Scholars Journal of Engineering and Technology

OPEN ACCESS

Abbreviated Key Title: Sch J Eng Tech
ISSN 2347-9523 (Print) | ISSN 2321-435X (Online)
Journal homepage: https://saspublishers.com

Gait Recognition Using SVM and LDA with Pal and Pal Entropy Image

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DOI: 10.36347/sjet.2020.v08i12.005 | **Received:** 13.11.2020 | **Accepted:** 21.12.2020 | **Published:** 30.12.2021

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Abstract **Review Article**

In Gait recognition, identification of a person or human being from far distance is performed without any cooperation from his side. Its motive is to develop identification of human being using Gait recognition method which provides high security in places such as banks, military, parking slots, airports etc. Recognition of any individual is a task to identify people. Human recognition methods such as face, fingerprints, and iris generally require a cooperative subject, physical contact or close area. These methods are not able to recognize an individual at a distance therefore recognition using gait is relatively new biometric technique without these disadvantages. 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 behavioral characteristics of biometric recognition. Gait offers ability of distance recognition or at low resolution. This thesis aims to recognize an individual using his gait features and proposed new method for Gait recognition using SVM and LDA with GAIT PAL and PAL ENTROPY technique. Different parameters are used such as distance between head and feet, distance between legs and one another additional parameter used by us is distance between hands. However the majority of current approaches are model free which is simple and fast but we will use model based approach for feature extraction and for matching of parameters with database sequences. After matching of parameters CCR (Correct Classification Rate) will be obtained using LDA (Linear Discriminant Analysis) and SVM (Support Vector Machine) technique. Some experimental results will show the effectiveness of proposed system.

Keywords: Gait Recognition, SVM, LDA and CCR.

I. INTRODUCTION

Surveillance technology is now present everywhere in modern society. This is due to the increase in number of crimes as well as it is necessary to provide a safer environment. Despite the huge increase of surveillance systems, the question whether current surveillance systems work as a deterrent to crime is still debatable. Security systems should not be only able to predict when a crime is about to happen but, more importantly they ought to identify the individuals suspected of committing crimes through the use of biometrics such as Gait Recognition. Recently, in surveillance applications the use of Gait for people identification has attracted researchers from computer vision. The suitability of Gait Recognition for surveillance systems emerges from the fact that Gait can be perceived from a distance as well as its non-invasive nature.

Today in banks, metropolitan public transport stations, and other real time applications, authentication and verification are always required. In such type of applications, biometric authentication methods are more attractive. Biomechanics research (e.g. gait analysis, sport or rehabilitation biomechanics, motor control studies) often involves measuring different signals such as kinematics, forces, and EMG. Gait is defined as “a manner of walking” in the Webster Collegiate Dictionary. The extend definition of gait is to include both the appearance and the dynamics of human walking motion. Gait analysis is the systematic study of human walking , using the eye and brain of experienced observers, augmented by instrumentation for measuring body movements, body mechanics and the activity of the muscles. Gait analysis can give qualitative as well as quantitative values for the gait parameter. Gait can be detected and measured at low resolution, and therefore it can be used in situations where face or iris information is not available in high enough resolution for recognition.

II. BIOMETRICS

The first important steps towards preventing unauthorized access are user authentication. User authentication is the process of verifying identity. Traditionally password were set as a string which included integer or special characters and were used for authentication and these password can easily cracked but now biometric authentications are used. Therefore, biometrics refers to the technologies that analyze and measure characteristics of human body such as fingerprint iris, voice and facial pattern, DNA etc. So it is critical to establish the identity of an individual in a variety of scenarios ranging from issuing a driver's license to granting access to highly secured resources. The need for reliable identification and authentication systems has increased due to rapid advancements in networking, communication and mobility.

Traditional passwords and ID cards have been used for authentication in many applications (e.g. Internet banking) or facilities (e.g. library) although such mechanisms have several limitations.

Passwords can be guessed or disclosed to unlawful users and ID cards can be stolen or forged, resulting in a break of security.

The most general definition of a biometric is:

> "A physiological or behavioral characteristic, which can be used to identify and verify the identity of an individual."

They can be classified into two categories as:

- **Physiological:** These are biometrics which is derived from a direct measurement of a part of a human body. These characteristics are related to the body. Recognition techniques come into this category is fingerprint, face, iris, DNA and palm print.

Figure 1: Fingerprint detection

Figure 2: Face and iris detection

- **Behavioural:** These extract characteristics based on an action performed by an individual; they are an indirect measure of the characteristic of the human form. The main feature of a behavioral biometric is the use of time as a metric. Established measures include keystroke-scan and speech

patterns. They are related to behavior of the person. Voice and gait recognition techniques come into this category.

As the physiological characteristics does not provide good results in low resolution and need user cooperation therefore recognition using Gait is more attractive.

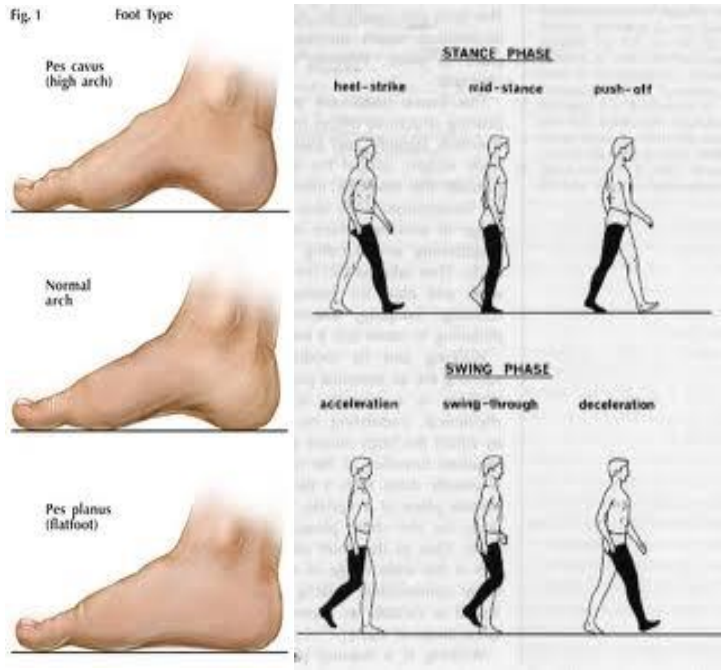


Figure 3: Gait detection

III. GAIT RECOGNITION

Gait Recognition aims to identify the individual by the way he walk or move. Gait based recognition is more suitable in video surveillance applications because of following advantages:

1 Recognition using gait do not need any user cooperation.
2 The gait of an individual can be captured at a distance.
3 Gait recognition does not require images that have been captured to be of very high quality and provide good results in low resolution.

Example: To analyze the video stream from surveillance cameras. If an unauthorized authority walk in front of camera. System will compare his gait with stored gait sequences and recognize him and alerts the appropriate authority for necessary action. The threat has been successfully detected from distance. Such a system have large amount of applications, such as banks, airports and high security areas.

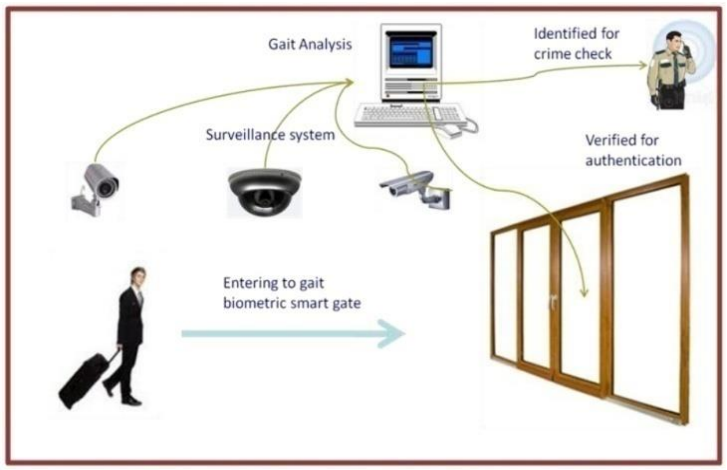


Figure 1: Gait recognition in security access application scenario. (Walker CEO walks steadily towards the entrance. As he gets close, his gait is recognized, the door opens automatically, and the intelligent system that manages the building, welcomes him with a friendly voice. When, walker Crime gets close to the gate, his gait is recognized as a criminal and before he becomes as a possible threat all security alerts are activated.)

Figure 4: Gait Recognition in Security Access Scenario

Gait as a biometric has many advantages as stated above which make it an attractive proposition as a method of identification. 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.

Ideal intelligent monitoring system should be able to automatically analyze the collected video data, give out an early warning before the adverse event happens, and reduce injury and economic loss. For example, when the system detects abnormal behavior, it can immediately determine the identities of all persons in the scene, rapidly investigate their previous activities, and track the suspects across the regions. It requires the monitoring system can not only estimate the quantity, location and behavior, but also obtain the identity information.

Gait is the most suitable biometrics in the case of intelligent visual surveillance. In monitoring scenes, people are usually distant from cameras, which make most of biometric features no longer available.

Gait Recognition Scenario

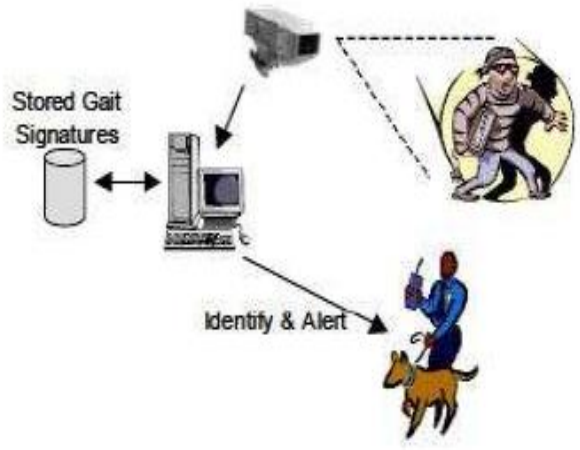


Figure 5: Gait Recognition Scenario

Example: In bank scenario, only few authorized people are allowed to go into lockers room, here gait analysis technique is used, gait sequences of those authorized people are stored in bank's database, therefore whenever an unauthorized person tries to enter into room, his gait sequences will not match with stored

sequences and alarm system will be activated for any action.

3.1 Advantages of Gait Recognition

The advantages of Gait as a biometric can be seen as 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.

Being a biometric, an individual's biometric signature will be affected by certain factors such as:

- **Stimulants** – drugs and alcohol will affect the way in which a person walks.
- **Physical changes** – a person during pregnancy, after an accident/disease affecting the leg, or after severe weight gain / loss can all affect the movement characteristic of an individual.
- **Psychological** – a person's mood can also affect an individual's gait signature.
- **Clothing** – the same person wearing different clothing may cause an automatic signature extraction method to create a widely varying signature for an individual.

Although these disadvantages are inherent in a gait biometric signature, other biometric measures can easily be disguised and altered by individuals, in order to attempt to evade recognition.

IV. GAIT RECOGNITION SYSTEM

Gait Recognition system and background

Block diagram of general gait recognition system is shown below in figure 6. Steps involved and exsting methods of all relevant steps are explained below:

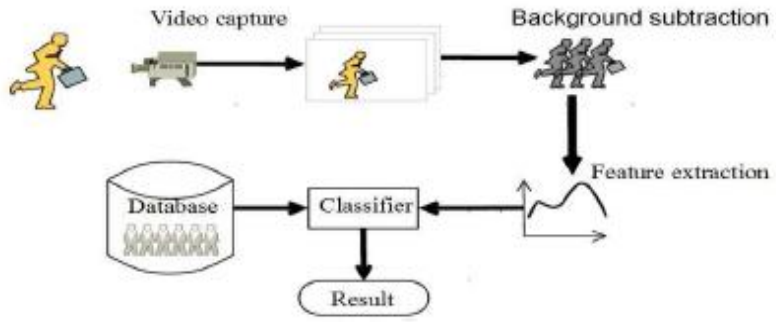


Figure 6: Gait Recognition System

A) Video Capture

In this method when a person enters his gait is captured through camera. Then this method of accurate tracking of a person in indoor surveillence video stream is obtained from static camera. Example a video camera on front door or any where in multicomplex can store gait sequences of a moving person, so that video can be used for further processing.

B) Background Subtraction

It is the most common approach of Gait recognition.

In this approach moving objects from background in the scene are identified first. After that we will consider the relevant part of the frame and irrelevant part will be deleted i.e. instead of complete frame only the portion in which a person is moving is identified. Also while implementing background subtraction we use median filter so that it helps in to remove noise.

Background subtraction techniques can be categorised into two types:

1. **Non-Recursive method:** Non-Recursive techniques use sliding window approach for background subtraction.
2. **Recursive method:** The recursive methods use single Gaussian method and Gaussian mixture model. Recursive techniques require less storage.

c) Feature Extraction

An important step in gait recognition is the extraction of appropriate feature that will effectively capture the gait characteristics.

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). To transform the input data into the set of features is called feature extraction.

d) Recognition

This is the last step of gait-based individual detection. Here, input test video sequences are compared with the trained sequence in the database. In general, minimum distance classifier may be used for gait recognition.

V. PROPOSED METHODOLOGY

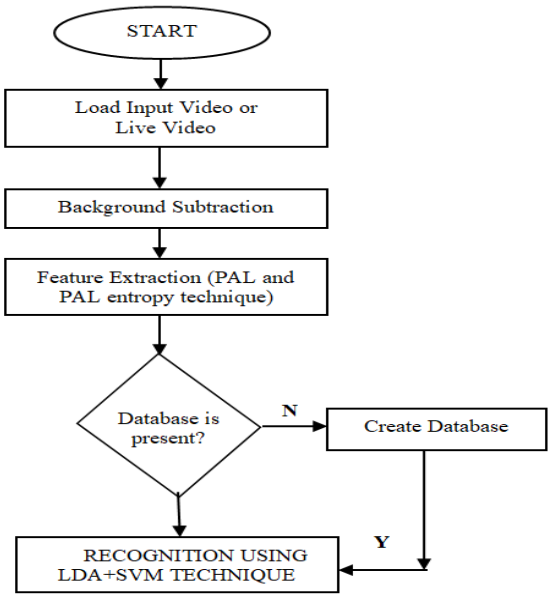
In this the two videos are captured through mobile and are made compatible by coding using MATLAB which are then converted into frames and frames to video using MATLAB command.

After that we are comparing Input or live video with database video which is then converted into frames.

The steps of the proposed work are as following:-

- Firstly, we are taking different videos having different extensions so as the input video when compared with database video will be converted into frames so that we can match them.
- Secondly, a live video when compared with database video will be matched based on the walking style of the person or on the basis of movement of the person that is if the walking style of both the persons is same then the result will be matched otherwise not matched.
- Thirdly, we will implement the concept of background subtraction so that the unneeded part will be deleted and so we need to concentrate only on him rather than the complete frame.
- Fourthly, the concept of feature extraction is implemented in which we are taking the parameters based on Hanavan's model which is model based approach and also the technique named Surf feature is used for matching the video.
- In the final step, that is recognition we are calculating the accuracy of the previous work SVM with the accuracy of our work using SVM and LDA for better results. Also, we are matching input video with database video i.e. we will check how much efficient our CCR is.

This proposed Gait Recognition System is the one which consists of the following steps which is shown with the help of flowcharts.



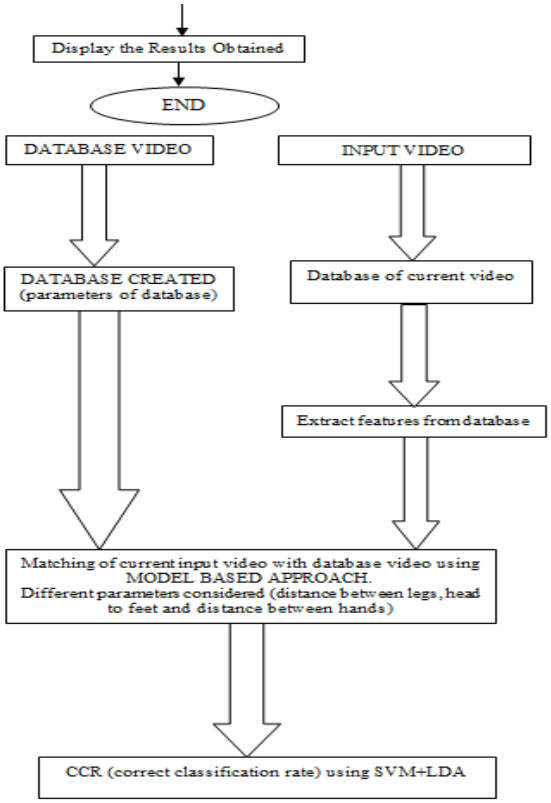


Figure 7: The Proposed Gait Recognition System

5.1 Input Video

The foremost step is to 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.

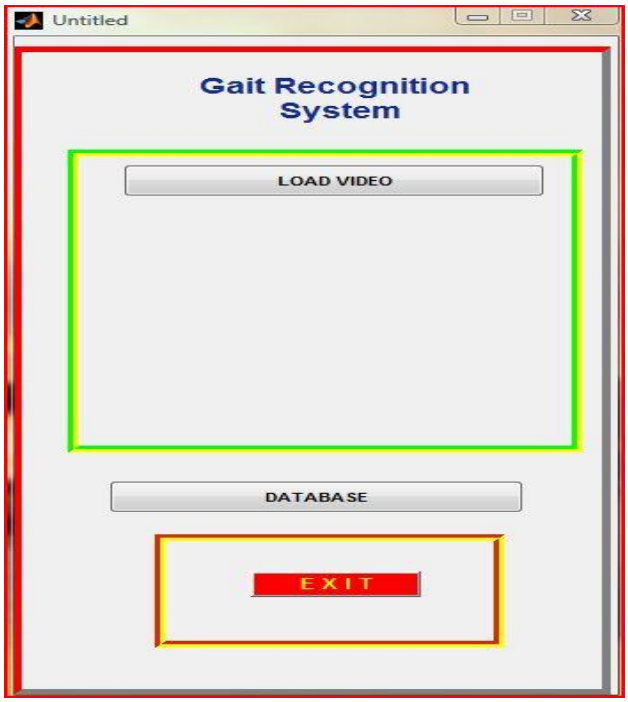


Figure 8: GUI figure file for loading video

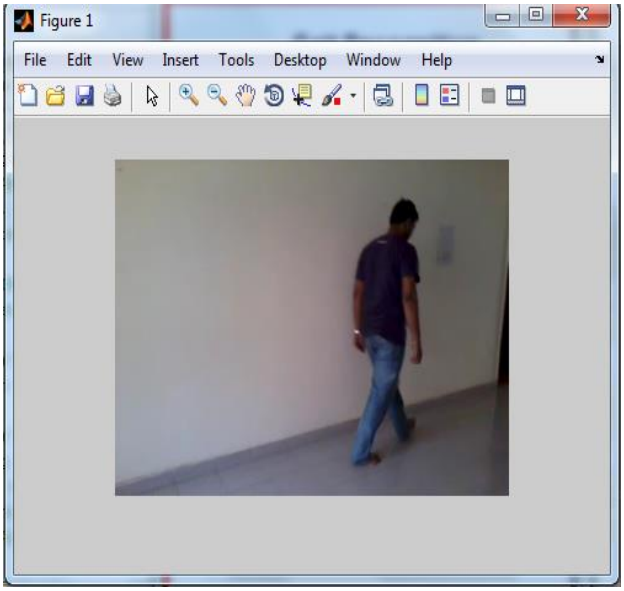


Figure 9: Loading the Video

5.2 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 in which an additional step of filtering by median filter can be involved to eliminate noise.

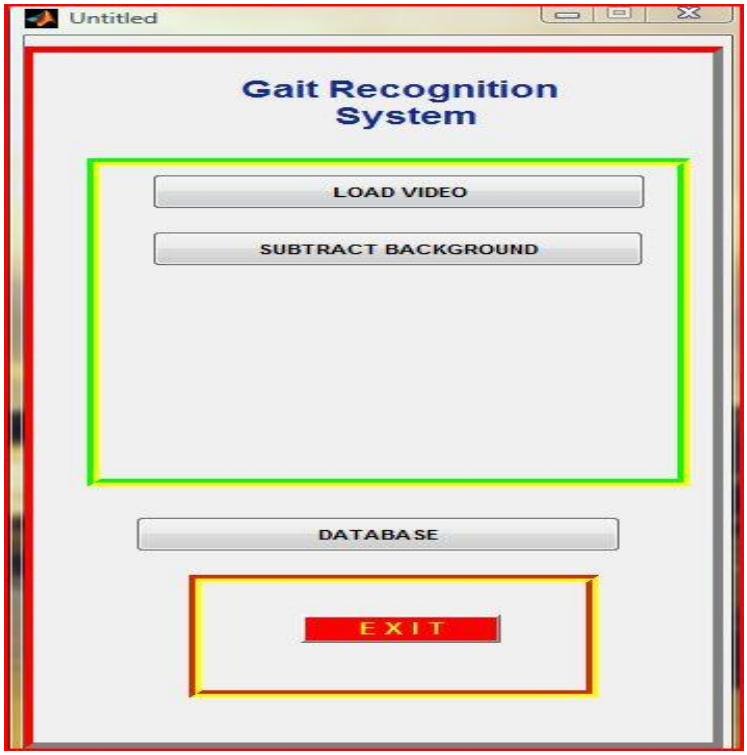


Figure 10: GUI figure file for Background Subtraction

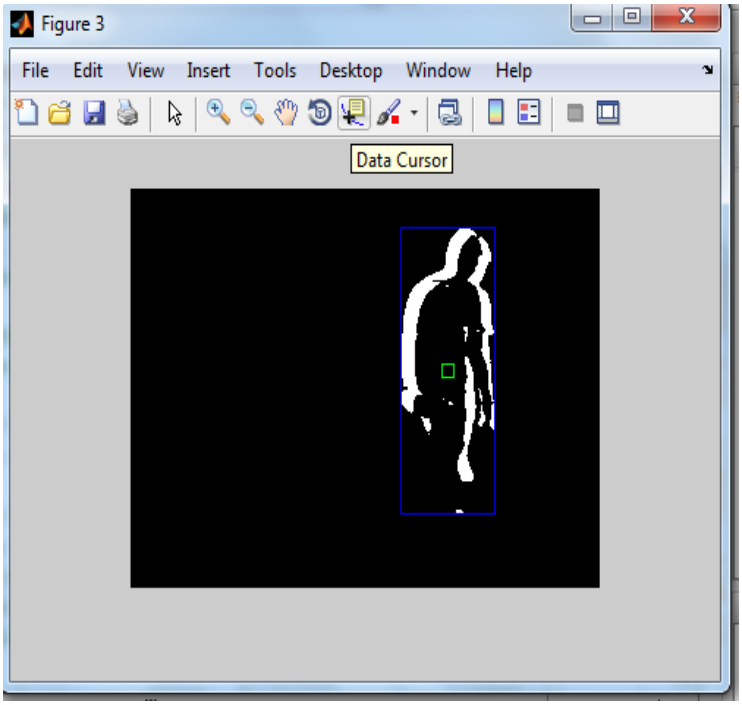


Figure 11: Background Subtraction

5.3 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 12 shows the stances during gait cycle. Gait cycle is determined by calculating sum of the foreground pixels. At rest positions this value is low.

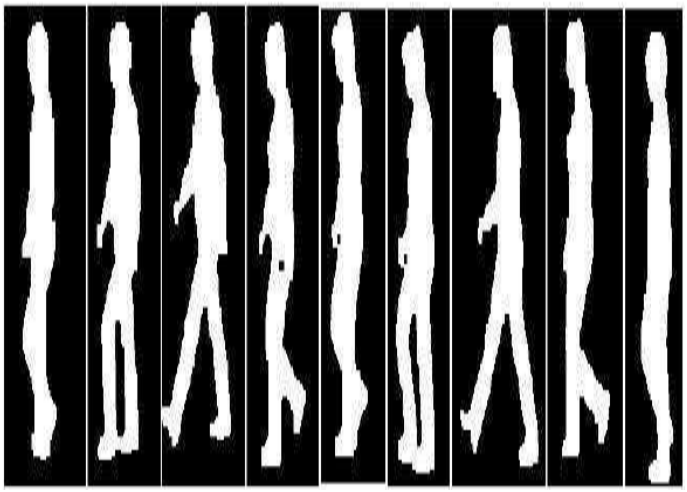


Figure 12: Stances during gait cycle

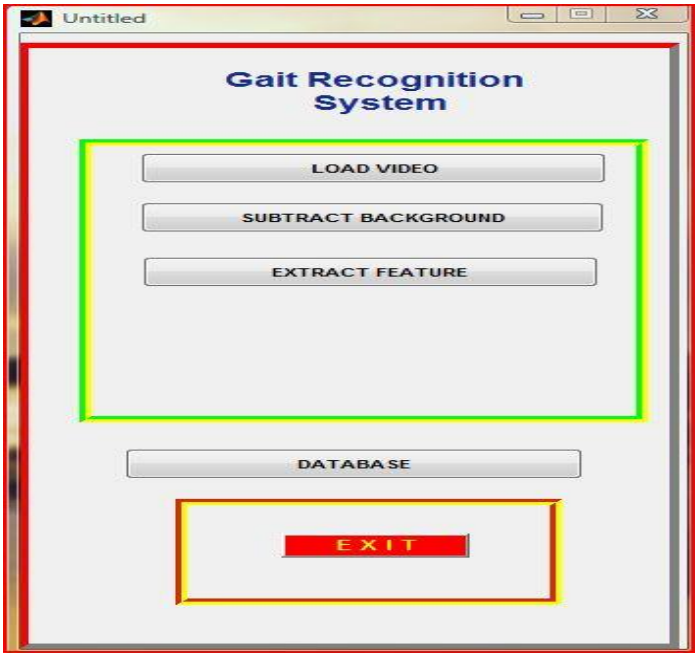


Figure 13: GUI figure file for feature extraction

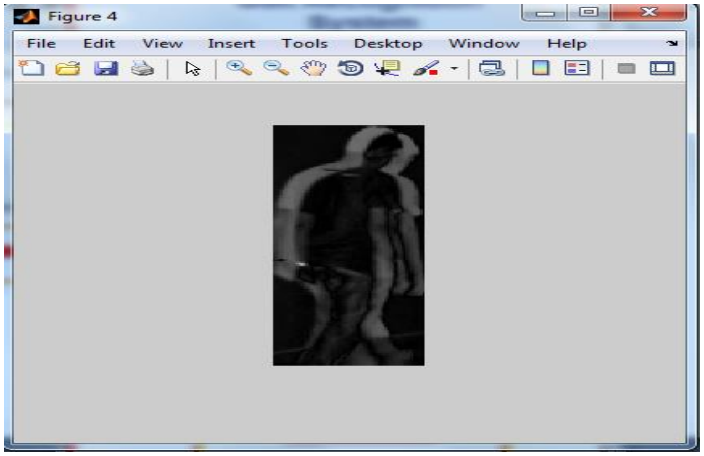


Figure 14: Cropped image

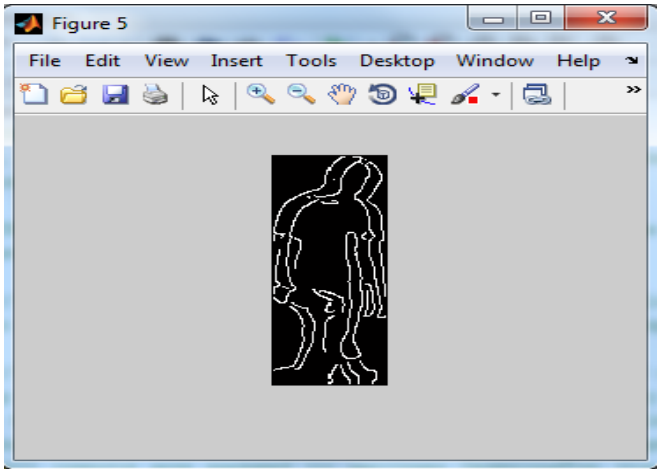


Figure 15: Canny Representation

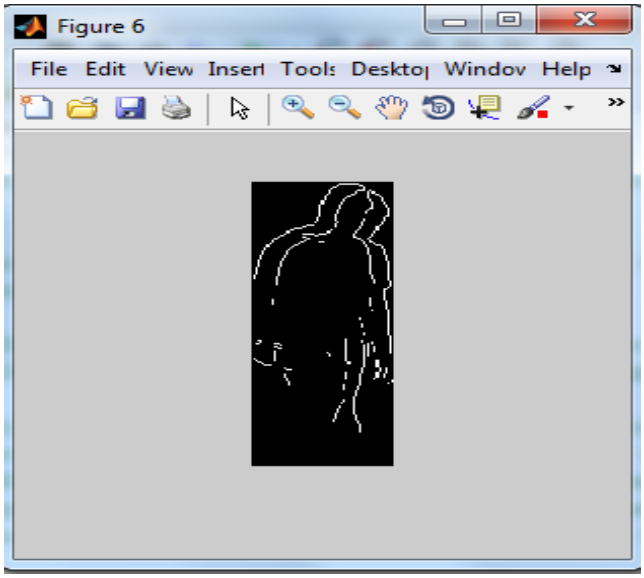


Figure 16: Prewitt Representation

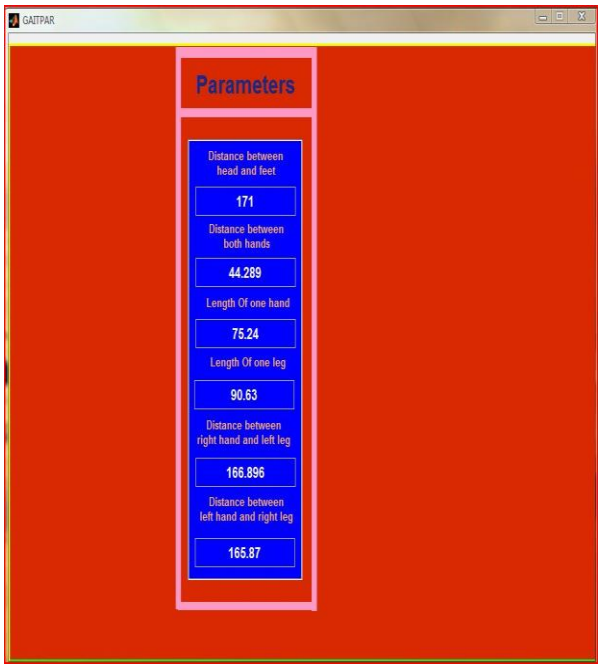


Figure 17: Parameters calculated for feature extraction

5.4 Matching and Recognition

The last step in this is recognition which means to compare the results i.e. we are comparing the input video with the database stored video to check whether they are same or not. For matching we use the surf method technique to match the two different images or frames. Then these extended vectors are matched to the trained data base with the help of Support Vector Machine and LDA.

A. SUPPORT VECTOR MACHINE (SVM)

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. Many researchers have used SVM on gait recognition. Therefore, it is to be noted that SVM is fundamentally a two-class classifier. First class maps the training samples into a high dimensions space and then finds a separating hyper plane that maximizes the margin between two classes in this high dimension space.

This has two advantages:

a) First, the ability to generate non-linear decision boundaries using methods designed for linear classifiers.

b) Second, the use of kernel functions allows the user to apply a classifier to data that have no obvious fixed-dimensional vector space representation.

B. 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. 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. 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 PCA, the shape and the location of the original data sets changes when transformed to a different spaces whereas LDA doesn't change the location but only tries to provide more class separability and draw decision between the given classes. In discriminant analysis, two scatter matrices, called *within-class* (*Sw)* and *between-class* (Sb) matrices, are defined to quantify the quality.

$S_w = \sum_{i=1}^{k} \sum_{x \in \pi_i} (x - m_i)(x - m_i)T$ *and* $S_b = \sum_{i=1}^{k} n_i (m_i - m)(m_i - m)^{\mathrm{T}}$ where $n_i = \frac{1}{n_i} \sum_{x \in \pi_i}$ x is the mean of ith class and m= $\frac{1}{n} \sum_{i=0}^{k} \sum_{x \in \pi_i}$ x is the global mean.

VI. RESULTS AND DISCUSSIONS

In the following figures, results of following figures are highlighted.

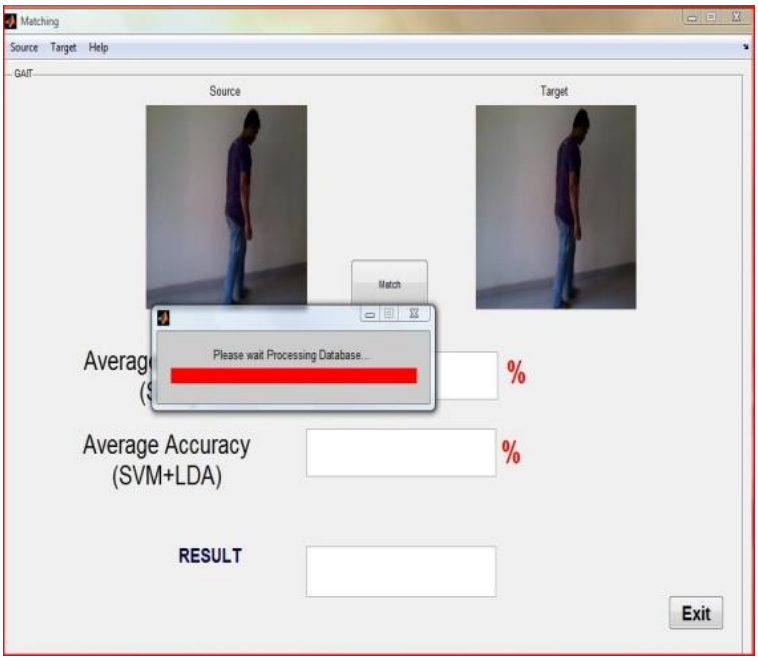


Figure 18: GUI figure file for matching the video

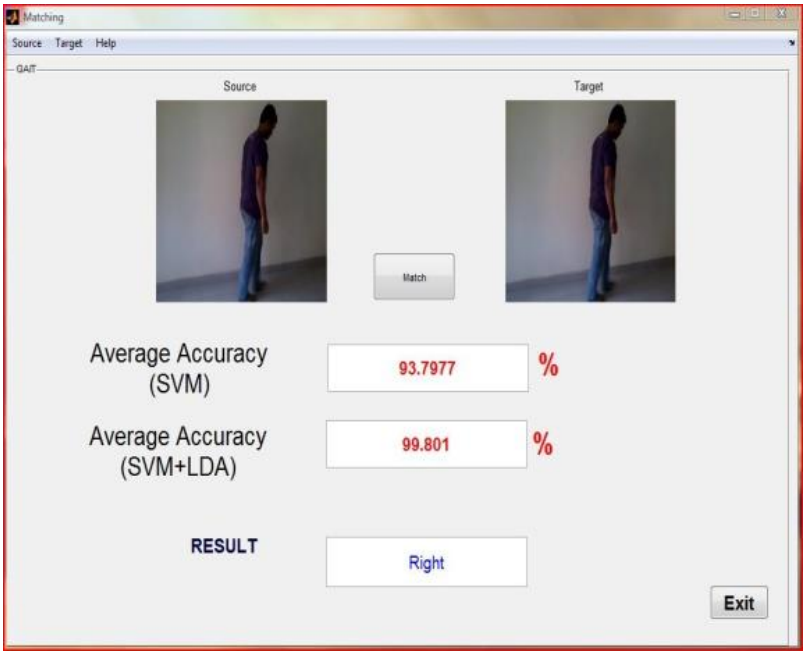


Figure 19: Successful Match

In the above figure Input video was matched with database image and SVM AND LDA results were calculated. In this case input video is same as database image. SVM and LDA results are better.

Table 4.1: Comparison of CCR between Previous and our algorithm

	Previous work SVM	**Proposed work SVM and LDA**
CCR	93.79	99.801

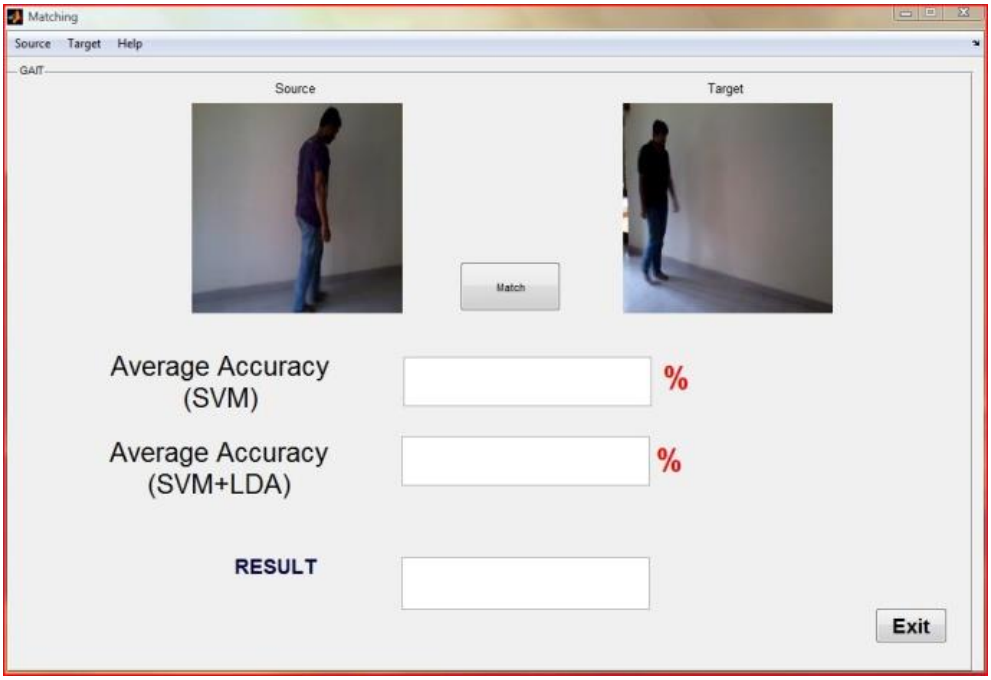


Figure 20: GUI figure file for matching the unsuccessful video

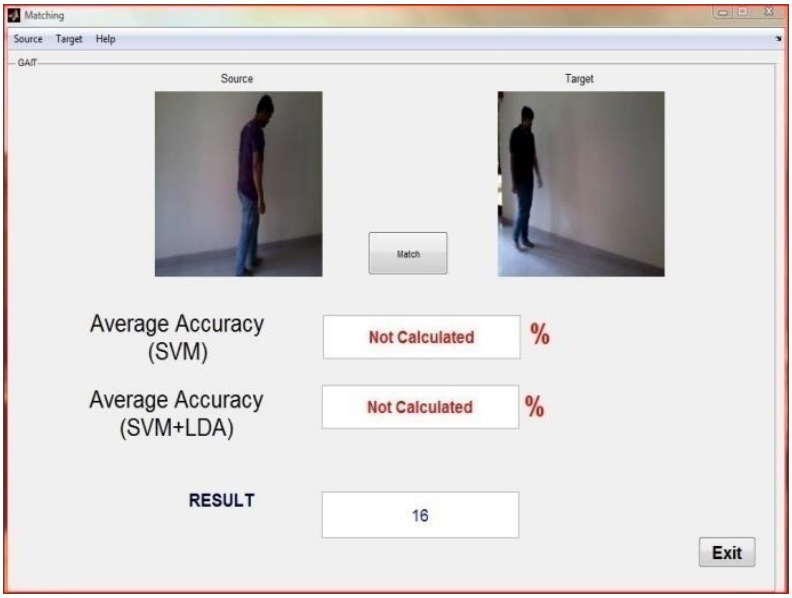


Figure 21: Unsuccessful match

This table in figure 22 shows comparison of accuracy between base paper technique i.e., GPPE (Gait Pal and Pal Entropy) with SVM and proposed work GPPE with SVM and LDA. Accuracy of proposed technique is better in comparison to previous technique. Accuracy value has been calculated using equation and algorithm which has been implemented using MATLAB software.For table uitable command is used in MATLAB.

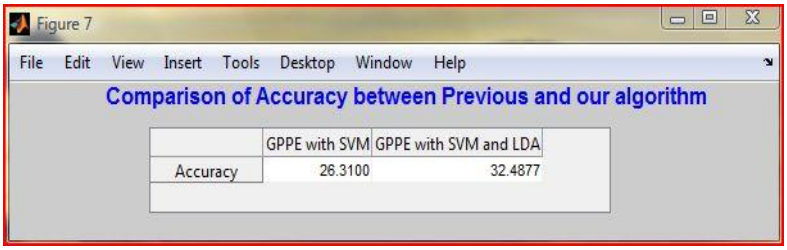


Figure 22: The accuracy value of GPPE with SVM and LDA

This bar graph in figure 23 shows comparison of accuracy between base paper technique i.e., GPPE GPPE (Gait Pal and Pal Entropy) with SVM and GPPE with SVM and LDA. Accuracy of proposed technique is better in comparison to previous technique as can be seen from bar graph. The values are same as shown in above table.For bar graph we use bar command in MATLAB.

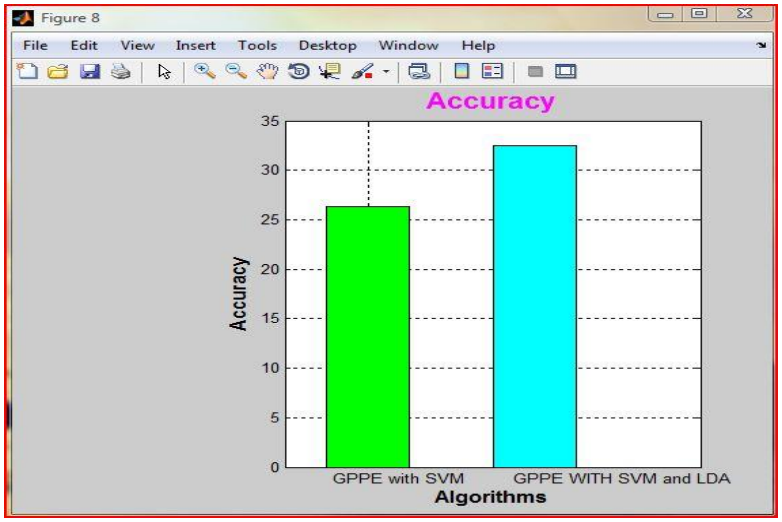


Figure 23: Accuracy graph of SVM and LDA

This table in figure 24 shows comparison of accuracy between base paper technique i.e., GEnI (Gait Entropy Intensity) with SVM and proposed work GEnI with SVM and LDA. Accuracy of proposed technique is better in comparison to previous technique. Accuracy value has been calculated using equation and algorithm which has been implemented using MATLAB software.For table uitable command is used in MATLAB.

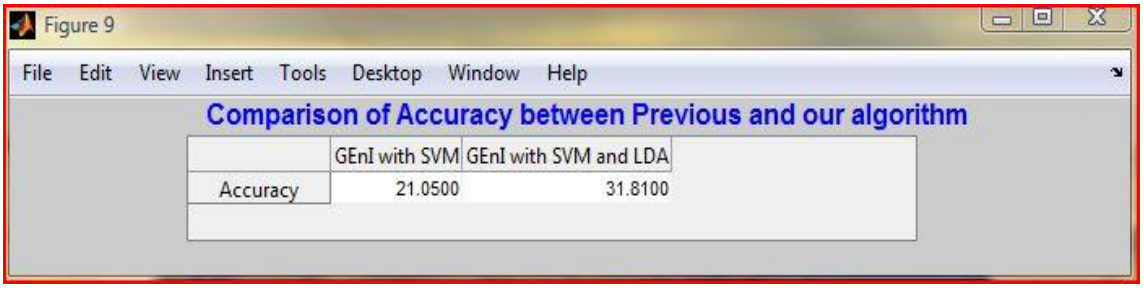


Figure 24: The accuracy value of GenI with SVM and LDA

This bar graph in figure 25 shows comparison of accuracy between base paper technique i.e., GEnI (Gait Entropy Intensity) with SVM and GEnI with SVM and LDA. Accuracy of proposed technique is better in comparison to previous technique as can be seen from bar graph. The values are same as shown in above table.For bar graph we use bar command in MATLAB.

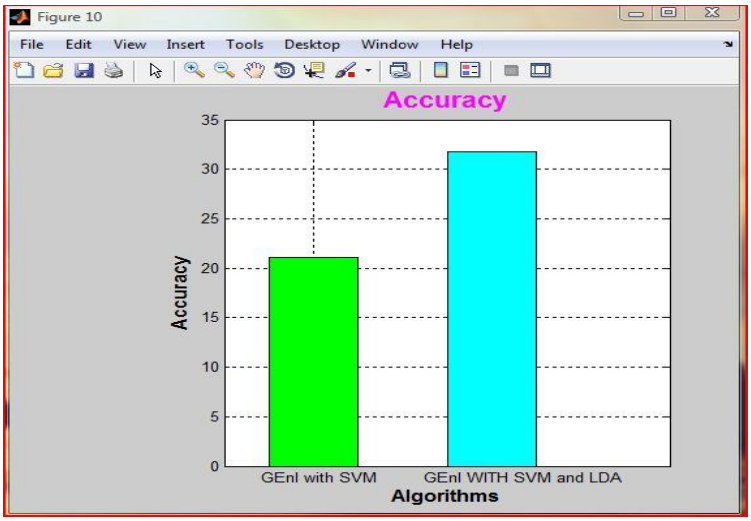


Figure 25: Accuracy graph of GenI with SVM and LDA

CONCLUSION

In this we conclude that to analyze the video streams from surveillance cameras of a person i.e. if a person walks by the camera who's gait has been previously recorded and it is a known threat then the system will recognize him and the concerned authorities can be alerted automatically so that the person can be detected before he is allowed to become a threat. The threat can be detected from a distance, creating the time buffer for authorities to take action.

Also in this work we use Gaussian mixture model for foreground object estimation in which an extra step regarding filtering through median filter can be involved to eliminate noise. Moving target classification algorithm is used to separate human being (i.e., pedestrian) from other foreground objects (viz., vehicles). Shape and boundary information is used for this moving target classification. The width vector of outer contour of binary silhouette and Gait PAL AND PAL ENTROPY coefficients for extracting the feature vector are used and these feature vectors extracted are used to recognize individual. Surf Feature is used for recognizing persons based on gait. The parameters like distance between head and feet, distance between hands and distance between legs are calculated. Finally SVM and LDA results are calculated which is far better in comparison to previous research paper.

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