Gait Analysis for Human Identification

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***Abstract* — Human gait, which is a new biometric, is aimed to recognize individual by the way they walk. Gait can be defined as the coordinated, cyclic combination of movements that results in human locomotion. Gait analysis provides human identification for authentication purpose from a distance and it is unobtrusive. Gait analysis is pose independent. In our work initially background is modeled from the input video captured from cameras deployed for security and the foreground that is moving object in individual frames are segmented using the background subtraction algorithm. Then various features such as measurement of width and height, step size, crotch height, foot angle, stride length, cadence, the distance between head and pelvis. These gait features of individuals are earlier enrolled in a database for the identification of the individuals. Then these features of are compared with features in database to identify the person. We have evaluated the results by using the University of Southampton database (SOTON).**

***Index Terms* — Gait identification, gait recognition, human identification, identification methods, biometric recognition.**

I. Introduction

Today's commercial available biometric system show good reliability. But, they generally lack user acceptance. In general, people favor system with the least amount of interaction. Using gait as a biometric feature is advantageous since it does not require any physical interaction from the user. Consequently, this is increasing user acceptance. The purpose of such schemes is to ensure that the rendered services are accessed only by a legitimate user and no one else. Some examples of such applications include protected access to computer systems, building, ATM's, video surveillance, mobile phones, in highly secured military areas.

Gait can be defined as the coordinated, cyclic combination of movements that results in human locomotion. Gait is an external appearance that consists of human body structure, motion regulating system, behavioral and psychological activities when person is walking.

Gait analysis is used in the identification and authentication field that permits an individual to access the highly restricted and secured area. Our project specifically serves the military areas and the research areas with our authentication module. It also does not require any physical inputs from the user. Gait analysis can be performed using a CCTV camera also to observe the number of people coming in and going out. Gait analysis has a number of applications [1].

II. Prominence Of Gait Biometrics

a) Gait identification aims to discriminate individuals by the way they walk.

b) Gait analysis is better than the other biometric identification features as gait is an unobtrusive method.

c) It depends on how the silhouette shape of an individual changes over time in an image sequence.

d) It doesn't require any physical contribution from the subject.

e) Compared with other biometrics, Gait requires no object contact and is measured at a distance.

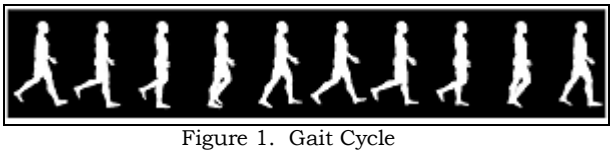


Figure 1. Gait Cycle

III. Block Diagram

Gait based human identification is a challenging system to execute in a real world. There are many methods by which human identification can be achieved. We have used the model-free approach for gait recognition [2]. The report features the following methodology used. The method comprises of various blocks. The block diagram is presented below in Fig.2.

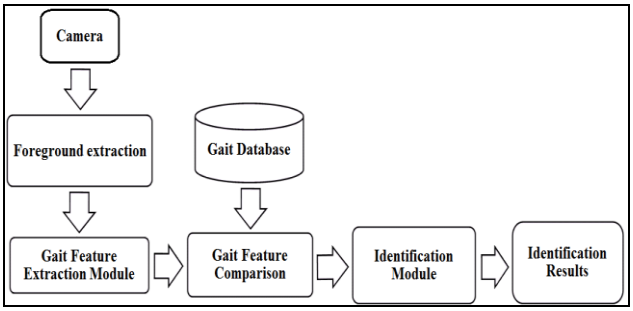


Figure 2. Block Diagram

A camera serves the basic need of sourcing the video of the walking individual. The video is basically a series of continuous images of the event. This acquired image sequence is given to the foreground extraction block. The gait analysis can be done by using different methods. The methods can be model-based, model-free or appearance based. In model-based method, skeletal representation of the individual is used. While in model-free method, the image of the individual is converted to a silhouette for feature extraction. The foreground extraction block extracts the individual from the entire video.

The silhouette of that individual is produced by this foreground extraction block. The silhouette produced is further sent to the gait feature extraction module. This module processes the silhouette to extract the gait features of that individual. The gait features can be stride length, cadence, crotch height, height, width, etc. of the silhouette. These gait features of individuals are earlier enrolled in a database for the identification of the individuals.

These gait features are extracted from the database to compare with the features extracted from the silhouette that was extracted from the gait feature extraction module. The comparison is carried out in the gait feature comparison module. After comparison, the result is passed to the identification module where the identification of an individual is attained. Thus the individual is identified and the results are displayed [3].

IV. Methodology

A. Foreground Extraction

Extracting moving objects from a video sequence captured using a static camera is a fundamental and critical task in visual surveillance. The common method to this critical task is to first perform background modeling to yield a reference model. With the help of the sequence of frames generated from video, background can be modeled which can be later used to visualize moving objects in the video. Most research has been concentered to develop a background model that is robust and sensitive enough to identify moving object of interest. In our implementation, for background modeling we make the fundamental assumption that the background will remain stationary. Thus it demands that the fixed camera and that lighting do not change suddenly.

We have compared five different background modeling techniques which are widely used in many works. These techniques are briefed as follows:

a) Gaussian filter:

The main idea of this method is to model the background of a probabilistic way based on Gaussian distribution. Each pixel has its probability Gaussian distribution characterized by average and variance. As background for each frame may change the mean and variance should be updated. The result of this technique is shown in Fig.3.(b), [4].

b) Reverse of Gaussian filter:

It is simply the opposite of Gaussian filter method i.e. it displays a white background as compared to the Gaussian filter. The output is as shown ion Fig.3.(c), [4].

c) Successive frame differencing:

The foreground image can be calculated by subtracting the current frame from the previous frame. Result is shown in Fig.3.(d), [5,6].

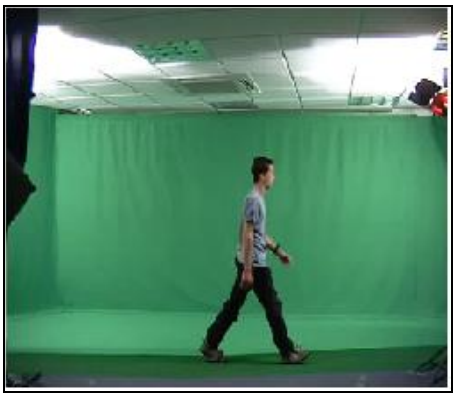
d) Median value method:

This method is most commonly used for background modeling. An estimate of the background image can be obtained by computing the median value for each pixel in the whole sequence. Result is shown in Fig.3.(e), [5,7].

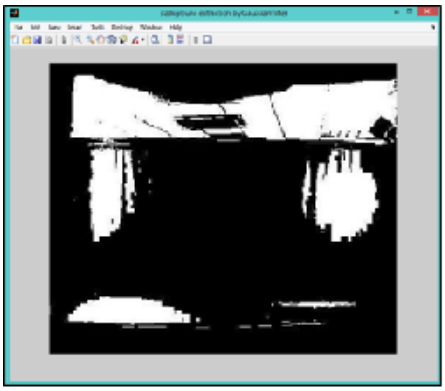
e) Approximate median method:

Approximate median method uses a recursive technique for estimating a background model. Where each background pixel is compared to the corresponding pixel in the current frame, and to be incremented by one if the new pixel is larger than the background pixel or decremented by one if smaller. The pixel from the background model effectively converges to a value where half of the incoming pixels are larger than and half are smaller than its value. This value is known as the median. Output for approximate median is shown in Fig.3.(f), [5]. Fig.3. (a) shows the original frame form the video sequence under analysis.

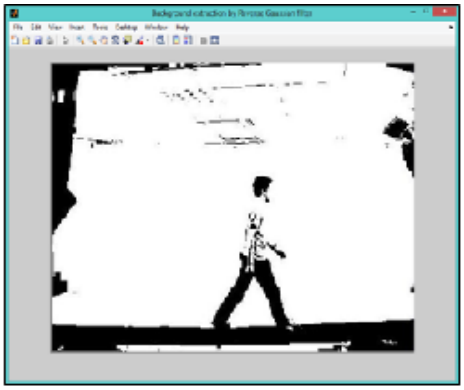
The results invaded that the approximate median and running average techniques extracted flawless foreground silhouette. The results are shown in Fig.3 below.



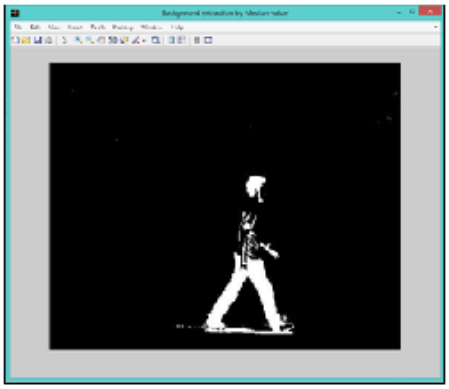
(a)



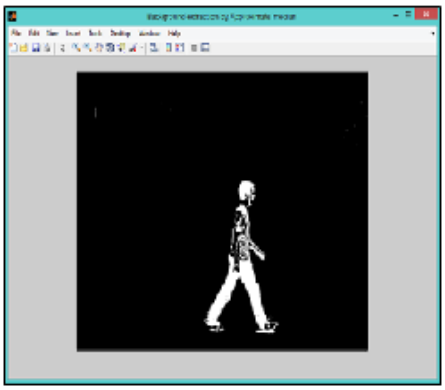
(b)



(c)



(d)



(e)

Figure 3. Foreground Extraction Results

B. Feature extraction

Various features are extracted for gait identification. The features that we extracted are briefed below.

a) Width and Height:

The width and height of the individual from each frame during the walking sequences are measured by using the bounding box of the enhanced human silhouette, as shown in Fig.4.

b) Step-length:

Step- length is the distance between the point of initial contact of one foot and the point of initial contact of the opposite foot. But in normal gait, both right and left step lengths are similar.

c) Crotch Height:

Crotch height is the distance between the crotches to the ground surface.

d) Measurement of Foot angle (Theta):

The foot angle describes an angle between the line of progression and a line drawn between the midpoints of the calcaneus and the second metatarsal head.

e) Stride length:

Stride length is defined as the distance between successive points of initial contact of the same foot [8].

f) Cadence:

Cadence is the walking rate and is calculated in steps per minute.

g) The distance between head and pelvis:

This distance gives the length from head to the pelvis of a human body.

C. Database

We prepared a database including a few videos of the students. The gait module was successfully tested and observed using our own database.

D. Flow chart

The following flow chart explains the flow of the process that was described in the block diagram below.

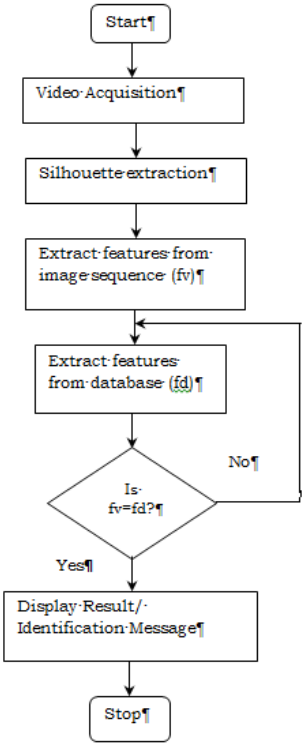


Figure 1. Flow chart

V. RESULT

We have performed gait analysis on people with different features. The identification was observed to be flawless and the results were displayed as shown in Fig.5.

Figure 2. Result

VI. CONCLUSION

Our project uses a model-free approach for the identification of an individual. We created our own database which included features from the videos of persons with different gait pattern. We are able to

identify an individual from the videos stored as well as from the camera capturing videos. Thus our project identifies an individual in both, offline and real-time modes. After the identification of the individual, it displays the information which includes the extracted features and name and an authenticated photo of that individual.

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