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A PROJECT REPORT ON

"Anomalous Event Detection in Video"

Submitted in the partial fulfillment of the requirement for the award of

Bachelor of Engineering

In

Information Science and Engineering

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CERTIFICATE

This is to certify that the project work entitled "Anomalous Event Detection in Video" is a bonafide work carried out by ABHILASH NIGAM (1DT12IS003), DALAL FENIL (1DT12IS013), FLYN SEQUEIRA (1DT12IS016) and RAMAKRISHNAN S (1DT12OS036), in partial fulfillment for the requirement of VIII semester, Bachelor of Engineering in Information Science & Engineering of Visvesvaraya Technological University, Belagavi during the year 2015-2016. It is certified that all corrections / suggestions indicated for the internal assessment have been incorporated in the report. This report has been approved as it satisfies the academic requirements in respect of project work prescribed for Bachelor of Engineering Degree.

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ABSTRACT

Observing and modeling human behavior and activity patterns for recognition or detection of anomalous events has gained significant research interest in recent years, particularly in the video surveillance community. An anomalous event might be characterized as an event that deviates from the normal or usual, but not necessarily in an undesirable manner. One of the main challenges of detecting such events is the difficulty to create models due to their unpredictability. Most digital video surveillance systems rely on human observation, which are naturally error prone. This only validates the rising demand of analysis of video surveillance. The system being proposed here is of minimum requirements with a competitive computational power when compared to the existing ones. The main objective of this research work is to build up a framework that recognizes small group of human and to detect the event in the video.

A combination of feature extraction using Histogram of Oriented Gradient (HOG) and feature reduction with Principle Component Analysis (PCA) is proposed in this methodology. The knowledge base and video feed for test cases are classified using the Support Vector Machine (SVM) to categorize the event as either anomalous or not based on various parameters.

The experimental analysis demonstrates that this approach is able to detect anomalous events with a competitive success rate. The framework can be used to identify various events such as abnormal event detection, person identification, gender classification, fall detection of elderly people and so on.

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CHAPTER 1

INTRODUCTION

1.1 Overview

Over the recent years, detecting human beings and recognizing events in a video scene of a surveillance system is attracting more attention due to its wide range of applications in abnormal event detection, human gait characterization, person counting in a dense crowd, person identification, gender classification, fall detection for elderly people, etc. The scenes obtained from surveillance video are usually with low resolution. Most of the scenes captured by a static camera are with minimal change of background. Objects in the outdoor surveillance are often detected in far field. Most exciting digital video surveillance systems rely on human observers for detecting specific activities in a real-time video scene. However, there are limitations in the human capability to monitor simultaneous events in a surveillance displays. Hence, human event analysis is automated video surveillance has become one of the most active and attractive research topics in the area of computer vision and pattern recognition.

An intelligent system detects and captures motion information of moving targets for accurate object classification. The classified object is being tracked for high level analysis. In this study, it focuses on detecting humans and to consider recognition of their complex activities. Human detection is a difficult task for a machine vision perspective as it is influenced by a wide range of possible appearance due to changing articulated pose, clothing, lighting, and background, but prior knowledge on these limitations can improve the detection performance.

New video cameras are installed daily all around the world, as webcams, for surveillance, or for multitude of other purposes. As this happens, it becomes increasingly important to develop methods that process such data streams automatically and in real-time, reducing the manual effort that is still required for video analysis. Of particular interest for many applications is the behavior of persons, e.g., for traffic safety, surveillance, or sports analysis. As most tasks at semantically higher level are based on trajectory information, it is crucial to robustly detect and track people in dynamic and complex real-world scenes. However, most exciting multi person tracking methods re still limited to special applications scenarios.

However, most existing multi-person tracking methods are still limited to special application scenarios. They require multi-camera input, scene specific knowledge, a static background, or depth information, or are not suitable for online processing.

The main challenge when using an object detector for tracking is that the detector output is unreliable and sparse, i.e. detectors only deliver a discrete set of responses and usually yield false positives and missing detections. Thus, the resulting association problem between detections and targets is difficult.

Several recent algorithms address this problem by optimizing detection assignments over a large temporal window is an offline step [1], [2], [3], [4]. They use information from future frames and locate the targets in the current frame with a temporal delay or after the entire sequence have been observed. In contrast, sequential Monte Carlo methods offer a framework for representing the tracking uncertainty in a casual manner. By only considering information from past frames, such approaches are more suitable for time-critical, online applications.

Moreover, there may be both individual and gathering activity in the same scene, it is much harder to speak to and receive such situations. Punctuation models have been generally utilized as a part of the complex visual occasion acknowledgment lately. To apply sentence structure in models or occasion acknowledgment, normally low-level components are firstly removed from features and after that characterized to an arrangement of terminal images, i.e., visual occasion primitives.

In a video like group of humans present, recognizing the human activities is not an easy task, the human activities in the videos consist of number of frames and each frame may have the different events or action such as hug, kick, punch and normal activities and so on. Unsupervised classifiers are used for learning method and labels are known, hence the instance such as kick, hug, punch, or any such features are extracted and events are detected. Before detecting the events the people in the video are detected and tracked to find group formation. The proposed work is used to represent both individual and group events, hence it overcomes the drawback of existing system, and it is based on cognitive linguistic method which uses unsupervised learning method.

1.2 Objective

The main objective of this research work is to build up a framework that recognizes the small human group and to detect the event in the video. This framework is utilized for robotized little human gathering occasion discovery inside of social or open spot environment furthermore serves to recognize a fording wrongdoing, in places like Railway station, traffic, collages, office, etc.

(a) Stadium

(b) Shopping Mall

(c) Airport

(d) University Pass

Figure 1.0 Different scenario that might be analyzed through anomalous event detection.

1.3Applications

Anomaly detection has a wide variety of applications. It has huge potential in the field of surveillance. Although video footage capturing devices are more affordable and popular in today's world, availability of human resources to monitor and analyse the footage is quite limited and sometimes not cheap. In many situations where surveillance cameras are used, it is common to find poor monitoring due to human factors like fatigue. An automated system will aid in overcoming such human errors. Events such as trespassing can be alerted immediately when an automated system is placed. Detection of non-human objects in unexpected places aids in betterment of security measures. It helps in person counting in densely crowded places such as those shown in Figure 1.0. An automated anomaly detection system may aid in fall detection in the homes of the elderly. Traffic safety is one of the major applications of anomaly detection. Detection of speeding vehicles or reporting drivers breaking the law immediately can be achieved using an anomaly detection system. Another growing field is in sports analysis where an automated system might alert the referee or judge in case of actions which may otherwise be overlooked.

1.4Problem Statement

Detecting human being and recognizing event in a video scene of a surveillance is attracting more attention due to its wide range of applications in abnormal event detection, human gait characterization, person counting in a dense crowd, person identification, gender classification, fall detection, etc.

The proposed work is used to represent both individual and multiple individuals in an event, hence it overcomes the drawback of existing system, and it is based on cognitive linguistic method which uses unsupervised learning method. This work investigates system capable to detect events automatically in video surveillance applications reducing or surpassing human interaction with the system and reporting alerts based on the events detected.

1.5 Proposed Methodology

The image is input into the training database. This RGB Frames is further preprocessed by reducing noise using mathematical morphological method and converting to Grayscale. Features are extracted using HoG methodology and reduced using PCA. These resultant are stored in a file which is trained using SVM classification.

On the other hand the testing dataset is converted to frames, preprocessed, and their absolute difference is evaluated to distinguish background from foreground. Further morphological operation takes place to reduce noise, followed by Feature extraction using HoG and PCA and classified using the SVM Classifier.The key techniques used are

1. Preprocessing
2. Feature Extraction and Reduction using HoG and PCA

3. Support Vector Machine Classifier

CHAPTER 2

LITERATURE SUVEY

1. Zhaozhuo Xu, Yuan Tian, XinjueHu, Fangling Pu, "Dangerous Human Event Understanding using Human-Object Interaction Model" in ICSPCC, 2015 IEEE Conference on, September 2015, pp. 1-5

The authors introduce a Human-Object Interaction model, and are able to establish methods and systems to recognize events that are dangerous. In this approach, the process of event understanding is based on identifying dangerous objects in possible areas predicted by human body parts. The accuracy of dangerous human events understanding is improved when human body parts estimation is combined with objects detection.

2. Oluwatoyin P. Popoola,Kejun Wang, "Video-Based Abnormal Human Behavior Recognition—A Review" IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews), January 2012, pp. 865 – 878

This paper presents an update to extending previous related surveys and also a focus on contextual abnormal human behavior detection especially in video surveillance applications. The main purpose of this survey is to extensively identify existing methods and characterize the literature in a manner that brings key challenges to attention.

3. Dongping Zhang, Feiyu Chen, Chao Tong , "Particle Motion-based Abnormal Events Detection in Group-Level Crowd" Journal of Convergence Information Technology, Volume 7, November 14, 2012

This paper presents an approach to identify group level crowds and detect any abnormal activities in them. It incorporates particle motion information calculated using a set of sample images with long trajectories and other properties, into identifying small human crowds in foreground images while in motion. Science of Human behaviour is studied and employed to detect normal and abnormal activity. Attributes such as orientation, velocity and crowd size are used to distinguish between normal and abnormal behaviour.

4. R. V. H. M. Colque, C. A. C. Júnior, and W. R. Schwartz, "Histograms of Optical Flow Orientation and Magnitude to Detect Anomalous Events in Videos" in Graphics, Patterns and Images (SIBGRAPI), 2015. 28thSIBGRAPI Conference. IEEE Conference on, August 2015, pp. 126 – 133

This paper proposes a new feature descriptor called Histogram of optical flow orientation and magnitude based on the existing HOOF feature descriptor. The new descriptor uses both the optical flow information and magnitude to better define the input images. The new method behaves competitively with all the existing systems for anomaly detection.

5.R. Raghavendra, A. Del Bue, M. Cristani and V. Murino, "Optimizing interaction force for global anomaly detection in crowded scenes", Proc. IEEE Int. Conf. Comput. Vis. Workshops (ICCVW), pp. 136-143

This paper presents a novel method for global anomaly detection in crowded scenes. The proposed method introduces the Particle Swarm Optimization (PSO) method as a robust algorithm for optimizing the interaction force computed using the Social Force Model (SFM). The main objective of the proposed method is to drift the population of particles towards the areas of the main image motion.

<u>DISADVANTAGES</u>**:-**

- Error rates increases with increase in the distance.

<u>ADVANTAGES</u>**:-**

- It does not require the tracking of individuals nor to perform a learning stage.
- Low computational cost.

6.Mahadevan, W. Li, V. Bhalodia, and N. Vasconcelos, "Anomaly detection in crowded scenes", in Proc. IEEE Conf. Comput. Vis. Pattern Recognit. (CVPR), Jun. 2010, pp. 1975–1981

The detection and localization of anomalous behaviors in crowded scenes is considered, and a joint detector of temporal and spatial anomalies is proposed. The proposed detector is based on a video representation that accounts for both appearance and dynamics, using a set of mixture of dynamic textures models.

DISADVANTAGES:–

- Defines a normalcy dataset anything not in it is an anomaly.
- Time to process each frame is 25 secs/frame.

ADVANTAGES :–

- Anomaly detector that spans time, space, and spatial scale.
- It produces very salient changes in the average motion intensity of the scene.

7. H. M. H. Teodorescu and D. J. Malan, "Swarm filtering procedure and application to MRI mammography", Polibits, vol. 42, no. 42, pp. 59–64, 2010.

This paper is to investigate the use of biologically-inspired swarm methods for signal filtering. The signal, in the case of images the grayscale value of the pixels along a line in the image, is modelled by the trajectory of an agent playing the role of the prey for a swarm of hunting agents.

DISADVANTAGES: –

- Needs trained personnel to operate.

ADVANTAGES:–

- Can repair damaged tissue without a surgery.
- Can cure many diseases.

8.VagiaKaltsa, Student Member, IEEE, Alexia Briassouli, Member, IEEE, IoannisKompatsiaris, Senior Member, IEEE, Leontios J. Hadjileontiadis, Senior Member, IEEE, and Michael GerasimosStrintzis, Fellow, IEEE "Swarm Intelligence for Detecting Interesting Events in Crowded Environments"

The paper proposed a novel framework for anomaly detection in different scenarios, recorded from static surveillance cameras. Swarm intelligence is exploited for the extraction of robust motion characteristics and together, with appearance features, form a descriptor capable of effectively describing each scene.

9. MyoThida, Yoke Leng Yong, Pau Climent-Pérez, How-lung Eng, Paolo Remagnino, "A Literature Review on Video Analytics of Crowded Scenes", Intelligent Multimedia Surveillance, 2013

The authors present a review of crowd video analysis in this paper. Automation of surveillance has become in crowded places such as shopping malls, railway stations and airports. Providing intelligent solutions to these places is of high priority to computer researchers. The paper provides a thorough review of the existing automation techniques for analyzing complex and crowded scenes.

The merits and demerits of the various modern methods are discussed in detail. Tracking individuals in a crowd is a major topic. It is a highly complex task due to interactions with various other objects present in the crowd.

10. M.Sivarathinabala, S.Abirami, "An Intelligent Video Surveillance Framework for Remote Monitoring", IJESIT Volume 2, Issue 2, March 2013

In this paper the authors propose an intelligent video surveillance system, which can be remotely monitored and alerts the user in a situation that the system may interpret as an anomaly. The main focus is on monitoring a single person in situations such as a burglary.

A live video is captured and reduced to images. The images undergo preprocessing. Human behaviour analysis plays an important role to detect any anomalous human activity. This is done by comparing existing sample templates with the processed image. If found, the image is stored in the system and an alert is sent as specified by the user either to MMS, SMS or email. The live video is then compressed and a key frame is specified to directly retrieve the required part of the video.

This paper concludes by providing an automated method for surveillance that not only identifies an anomaly but also triggers an alert to the user. It helps in retrieval of the suspected video by holding key frame values and help in extracting of images of individuals before and after the incident.

11. Manoranjan Paul, Shah M E Haque, Subrata Chakraborty, "Human detection in surveillance videos and its applications – A review", Journal on Advances in Signal Processing 2013

The paper throws light on the need for accurately detecting anomalies in videos and its applications in surveillance technologies. Detecting human beings and their actions accurately in a video has various applications such as person identification, fall detection for elderly people, event classification and gender classification.

The authors use the benchmarks set by few existing datasets for comparison and providing their assessment. An intelligent system can capture and detect moving objects in a video. In this study the authors focus on detecting only human beings in general. This in itself is a complex task due to the number of various attributes each person may have such as, clothing, pose, lighting and background.

Detecting objects in a surveillance video is a challenging task due to the low resolution of the video. This paper discusses different methods of object identification and object classification. The various benchmarks are discussed and the applications of human detection in surveillance videos are reviewed.

12. C. Stauffer and W. E. L. Grimson, "Adaptive background mixture models for real-time tracking," in Proc. IEEE Int. Conf. Computer. Vis. Pattern Recognit ., vol. 19. Jun. 1999, pp. 23–25.

Computer vision algorithmproposed for detecting or analyzing the motion of people in crowds. Computer vision algorithm divide background in regions and track the crowds and analyses every movement of people.

13. D. Ryan, S. Denman, C. Fookes, and S. Sridharan, "Scene invariant crowd counting for real-time surveillance," in Proc. IEEE 2nd Int. Conf. Signal Process. Common. Syst., Dec. 2008, pp. 1 – 7.

Scene independent approach that can count the no of people in the crowd. A scene independent counting system can easily be deployed at different place. The counting is been done using a global scaling factor to relate crowd size from one scene to another.

14. M. Cheriyadat and R. J. Radke, "Detecting dominant motions in dense crowds," IEEE J. Sel. Topics Signal Process. vol. 2, no. 4 , pp. 568–581, Aug. 2008.

Thisapproach is used to detect abnormal situations in crowded scenes by analyzing the motion .This detect sudden change and abnormal motion variations of a set of point of interest. A techniques is use in Motion based approach is Optical flow technique. Optical flow techniquesis use to extract information such as density, direction and velocity

15. Mykhaylo Andriluka Stefan Roth Bernt Schiele "People-Tracking-by-Detection and People-Detection-by-Tracking"Computer Science Department, TU Darmstadt, Germany

Detection and tracking people are challenging problems, especially in complex real world scenes that commonly involve multiple people, complex, cluttered or even moving backgrounds. Detectors have been shown to be able to detect pedestrians but with many false positives. Person Identification has also remained a challenge. Tracking methods have been able to identify a person in different frames.

This paper combines the advantage of Detection and Tracking by approximately articulating each person, detected in every frame, based on local features that model the appearance of individual body part. This is modelled using a hierarchical Gaussian process latent variable model (hGPLVM). The paper shows how the combination of these results leads to better articulation and position of the person in subsequent frames, and presents experimental results for the same.

16. Jerome BerclazFrancois Fleuret "Pascal Fua Robust People Tracking with Global Trajectory Optimization" EPFL – CVLAB CH – 1015 Lausanne, Switzerland

The paper uses dynamic programming to upto 6 individuals across 1000 frames, from three or four synchronized videos taken at eye level and from different angles, despite significant occlusions.

It also derives metrically accurate trajectories for each one of them.

The paper shows that it is possible to track multiple individuals reliably, under the condition of providing the right heuristic ranking to the individuals, to avoid confusing them with one another. Hence, achieve robustness by finding optimal trajectories over many frames while avoiding the combinatorial explosion that would result from simultaneously dealing with all individuals.

CHAPTER 3

SYSTEM DESIGN

3.1 Overview

The following image represents the system architecture which is further broken down into a clear flowchart in the later segments. The architecture as described in the image consists of a testing phase and a training phase. In the training phase, the training video is added into the knowledge base after preprocessing, feature extraction and reduction. This dataset is classified into either normal or abnormal event using SVM Classifier. The testing set of the video, which goes through the same operations are classified as abnormal or normal by comparing it to the sample frames of the training videos that are classified already. The output classifies each frame to be either “Normal” or “Abnormal”.

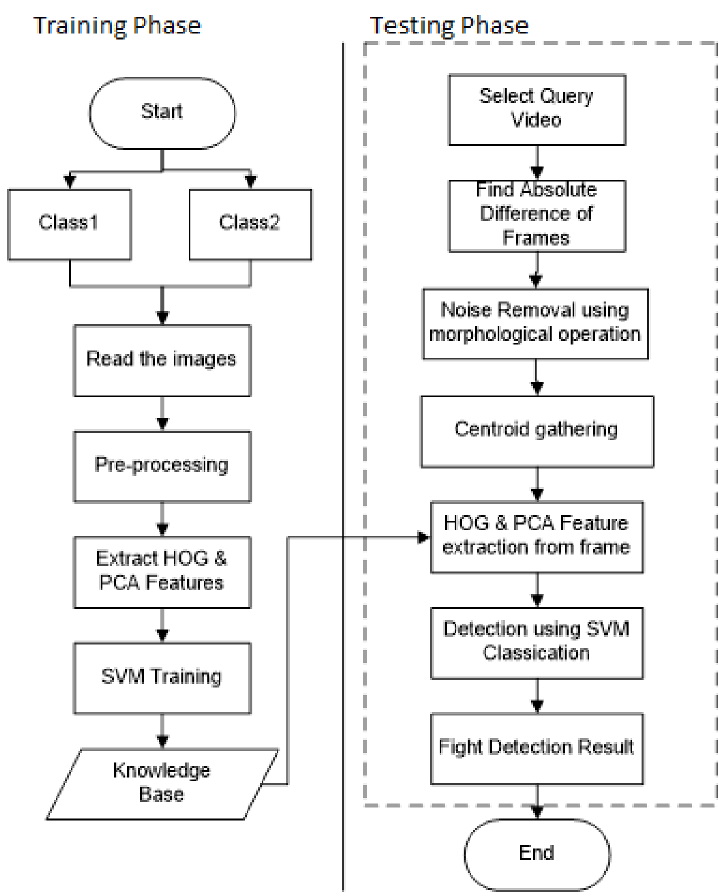

Figure 3.1 Overall flow chart of the proposed system

3.2 Preprocessing

Initially the given video is converted into frames. The converted frames are used for further processing. In pre-processing unnecessary noise in the frames are eliminated. In order to get a more accurate difference between the background and the foreground, the image needs to have lesser noise.

Edge detection is an important aspect in image processing. When a noisy image is presented for edge detection, the noise creates problem in the process of edge detection using conventional methods. One of the disadvantages of the conventional methods is that the noise is not removed automatically. A better approach for noise removal cum edge detection for both grey scale and binary images would be the use of morphological operations. [7]

3.3 Feature Extraction

The main purpose of feature extraction is the extraction of image component and separating the foreground from the background through HOG feature extraction and further reducing the obtained attributes by the method of PCA. This helps in providing faster time for analysis due to a better predictive model, with many similar attributes reduced to a single attribute.

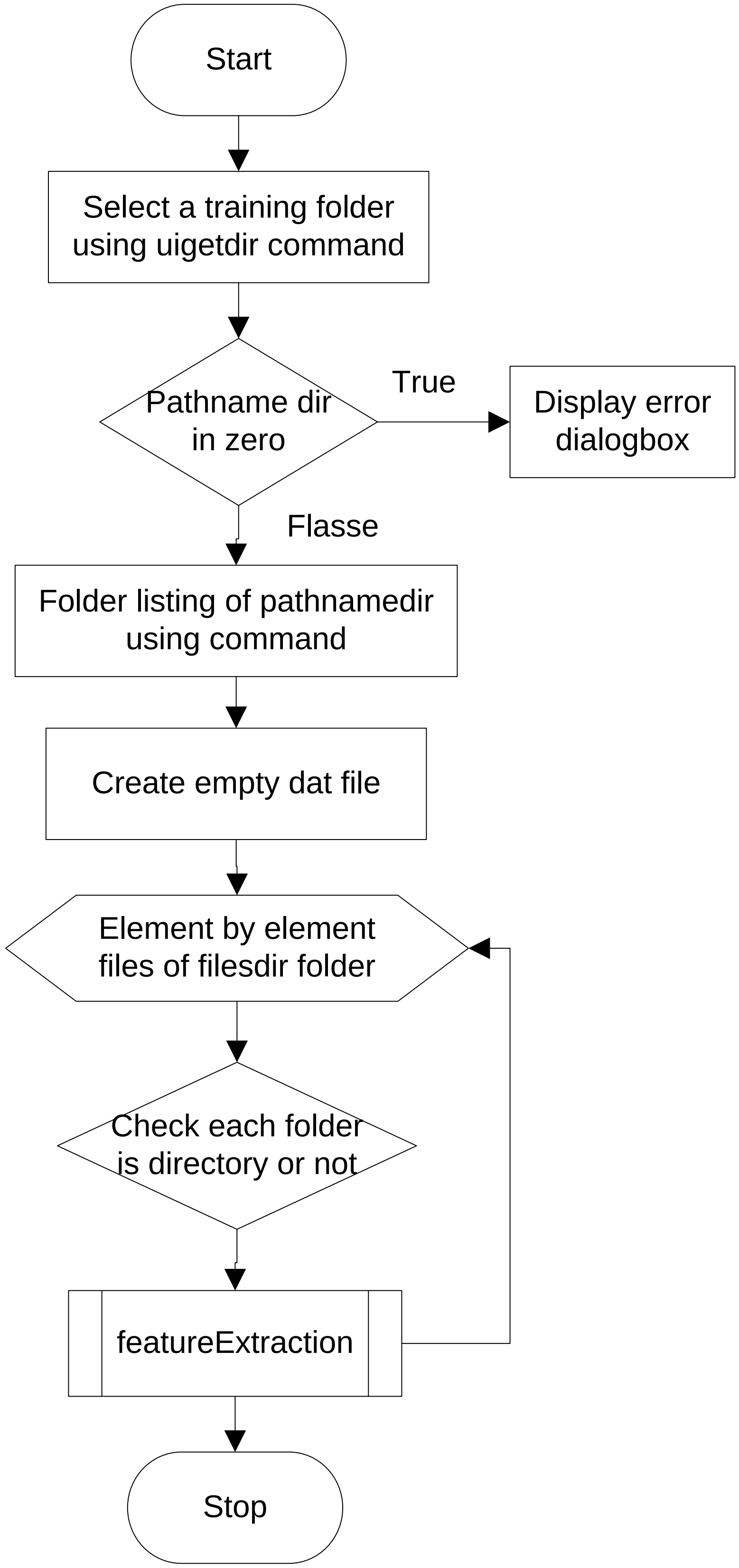

Figure 3.2 Feature Collection

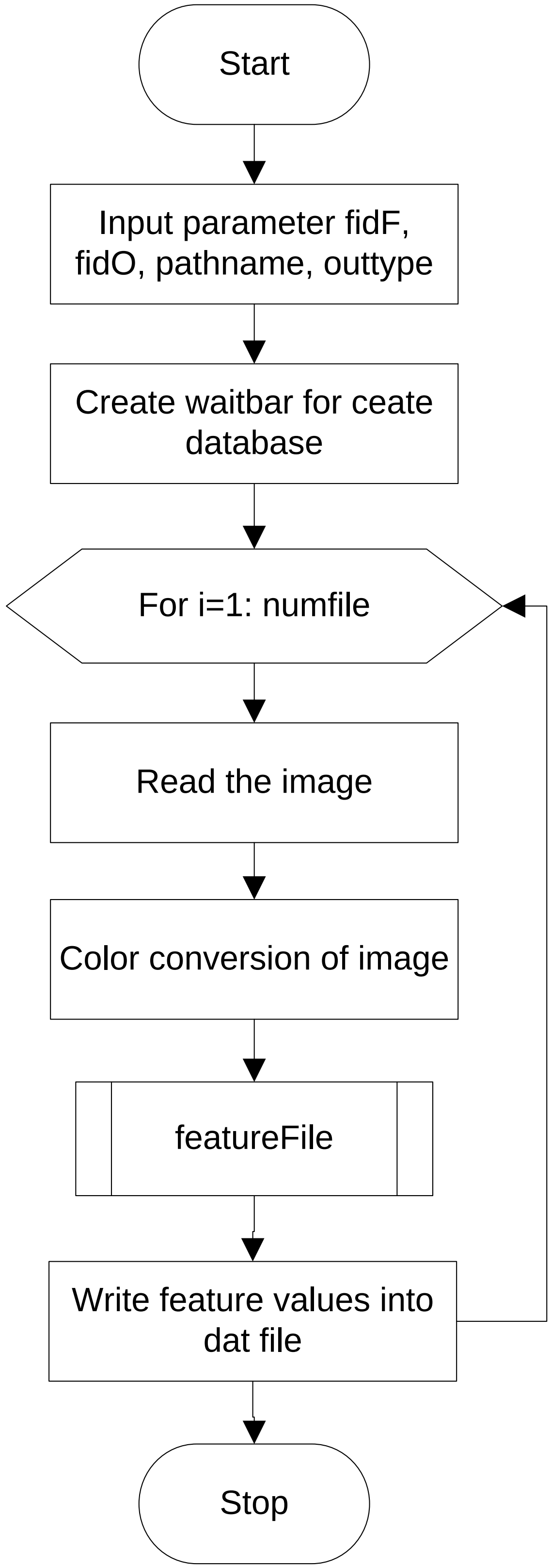

Figure 3.3 Feature Extraction

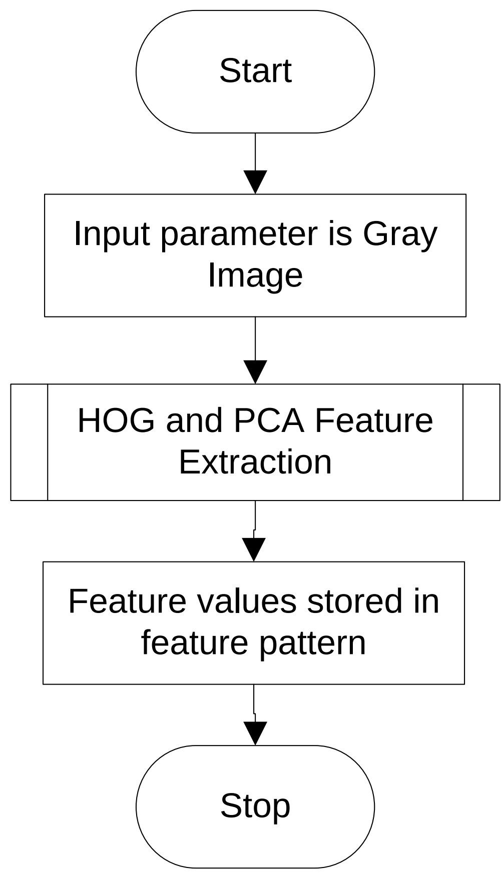

Figure 3.4 FeatureFile Subroutine that Performs HOG and PCA feature extraction/reduction

3.3.1 Histogram of Oriented Gradients

Histogram of oriented gradients is a feature descriptor used in image processing for detecting objects. The technique counts occurrences of gradient orientation in localized portions of an image.

The local object appearance and shape within an image can be described by the distribution of intensity gradients or edge directions. Histogram differentiates these attributes to detect objects in the image. The image is divided into small connected regions called cells, and for the pixels within each cell, a histogram of gradient directions is compiled. The descriptor is the concatenation of these histograms. For improved accuracy, the local histograms can be contrast-normalized by calculating a measure of the intensity across a larger region of the image, called a block, and then using this value to normalize all cells within the block. This normalization results in better invariance to changes in illumination and shadowing.

The HOG descriptor has a few key advantages over other descriptors. Since it operates on local cells, it is invariant to geometric and photometric transformations, except for object orientation. Such changes would only appear in larger spatial regions. Moreover, as Dalal and Triggs discovered, coarse spatial sampling, fine orientation sampling, and strong local photometric normalization permits the individual body movement of pedestrians to be ignored so long as they maintain a roughly upright position. The HOG descriptor is thus particularly suited for human detection in images.

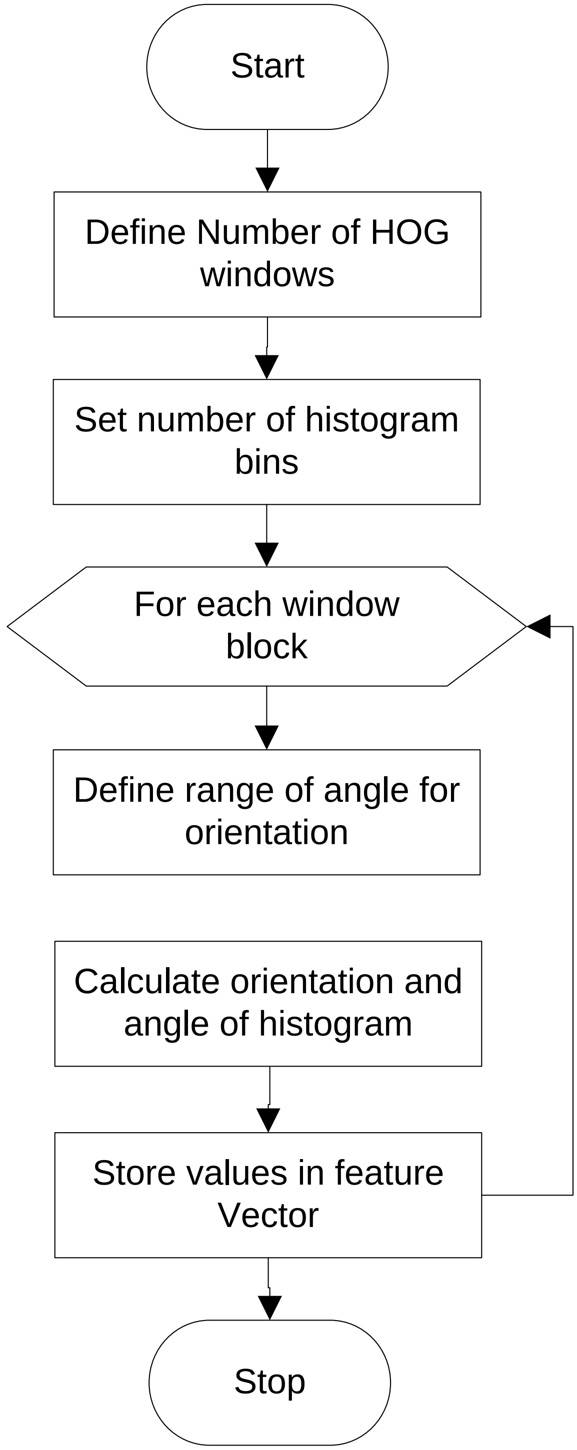

Figure 3.5 HOG Feature Extraction

3.3.2 Principal Component Analysis

Principal component analysis is central to the study of multivariate data. Although one of the earliest multivariate techniques, it continues to be the subject of much research, ranging from new model-based approaches to algorithmic ideas from neural networks. It is extremely versatile, with applications in many disciplines.

PCA is mathematically defined[8] as an orthogonal linear transform that transforms the data to a new coordinated system such that the greatest variance by some projection of the data comes to lie on the first coordinate (called the first principal component), the second greatest variance on the second coordinate, and so on.

PCA applied to image processing in this particular project to reduce the orientation values of HOG that are stored. This helps in improved performance and faster detection and analysis of objects in the frames

3.4 Support Vector Machine Classifier

Support Vector Machines (SVM) recently became one of the most popular classification methods. [11] They have been used in a wide variety of applications such as text classification [8], facial expression recognition [10], gene analysis [7] and many others. Support Vector Machines can be thought of as a method for constructing a special kind of rule, called a linear classifier, in a way that produces classifiers with theoretical guarantees of good predictive performance (the quality of classification on unseen data). The theoretical foundation of this method is given by statistical learning theory [12].

3.4.1 SVM Classification using “KERNAL TRICKS”

Kernel techniques have long been used in SVM to handle linearly inseparable problems by transforming data to a high dimensional space, but training and testing large data sets is often time consuming. In contrast, we can efficiently train and test much larger data sets using linear SVM without kernels. It is possible apply fast linear-SVM methods to the explicit form of polynomially mapped data and investigate implementation issues. The approach enjoys fast training and testing, but may sometimes achieve accuracy close to that of using highly nonlinear kernels. Empirical experiments show that the proposed method is useful for certain large-scale data sets. We successfully apply the proposed method to a natural language processing (NLP) application by improving the testing accuracy under some training/testing speed requirements. [6]

3.4.2 Radial Basis Kernal Function for SVM Classification of Images

In machine learning, the (Gaussian) radial basis function kernel, or RBF kernel, is a popular kernel function used in various kernelized learning algorithms. In particular, it is commonly used in support vector machine classification. Further, the best solution to classify images would be to use RBF kernals. [7]

The RBF kernel on two samples **x** and **x'**, represented as feature vectors in some *input space*, is defined as

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

$||\mathbf{x} - \mathbf{x'}||^2$ may be recognized as the squared Euclidean distance between the two feature vectors. σ is a free parameter. An equivalent, but simpler, definition involves a parameter $\gamma = \frac{1}{2\sigma^2}$:

$$K(\mathbf{x}, \mathbf{x'}) = \exp(-\gamma||\mathbf{x} - \mathbf{x'}||^2)$$

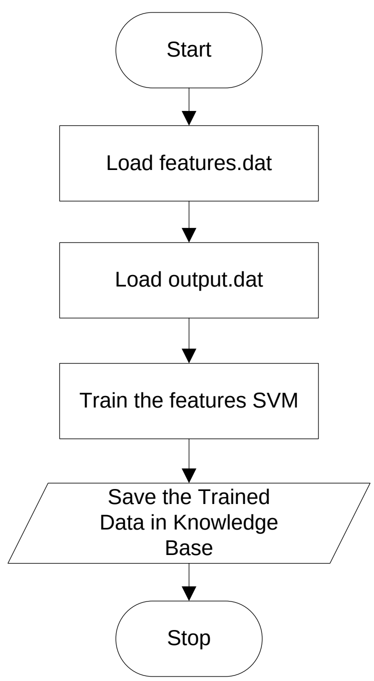

Figure 3.6 SVM Training

As shown in Figure 3.6, we use SVM training loading the extracted features which are stored in features.dat. The output frames loaded in output.dat is compared to the trained features that are stored in the knowledge base.

3.5 Data Flow

The following image represents the system architecture which is further broken down into a clear data flow diagram. The architecture as described in the image consists of a testing phase and a training phase. In the training phase, the training video is added into the knowledge base after preprocessing, feature extraction and reduction. This dataset is classified into either normal or abnormal event using SVM Classifier. The testing set of the video, which goes through the same operations are classified as abnormal or normal by comparing it to the sample frames of the training videos that are classified already. The output classifies each frame to be either “Normal” or “Abnormal”.

In figure 3.7, two phases of data flow are considered. The image is read in RGB Frame format. In the preprocessing stage, the data is converted to gray scale format. This resultant format is used for feature extraction using HOG and PCA features. The features that are extracted are trained using SVM and the trained data is stored in the knowledge base and used for classifying the data under the SVM. The input data falls under any of the categories under this SVM Classification.

In the testing phase, the video read is broken down into frames. The frame with only the background is used for subtracting the further frames containing an object (or a foreground), to leave out only the foreground. This is done by finding their Absolute difference. On the difference blocks, a morphological operation takes place. This is basically the noise reduction stage. Feature extraction takes place on the noise free images. The feature extraction procedures include HOG & PCA Features. These features fall under a classification trained under the SVM, as explained earlier.

In the current project, the SVM classifies data as either Normal or Anomalous (Abnormal). The detected region and recognition result is displayed along with the frame.

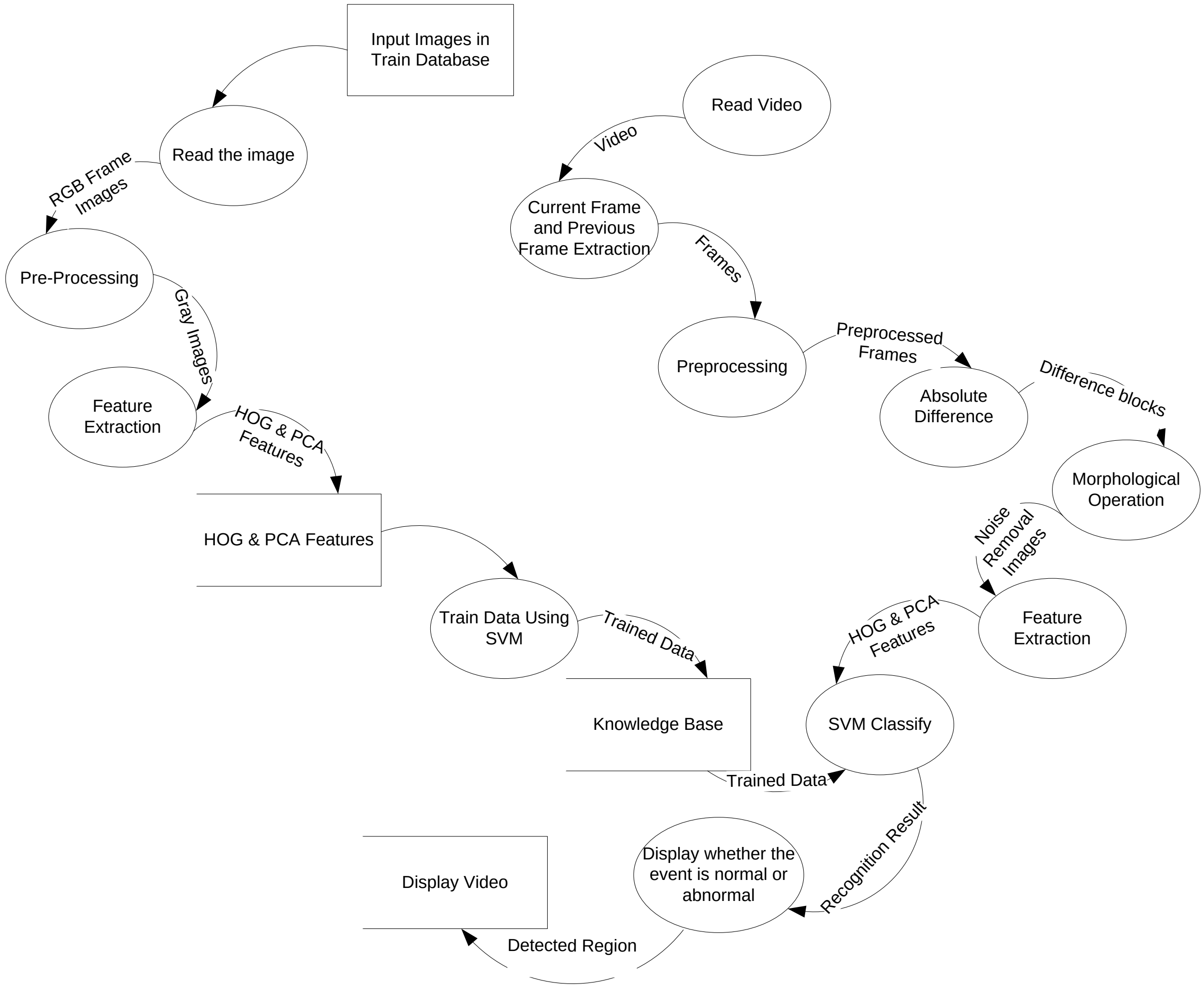

Figure 3.7 Data Flow Diagram

CHAPTER 4

IMPLEMENTATION

4.1 HARDWARE REQUIREMENT

Minimum Requirements

Intel Pentium dual core and above OR AMD Athlon and above

2 GB RAM

No Graphic Processer required for this algorithm to run

6 GB of free space

Recommended Requirements

Intel 2nd gen i5 or AMD Phenom 2 X4 and above

3 GB RAM

10 GB free space

4.2 SOFTWARE REQUIREMENTS

Windows XP/ Linux Distro that supports matlab/ OS X Mountain Lion and Above

Matlab R2010a

C++ distributions to run SVM classification

4.3 MATLAB

MATLAB (matrix laboratory) is a multi-paradigmnumerical computing environment and fourth-generation programming language. Developed by Math Works, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java, and Fortran.

MATLAB is an interactive system for doing numerical computations. A numerical analyst called Cleve Moler wrote the first version of MATLAB in the 1970's. It has since evolved into a successful commercial software package. MATLAB relieves you of a lot of the tasks associated with problems solving numerically. This allows you to spend more time thinking, and encourages you to experiment. MATLAB makes use of highly respected algorithms and hence you can be confident about your results. Powerful operations can be performed using just one or two commands. You can build up your own set of functions for a particular application. Excellent graphics facilities are available, and the pictures can be inserted into LATEX and Word document.

MATLAB is an interactive environment and programming language for numeric scientific computation. It will allow you to solve many technical computing problems, especially those with matrix and vector formulations. One of its distinguishing features is the use of matrices as the only data type.

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problem and solutions are expressed familiar mathematical notation. Typical uses include,

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation.

Typical uses include

• Math and computation

• Algorithm development

• Data acquisition

• Modeling, simulation, and prototyping

• Data analysis, exploration, and visualization

• Scientific and engineering graphics

• Application development, including graphical user interface building

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non interactive language such as C or Fortran. The name MATLAB stands for matrix laboratory. MATLAB was originally written to provide easy access to matrix software developed by the LINPACK and EISPACK projects. Today, MATLAB engines incorporate the LAPACK and BLAS libraries, embedding the state of the art in software for matrix computation.

MATLAB has evolved over a period of years with input from many users. In university environments, it is the standard instructional tool for introductory and advanced courses in mathematics, engineering, and science. In industry, MATLAB is the tool of choice for high-productivity research, development, and analysis.

MATLAB features a family of add-on application-specific solutions called toolboxes. Very important to most users of MATLAB, toolboxes allow you to learn and apply specialized technology. Toolboxes are comprehensive collections of MATLAB functions (M-files) that extend the MATLAB environment to solve particular classes of problems. Areas in which toolboxes are available include signal processing, control systems, neural networks, fuzzy logic, wavelets, simulation, and many others. The MATLAB System

4.3.1 DESKTOP TOOLS AND DEVELOPMENT ENVIRONMENT

This is the set of tools and facilities that help you use MATLAB functions and files. Many of these tools are graphical user interfaces. It includes the MATLAB desktop and Command Window, a command history, an editor and debugger, a code analyzer and other reports, and browsers for viewing help, the workspace, files, and the search path.

4.3.2 MATLAB MATHEMATICAL FUNCTION LIBRARY

This is a vast collection of computational algorithms ranging from elementary functions, like sum, sine, cosine, and complex arithmetic, to more sophisticated functions like matrix inverse, matrix eigenvalues, Bessel functions, and fast Fourier transforms.

4.3.3 MATLAB LANGUAGE

This is a high-level matrix/array language with control flow statements, functions, data structures, input/output, and object-oriented programming features. It allows both "programming in the small" to rapidly create quick and dirty throw-away programs, and "programming in the large" to create large and complex application programs

4.3.4 GRAPHICS

MATLAB has extensive facilities for displaying vectors and matrices as graphs, as well as annotating and printing these graphs. It includes high-level functions for two-dimensional and three-dimensional data visualization, image processing, animation, and presentation graphics. It also includes low-level functions that allow you to fully customize the appearance of graphics as well as to build complete graphical user interfaces on the MATLAB applications.

4.3.5MATLAB EXTERNAL INTERFACES

This is a library that allows you to write C and Fortran programs that interact with MATLAB. It includes facilities for calling routines from MATLAB (dynamic linking), calling MATLAB as a computational engine, and for reading and writing MAT-files.

4.3.6 IMAGE PROCESSING TOOLBOX

Image Processing Toolbox provides a comprehensive set of reference-standard algorithms and graphical tools for image processing, analysis, visualization, and algorithm development. You can perform image enhancement, image deblurring, feature detection, noise reduction, image segmentation, spatial transformations, and image registration. Many functions in the toolbox are multithreaded to take advantage of multicore and multiprocessor computers.

Image Processing Toolbox supports a diverse set of image types, including high dynamic range, Gigapixel resolution, ICC-compliant color, and tomographic images. Graphical tools let you explore an image, examine a region of pixels, adjust the contrast, create contours or histograms, and manipulate regions of interest (ROIs). With the toolbox algorithms you can restore degraded images, detect and measure features, analyze shapes and textures, and adjust the color balance of images.

4.3.7 KEY FEATURES

- Image enhancement, filtering, and de-blurring. Image analysis, including segmentation, morphology, feature extraction, and measurement
- Spatial transformations and image registration
- Image transforms, including FFT, DCT, Radon, and fan-beam projection
- Workflows for processing, displaying, and navigating arbitrarily large images
- Modular interactive tools, including ROI selections, histograms, and distance measurements
- ICC color management
- Multidimensional image processing
- Image-sequence and video display
- DICOM import and export

4.3.8 IMPORTING AND EXPORTING IMAGES

Image Processing Toolbox supports images generated by a wide range of devices, including digital cameras, satellite and airborne sensors, medical imaging devices, microscopes, telescopes, and other scientific instruments. You can visualize, analyze, and process these images in many data types, including single- and double-precision floating-point and signed and unsigned 8-, 16-, and 32-bit integers.

There are several ways to import and export images into and out of the MATLAB environment for processing. You can use Image Acquisition Toolbox to acquire live images from Web cameras, frame grabbers, DCAM-compatible cameras, and other devices. Using Database Toolbox, you can access images stored in ODBC/JDBC-compliant databases.

MATLAB supports standard data and image formats, including JPEG, JPEG-2000, TIFF, PNG, HDF, HDF-EOS, FITS, Microsoft Excel, ASCII, and binary files. It also supports the multiband image formats BIP and BIL, as used by LANDSAT for example. Low-level I/O and memory mapping functions enable you to develop custom routines for working with any data format.

Image Processing Toolbox supports a number of specialized image file formats. For medical images, it supports the DICOM file format, including associated metadata, as well as the Analyze 7.5 and Interfile formats. The toolbox can also read geospatial images in the NITF format and high dynamic range images in the HDR format.

4.3.9 DISPLAYING AND EXPLORING IMAGES

Image Processing Toolbox extends MATLAB graphics to provide image display capabilities that are highly customizable. You can create displays with multiple images in a single window, annotate displays with text and graphics, and create specialized displays such as histograms, profiles, and contour plots.

In addition to display functions, the toolbox provides a suite of interactive tools for exploring images and building GUIs. You can view image information, zoom and pan around the image, and closely examine a region of pixels. You can interactively place and manipulate ROIs, including points, lines, rectangles, polygons, ellipses, and freehand shapes. You can also interactively crop, adjust the contrast, and measure distances. The suite of tools is available within Image Tool or from individual functions that can be used to create customized GUIs.

The toolbox includes tools for displaying video and sequences in either a time-lapsed video viewer or an image montage. Volume visualization tools in MATLAB let you create isosurface displays of multidimensional image data sets.

4.3.10 PREPROCESSING AND POSTPROCESSING IMAGES

Image Processing Toolbox provides reference-standard algorithms for preprocessing and postprocessing tasks that solve frequent system problems, such as interfering noise, low dynamic range, out-of-focus optics, and the difference in color representation between input and output devices.

Image enhancement techniques in Image Processing Toolbox enable you to increase the signal-to-noise ratio and accentuate image features by modifying the colors or intensities of an image. You can:

- Perform histogram equalization
- Perform decorrelation stretching
- Remap the dynamic range
- Adjust the gamma value
- Perform linear, median, or adaptive filtering

The toolbox includes specialized filtering routines and a generalized multidimensional filtering function that handles integer image types, offers multiple boundary-padding options, and performs convolution and correlation. Predefined filters and functions for designing and implementing your own linear filters are also provided.

Image de-blurring algorithms in Image Processing Toolbox include blind, Lucy-Richardson, Wiener, and regularized filter de-convolution, as well as conversions between point spread and optical transfer functions. These functions help correct blurring caused by out-of-focus optics, movement by the camera or the subject during image capture, atmospheric conditions, short exposure time, and other factors. All de-blurring functions work with multidimensional images.

Management in Image Processing Toolbox enables you to accurately represent color independently from input and output devices. This is useful when analyzing the characteristics of a device, quantitatively measuring color accuracy, or developing algorithms for several different devices. With specialized functions in the toolbox, you can convert images between device-independent color spaces, such as sRGB, XYZ, xyY, L*a*b*, uvL, and L*ch.

For more flexibility and control, the toolbox supports profile-based color space conversions using a color management system based on ICC version 4. For example, you can import n-dimensional ICC color profiles, create new or modify existing ICC color profiles for specific input and output devices, specify the rendering intent, and find all compliant profiles on your machine.

Image transforms such as FFT and DCT play a critical role in many image processing tasks, including image enhancement, analysis, restoration, and compression. Image Processing Toolbox provides several image transforms, including Radon and fan-beam projections. You can reconstruct images from parallel-beam and fan-beam projection data (common in tomography applications). Image transforms are also available in MATLAB and Wavelet Toolbox.

Image conversions between data classes and image types are a common requirement for imaging applications. Image Processing Toolbox provides a variety of utilities for conversion between data classes, including single- and double-precision

floating-point and signed or unsigned 8-, 16-, and 32-bit integers. The toolbox includes algorithms for conversion between image types, including binary, gray scale, indexed color, and truecolor. Specifically for color images, the toolbox supports a variety of color spaces (such as YIQ, HSV, and YCrCb) as well as Bayer pattern encoded and high dynamic range images.

4.3.11 ANALYZING IMAGES

Image Processing Toolbox provides a comprehensive suite of reference-standard algorithms and graphical tools for image analysis tasks such as statistical analysis, feature extraction, and property measurement.

Statistical functionslet you analyze the general characteristics of an image by:

- Computing the mean or standard deviation
- Determining the intensity values along a line segment
- Displaying an image histogram
- Plotting a profile of intensity value

Edge-detection algorithms let you identify object boundaries in an image. These algorithms include the Sobel, Prewitt, Roberts, Canny, and Laplacian of Gaussian methods. The powerful canny method can detect true weak edges without being "fooled" by noise.

Image segmentation algorithms determine region boundaries in an image. You can explore many different approaches to image segmentation, including automatic thresholding, edge-based methods, and morphology-based methods such as the watershed transform, often used to segment touching objects.

Morphological operators enable you to detect edges, enhance contrast, remove noise, segment an image into regions, thin regions, or perform skeletonization on regions. Morphological functions in Image Processing Toolbox include:

- Erosion and dilation
- Opening and closing
- Labeling of connected components
- Watershed segmentation
- Reconstruction
- Distance transform

Image Processing Toolbox also contains advanced image analysis functions that let you:

- Measure the properties of a specified image region, such as the area, center of mass, and bounding box
- Detect lines and extract line segments from an image using the Hough transform
- Measure properties, such as surface roughness or color variation, using texture analysis functions

1. Math and computation
2. Algorithm development
3. Data acquisition

4. Modeling, simulation, and prototyping
5. Data analysis, exploration, and visualization

MATLAB Commands

1. imread()

Read gray scale or color images from graphics file.

2. imwrite ()

Write gray scale or color images to graphics file.

3. imshow ()

Displays the image

4. imaqfind ()

It returns an array containing all the video input objects that exist in memory. If only a single video input object exists in memory, imaqfinddisplays a detailed summary of that object.

5. imhist ()

Display histogram of image data.

6. subplot ()

Subplot divides the current figure into rectangular panes that are numbered row wise. Each pane contains an axes object which you can manipulate using axes Properties. Subsequent plots are output to the current pane.

4.4 Non Functional Requirements

- **Reliability**

The framework ought to be dependable and solid in giving the functionalities. When a client has rolled out a few improvements, the progressions must be made unmistakable by the framework. The progressions made by the Programmer ought to be unmistakable both to the Project pioneer and in addition the Test designer.

- **Security**

Aside from bug following the framework must give important security and must secure the entire procedure from smashing. As innovation started to develop in quick rate the security turned into the significant concern of an association. A great many dollars are put resources into giving security. Bug following conveys the greatest security accessible at the most noteworthy execution rate conceivable, guaranteeing that unapproved clients can't get to imperative issue data without consent. Bug following framework issues diverse validated clients their mystery passwords so there are limited functionalities for all the clients.

- **Maintainability**

The framework observing and upkeep ought to be basic and target in its approach. There should not be an excess of occupations running on diverse machines such that it gets hard to screen whether the employments are running without lapses.

- **Performance**

The framework will be utilized by numerous representatives all the while. Since the framework will be facilitated on a solitary web server with a solitary database server out of sight, execution turns into a noteworthy concern. The framework ought not succumb when numerous clients would be utilizing it all the while. It ought to permit quick availability to every last bit of its clients. For instance, if two test specialists are all the while attempting to report the vicinity of a bug, then there ought not be any irregularity at the same time.

- **Portability**

The framework should to be effectively versatile to another framework. This is obliged when the web server, which s facilitating the framework gets adhered because of a few issues, which requires the framework to be taken to another framework.

- **Scalability**

The framework should be sufficiently adaptable to include new functionalities at a later stage. There ought to be a typical channel, which can oblige the new functionalities.

- **Flexibility**

Flexibility is the capacity of a framework to adjust to changing situations and circumstances, and to adapt to changes to business approaches and rules. An adaptable framework is one that is anything but difficult to reconfigure or adjust because of diverse client and framework prerequisites. The deliberate division of concerns between the trough and motor parts helps adaptability as just a little bit of the framework is influenced when strategies or principles change.

4.5Working

The code is run on Matlab R2010a with the representation of the key switch cases on the GUI output. The main function is a clear interface to the GUI and the rest of the algorithms usedin the program.

1. Creating Database

2. SVM Training

3. Query Image

4. Exit

4.5.1 Creating Database

It involves the process of breaking the video into frames in feature collection file, followed by feature extraction, where the image is read, sent to the featureFilesubroutine and represented in the first window of the output. In the featureFile, the image is converted to Gray scale if the image isn't already in grayscale. Furthur the image features are extracted using HOG. Further the attributes are reduced using PCA.

The initial part of feature extraction involves the accumulation of values. These values of the attributes are stored in a feature file stored as a dat file. Feature extraction in this project involves the separation of object from the background using the technique of HOG. The values go through a process of Principle Component Analysis for reduction of the features to combine a combination of multiple features into one feature.

The foreground and the background that is separated are shown in the output window, followed by the histogram orientation.

4.5.1.1 Feature Collection

Algorithm 4.1: Feature Collection

1: Select training and testing Folder using ***"uigetdir('path address');"***

2: If there is no directory, Check for the correct path address

3: Choose the folder

4: Create an empty dat file

5: For each element in element file of folder '*filedir*'

6: If folder is present continue to step 7

7: Execute featureExtraction function and return to step 5

4.5.1.2 Feature File

Algorithm4.2: Feature File

1: Take the grey image as input

2: Execute HOG and PCA feature Extraction

3: Store the result of the previous step in the feature pattern

4.5.1.3 HOG Feature Extraction

Algorithm4.3: HoG Feature Extraction

1: Define number of HOG windows

2: Set number of histogram bin

3: For each window block

4: Define range of angle for orientation

5: Calculate orientation and Angle of Histogram

6: Store values in feature vector and return to step 3

4.5.2 SVM Training

The SVM file that is stored in a C file is an RBF technique of SVM classification, for categorizing the input frame to be either Normal or Abnormal, by comparison of the general class of orientation of the trained data set that is either classified as Normal or Abnormal. This is done by picking the abnormal training frames and storing them in folder 02 and the normal frames in folder 01. The algorithm of its working is given below.

<u>Algorithm4.4: SVM Training</u>

1: Load the created feature.dat file
2: Load the output.dat
3: Train the features SVM system
4: Save the trained data in knowledge base

4.5.3 Query Image

The input video that is put runs through the entire process of preprocessing, feature extraction, feature reduction, and SVM Classification to be categorized as either ‘Normal’ or ‘Abnormal’ that is also displayed on the output. The algorithm is given below.

CHAPTER 5

TESTING

Testing is an important phase in the development life cycle of the product. This is the phase, where the remaining errors, if any, from all the phases are detected. Hence testing performs a very critical role for quality assurance and ensuring the reliability of the software.

During the testing, the program to be tested was executed with a set of test cases and the output of the program for the test cases was evaluated to determine whether the program was performing as expected. Errors were found and corrected by using the below stated testing steps and correction was recorded for future references. Thus, a series of testing was performed on the system, before it was ready for implementation.

It is the process used to help identify the correctness, completeness, security, and quality of developed computer software. Testing is a process of technical investigation, performed on behalf of stake holders, i.e. intended to reveal the quality-related information about the product with respect to context in which it is intended to operate. This includes, but is not limited to, the process of executing a program or application with the intent of finding errors.

The quality is not an absolute; it is value to some person. With that in mind, testing can never completely establish the correctness of arbitrary computer software; Testing furnishes a 'criticism' or comparison that compares the state and behaviour of the product against specification. An important point is that software testing should be distinguished from the separate discipline of Software Quality Assurance (SQA), which encompasses all business process areas, not just testing.

There are many approaches to software testing, but effective testing of complex products is essentially a process of investigation not merely a matter of creating and following routine procedure.

Although most of the intellectual processes of testing are nearly identical to that of review or inspection, the word testing is connoted to mean the dynamic analysis of the product-putting the product through its paces. Some of the common quality attributes include capability, reliability, efficiency, portability, maintainability, compatibility and usability.

A good test is sometimes described as one, which reveals an error; however, more recent thinking suggest that a good test is one which reveals information of interest to someone who matters within the project community.

5.1 Types of Testing

5.1.1 Unit Testing

Individual component are tested to ensure that they operate correctly. Each component is tested independently, without other system component. This system was tested with the set of proper test data for each module and the results were checked with the expected output. Unit testing focuses on verification effort on the smallest unit of the software design module. This is also known as MODULE TESTING. This testing is carried out during phases, each module is found to be working satisfactory as regards to the expected output from the module.

5.1.2 Integration Testing

Integration testing is another aspect of testing that is generally done in order to uncover errors associated with flow of data across interfaces. The unit-tested modules are grouped together and tested in small segment, which make it easier to isolate and correct errors. This approach is continued unit I have integrated all modules to form the system as a whole.

5.1.3 System Testing

System testing is actually a series of different tests whose primary purpose is to fully exercise the computer-based system. System testing ensures that the entire integrated software system meets requirements. It tests a configuration to ensure known and predictable results. An example of system testing is the configuration oriented system integration testing. System testing is based on process description and flows, emphasizing pre-driver process and integration points

5.1.4 Performance Testing

The performance testing ensure that the output being produced within the time limits and time taken for the system compiling, giving response to the users and request being send to the system in order to retrieve the results.

5.1.5 Validation Testing

The validation testing can be defined in many ways, but a simple definition is that. Validation succeeds when the software functions in a manner that can be reasonably expected by the end user.

Black Box testing

Black box testing is done to find the following

- ✓ Incorrect or missing functions
- ✓ Interface errors
- ✓ Errors on external database access
- ✓ Performance error
- ✓ Initialization and termination error

White Box Testing

This allows the tests to

- ✓ Check whether all independent paths within a module have been exercised at least once
- ✓ Exercise all logical decisions on their false sides
- ✓ Execute all loops and their boundaries and within their boundaries
- ✓ Exercise the internal data structure to ensure their validity
- ✓ Ensure whether all possible validity checks and validity lookups have been provided to validate data entry.

5.1.6 Acceptance Testing

This is the final stage of testing process before the system is accepted for operational use.

The system is tested within the data supplied from the system procurer rather than simulated data.

CHAPTER 6

RESULT ANALYSIS

6.1 Discussion

The dataset used in this project was shot in a Canon D750 camera at 55mm focal length. The video resolution is adjusted to 380x240 pixels at a frame rate of 15. Three different scenarios are evaluated in the datasets. The first two datasets were used to depict anomalous event such as punching and kicking. This also depicts normal scenarios of handshake and hug. The third dataset is of a typical fall detection even that may occur at any old age homes.

6.2 Performance of our system

The system, when tested with the datasets mentioned above, an error rate of **0.27** was obtained. The error rate was calculated using the formula:

Error Rate = No of False Negatives / (No of False Negatives + No of True Positives)

Here False Negatives refer to the anomalous events that were not identified. True Positives are the anomalous events that were identified correctly.

	Dataset 1	**Dataset 2**	**Dataset 3**	**Total**
True Positives	33	16	20	69
False Positives	1	0	7	8
False Negatives	8	5	12	25
Err Rate	0.20	0.24	0.38	**0.27**

Table 1: Comparison of error rate for the three datasets

Table 1 provides a detailed overview of the performance. The SVM classifier was successfully able to classify most of the event as normal or abnormal. The dataset was provided as frames to the classifier with specification for classification process.

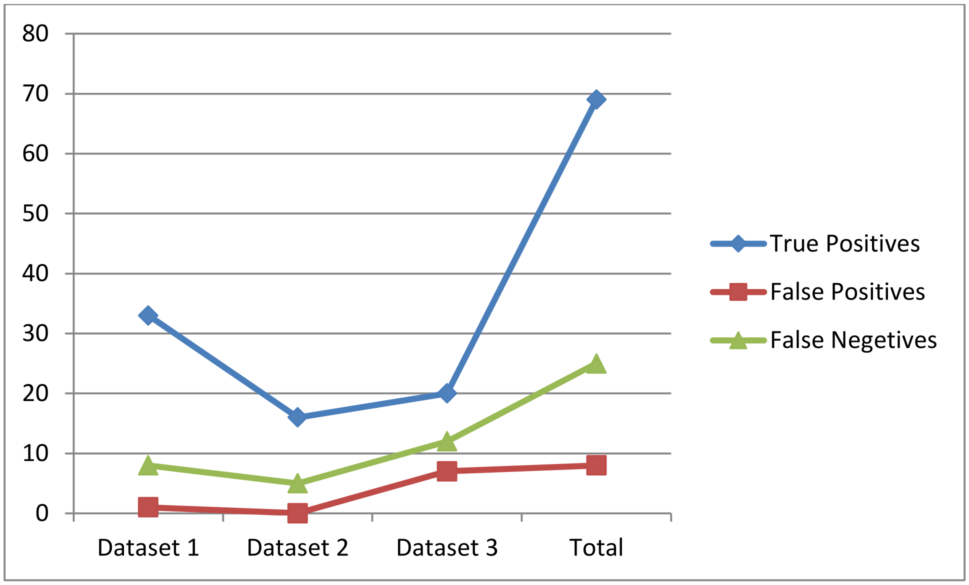

Figure 6.1 Performance comparisons for three datasets

6.2.1 Result Discussion

The dataset 3 produced the highest number of false negatives because the person of interest's movement and placement towards the camera made it difficult for the classifier to identify the event. The feature extraction was also not optimal due the constant changes the objects of the environment.

It is observed that when this dataset was removed from evaluation the error rate was reduced to only **0.21**. This shows the importance of a static background for our system, which is also a drawback and suggestion for future enhancement.

Table depicts the performance when dataset 3 is removed.

	Dataset 1	Dataset 2	Total
True Positive	33	16	49
False Positives	1	0	1
False Negatives	8	5	13
Err Rate	0.20	0.24	**0.21**

Table 2: Comparison of error rate without the challenging video

The performance for the system is seen with and without the challenging video in Figure 6.1 and Figure 6.2.Figure 6.3 provides a look at the three datasets

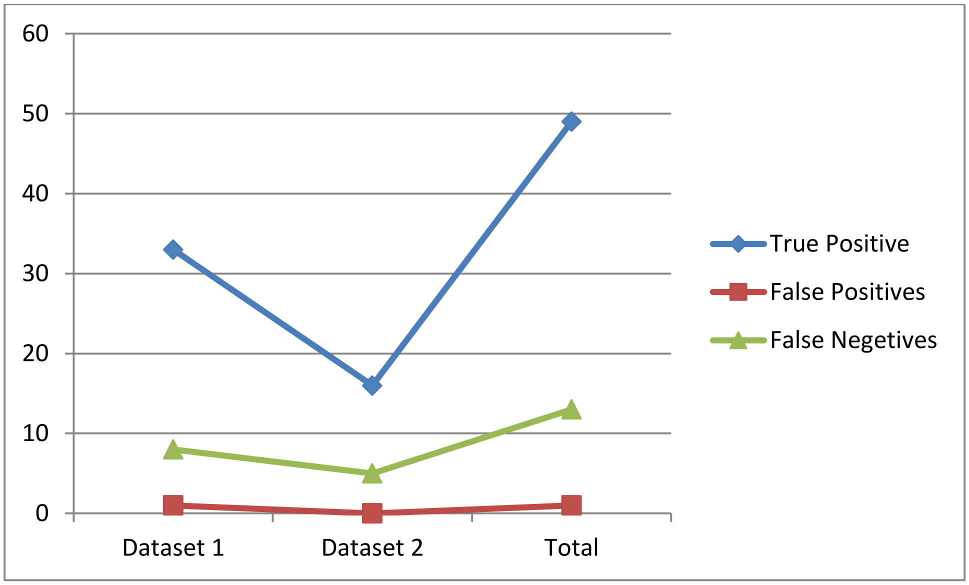

Figure 6.2 Performance comparisons without the challenging video

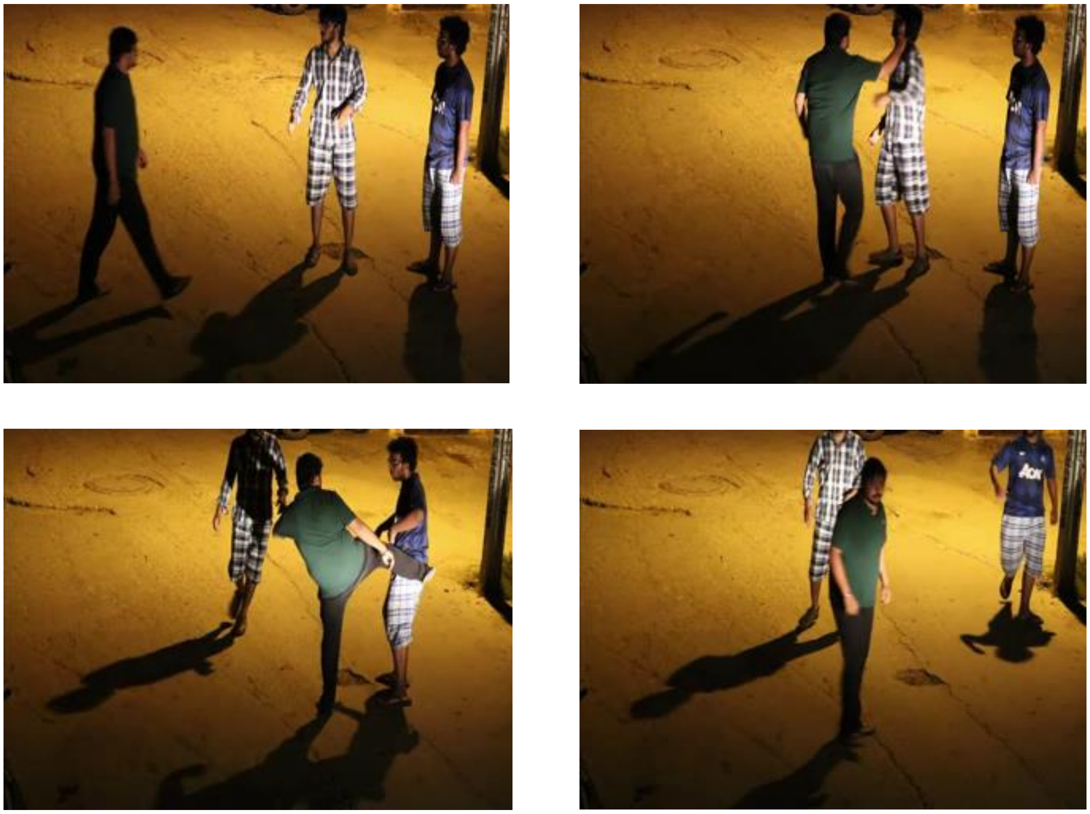

Figure 6.3(a) Dataset 1: Shows sequence of Normal and Anomalous events

Figure 6.3(b) Dataset 2: Handshake, Punch, Kick, High Five events

Figure 6.3(c) Dataset 3: False Negative event followed by fall detection event

6.3 Output

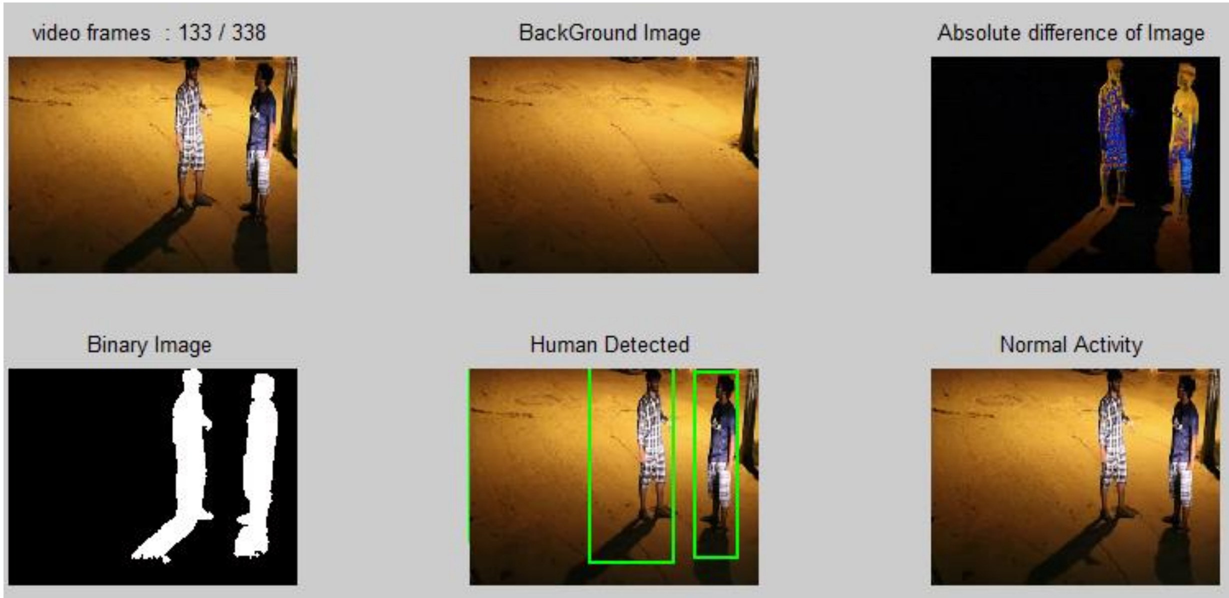

Figure 6.4 Normal event recognition as seen in Dataset 1

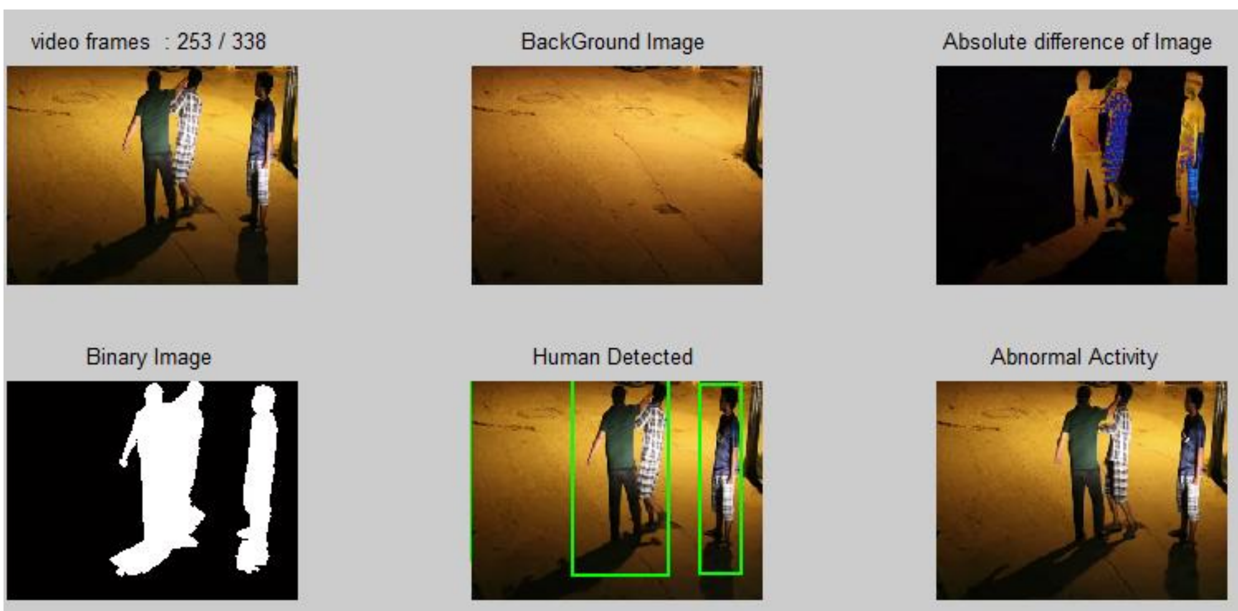

Figure 6.5 Anomalous (or Abnormal) event recognition as seen in Dataset 1

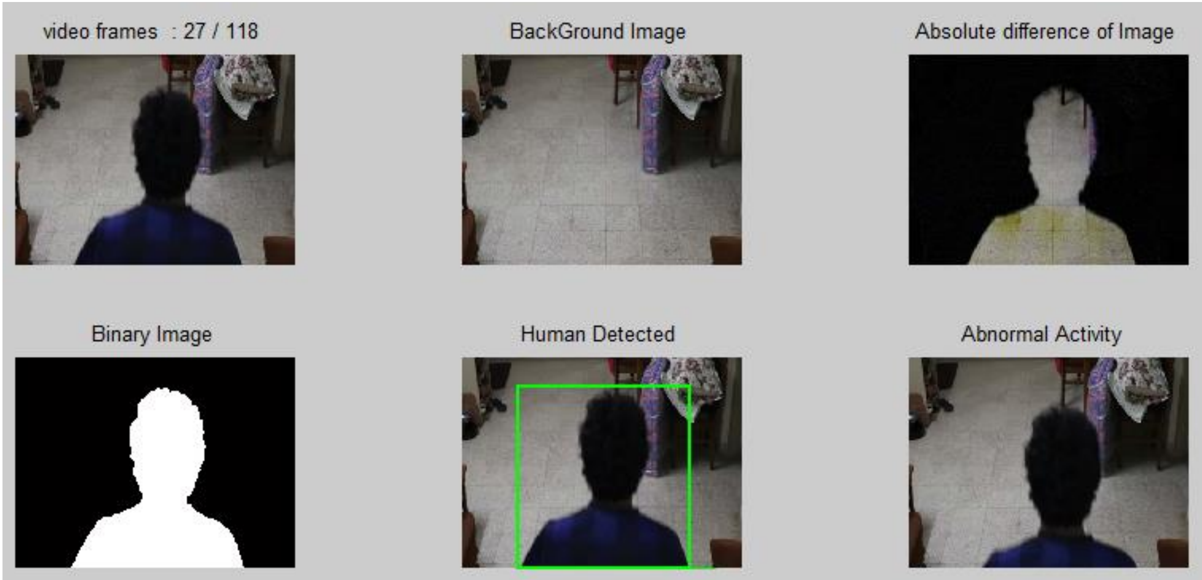

Figure 6.6 False Negative events in Dataset 3

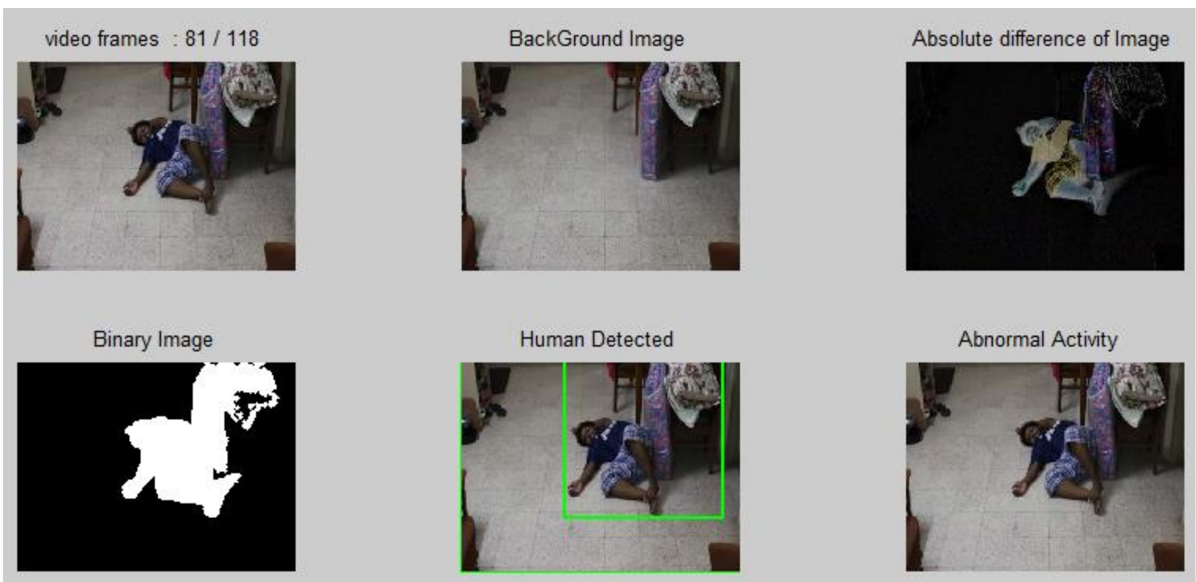

Figure 6.7 Fall detection in Dataset 3

CHAPTER 7

CONCLUSION AND FUTURE SCOPE

The anomalous event detection in video surveillance systems is fast growing field of study. The increasing computational power, provide a great environment for improving the existing systems.

The method proposed in this project has provided satisfactory results as expected. The dataset used in this implementation was taken from a static camera and the implementation was designed for a static camera. An error rate of 0.27 was achieved when tested with the given datasets. A better error rate of 0.21 was achieved when a challenging video was removed from the dataset. This method can further be improved to be implemented for real time systems and live operations.

Future Scope

To make the feature extraction available for dynamic videos that does not require a static camera.

Many factors cause the camera to get shaky or there might be future enhancements such as cameras that move. In such situations, the previous background is subtracted from the next background to extract a large unnecessary portion of the video.

Implement the proposed system in real time

Expand the dataset to accommodate more scenarios, and reduce error rate. Powerful distributed systems can be used to implement the same concept for real time operations. If input data is solved in real time, the study for anomalous event detection can grow further.

CHAPTER 8

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APPENDIX A

Acronyms	Abbreviations
HoG	Histogram of oriented gradients
PCA	Principle component Analysis
SVM	Support vector machine
RBF	Radial Basis Function

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