDA method is employs to perform training and projecting on original gait feature. It reduces dimensionality of high dimensional gait feature with PCA, and then performs optimal classification on low dimensional space with the LDA algorithm[13].The objective of LDA is to perform dimensionality reduction while preserving as much of the class discriminatory information as possible.

In general, if each class is tightly grouped, but well separated from the other classes, the quality of the cluster is considered to be high. In discriminant analysis, two scatter matrices, called *within-class* ($S_w$) and *between-class* ($S_b$) matrices, are defined to quantify the quality of the cluster, as follows [14]:

$S_w = \sum_{i=1}^{k} \sum_{x \in \Pi_i} (x - m_i)(x - m_i)^T$ and $S_b = \sum_{i=1}^{k} n_i (m_i - m)(m_i - m)^T$, where $m_i = \frac{1}{n_i} \sum_{x \in \Pi_i} x$ is the *mean* of the *i*th class, and $m = \frac{1}{n} \sum_{i=1}^{k} \sum_{x \in \Pi_i} x$ is the *global mean*.

*Multi Linear Discriminant Analysis(MDA)*

MDA is a technique, when three or more class classifications are identified. The objective of this technique is to maximize distance between different classes and minimize difference between each class.[15].

## V. EXPERIMENTAL RESULT

In this, results of all the intermediate steps of the proposed methods are highlighted. Furthermore, the proposed frame work is validated by considering different gait databases. Experimental results of intermediate steps shows the efficiency of the proposed approach**.** Results includes following steps:

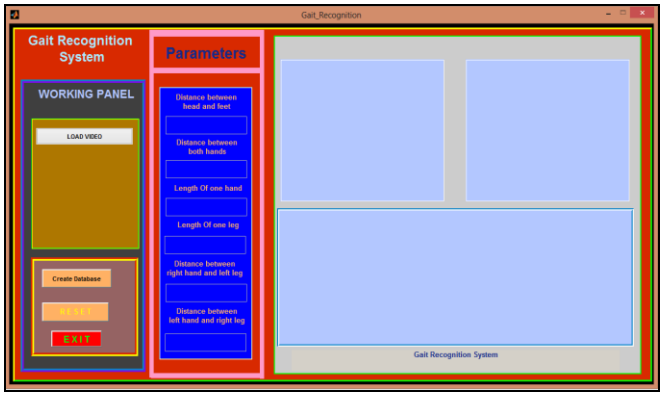


**Fig.5. The basic GUI for the Proposed Gait Recognition System**

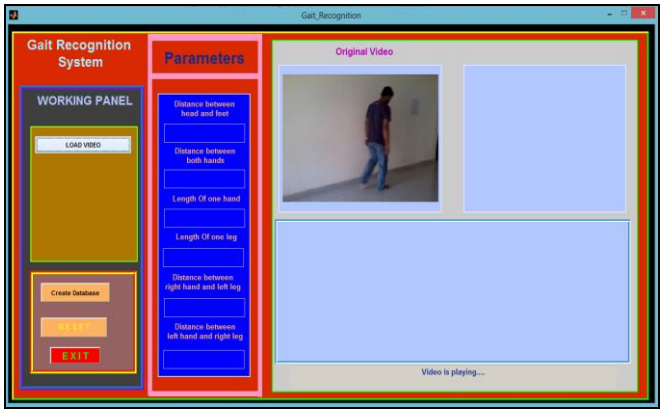


**Fig.6 After processing the Input Video.**

In figure 7, the backgound subtraction is carried out and in figure.8. various parameters such as distance between leg and hand, length of one hand, length of one leg, height of the silhoutte, distance between one hand and leg are calculated.



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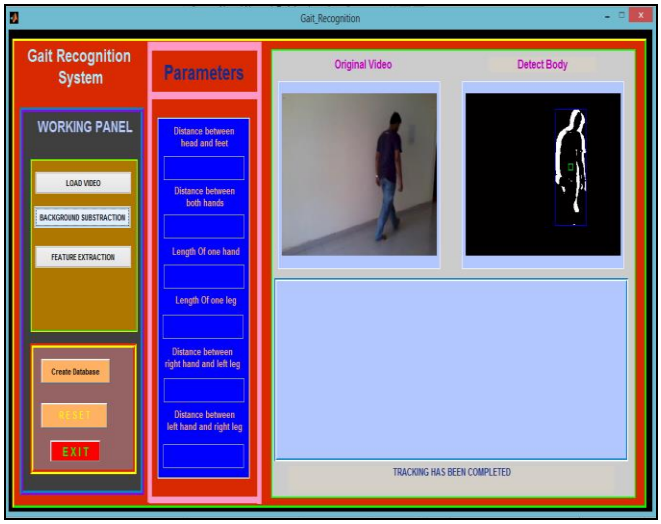


**Fig.7. Silhouette Extraction after Background Subtraction**

In the following figure, we obtain the various values for the various parameters such as distance between head and feet, distance between the right hand and left leg, length of one hand, length of one leg, and distance between left hand and right leg.

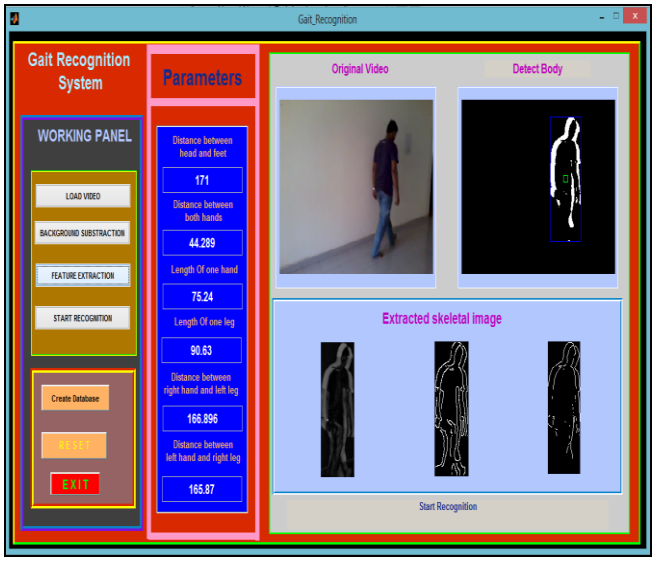


**Fig.8. After applying the Background Subtraction, various parameters can be calculated.**

We can also extrct the various elements of the silhouette by using the filters, like by edge detection.

In the below figure, the CBIR is carried out. In this the histogram of the source image and the target image is carried out and then been compared with each other.

In this the histogram of the traget image and the source image are been compared so as to get the better matching processing.

For each different silhouette the value of each histogram changes.

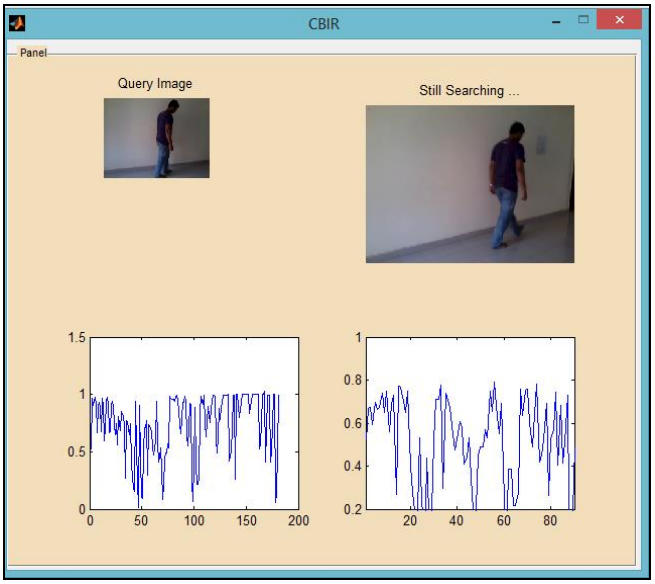


**Fig.9. The CBIR is carried out.**

Here we are able to get the accuracy of about 98.8% by the combination of MDA and BPNN whereas in the previous reseach[9] we get the accuracy of MDA and BPNN about 97.63% and 94.33% respectively.

Again all the previous steps were performed with different Input Video .Input Video was matched with database image and BPNN+MDA and BPNN+LDA results were calculated. In this case input video is same as database image. Both results are better.


**Fig.10. 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.

In Figure 10. The source image and the target image are similar to each other therefore, the recognition process is carried out on them and by using the combination of the BPNN+LDA and BPNN+MDA we obtain the CCR percentage which is much better then the previously used systems.



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Hence we get the better accuracy result in the above proposed Gait Recognition System.

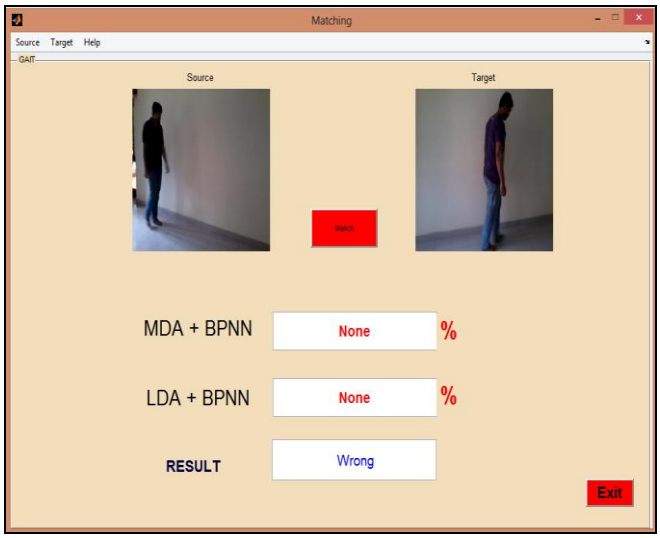


**Fig.11. Input Video was matched with database image and BPNN+LDA And BPNN+MDA results were calculated. In this case input video is different to database image.**

In the above figure11. The source image and the target image are different, therefore the proposed gait recognition system will not show any CCR percentage value.
These results shows the accuracy of proposed methodology and provide better and enhanced results then previous researches.

## 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. The development of computer vision techniques has also assured that vision based automatic gait analysis can be gradually achieved. 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. A large number of experimental results have demonstrated the validity of the proposed algorithm. Gait based recognition has been described in context of person authentication.
Two classification methods – MDA with BPNN and LDA with BPNN are used for recognition. Experimental results show that all these two approaches can achieve similar high accuracy which indicates the outermost contour feature is robust and our feature extraction method is effective.
In this paper, the rate of accuracy obtained by the proposed gait recognition system is more then 98%, which provides the better efficiency.

## VII. FUTURE WORK

This proposed gait recognition system is limited to acquiring gait characteristics from single camera based set up. Using multi camera based set up has more advantages.

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