

An Efficient System for Road Traffic Monitoring & Theft Recognition

J. Thilagavthy

Assistant Professor

Department of Electronics & Communication Engineering

Dr. Sivanthi Aditanar College of Engineering, Tiruchendur, India

Abstract— An efficient public automotive security system is implemented for theft prevention and traffic control using an intelligent system. It comprises of precision high definition camera along with antenna for Global Positioning System (GPS) and Global System of Mobile (GSM) to establish communication link. The general public safety can be ensured with this advanced mobile unit connected on a patrol. The unit comprises of a speed monitoring unit to regularize the vehicle speed to minimize and control unavoidable accidents causing fatal injury and death. The individual units of the system are integrated to an image processing unit to verify the violators and track the event process in every stage of monitoring. The system integration with the web server will enhance the system performance for comparing the data with country's central data base to enhance security in the country. The system is designed to provide ample security to common public through advanced monitoring and control system with this intelligent mobile tracking patrol system on vehicle. The system will be connected with the cloud server to have records on all the events for future reference to limit the crimes and save life.

Key words: Road Traffic Monitoring & Theft Recognition, GSM, RFID technology, Face Recognition

I. INTRODUCTION

Face detection is a technique that determines the location and sizes of human faces in digital images or video frames. Sensor networks are used to detect traffic density and stolen vehicles. The stolen vehicles can be detected by RFID technology. The system developed a near real time computer system that can locate and track a person by comparing characteristics of the face to those of known individual computer that recognize faces could be applied to wide variety of problems including criminal identification, security system, image and film processing and human-computer interaction system. The image compressions applications in the face recognition system have categorized into two separate problems are image compression effects on face recognition accuracy and possibilities of performing face recognition in compressed domain. In most cases, a face recognition algorithm can be divided into a face image detector that finds the location of human faces from a normal picture against simple or complex background, and a face recognizer determines the person. Both the face detector and the face recognizer allow the same framework; they both have a feature extractor that transforms the pixels of the facial image into a useful vector representation, and a pattern recognizer that searches incoming face image. Face detection is a procedure by which it is possible to extract face region from human body. The concept can be implemented in various ways but mainly there are four steps for this implementation. In the first step, the face is recognized, in the second step, detected region is normalized to align various facial features. In the third step we extract various facial features like eyes, nose, mouth, are

extracted. And the fourth step, it verify whether the anticipated parts are actually carrying a face or not. There are a huge number of papers regarding the literature survey of face detection. Most of the earlier work was on the front upright face, but recent work is mainly focus on the detection of a particular persons face from a group of peoples, with unique feature identification.

A. Objective

- To ensure the general public safety with advanced mobile unit connected on a patrol.
- To integrate the individual units of the system to an image processing unit for verifying the violators and track the event process in every stage of monitoring.
- To provide ample security to common public through advanced monitoring and control system with culprit auto tracking unit.

II. SYSTEM CONCEPT

The system comprises of a controller connected with an image processing unit connected with a local server linked to web server. As shown in the fig 2, the block diagram consists of microcontroller with a LCD display and GSM module. The image processing unit captures the image in periodical intervals. Every frame that captured is analyzed using Viola Jones Algorithm for face detection and number plate detection. The image frames captured is analyzed to detect the expected person or object from the available local data base or web server connected to the countries central data base. The classified person or object from a detected unit is traced or followed by all nearby mobile units until captures for the public safety. Any authenticated face image to be detained for public safety will be sent to all the police patrol through SMS. The stepper motor is connected with the microcontroller using the driver circuit in which the high precision camera is fixed. Along with the stepper motor, camera is used to capture the image of the number plate and face in the selected area or region. The captured vehicle information registration plate images are sent to the RTO database to compare and detect the information of the vehicle. This data analyzed at the central system will be utilized for effective screening and detection by all the police patrol.

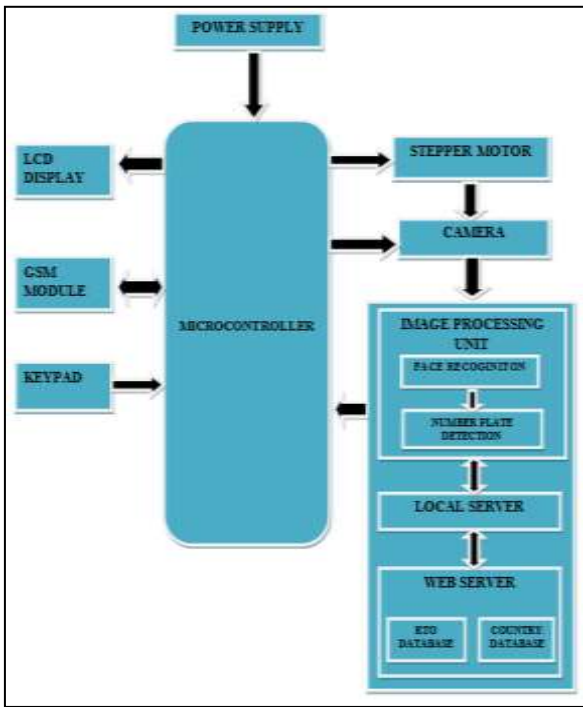


Fig. 2: System Concept

The stepper motor is connected to the Pin P₃₀, P₃₁, P₃₂, P₃₃ in the micro controller using driver circuit. The keypad is used to control the rotation of stepper motor as follows:

- 1) Switch 1- Clockwise Direction
- 2) Switch 2- Anti-clock wise Direction
- 3) Switch 3- Camera On
- 4) Switch 4- Clock wise Required Angle Rotation
- 5) Switch 5- Anti-clock wise Required Angle Rotation
- 6) Switch 6- Buzzer

The GSM transmitter and receiver pins are connected with AT89s52 such as pins P₁₀ and P₁₁, the relay is used for power consumption, 12V supply from relay is given to VCC of AT89s52 and the input is connected to pin P₃₄ of microcontroller. The power supply for microcontroller is given from computer. The camera with resolution is connected with computer using Easy cap cable. The captured image is forwarded to image processing technique. It involves facial recognition for detecting the face and number plate detection analysis also performed. The purpose of local server is to collect the information about the person. Web server consists of country and RTO database which involves the identity of a person as well as the number plate details of vehicle.

The flow diagram of facial recognition is shown in the fig 2.1, here first step of the system is to capture an image then it undergoes a process and have feature extraction of an image. Then the recognized image will compare the face attributes which is present in the database. Once the face is matched it will display a details about the person through communication module, otherwise it give enquire and notify to the officials.

A. Flow Diagram

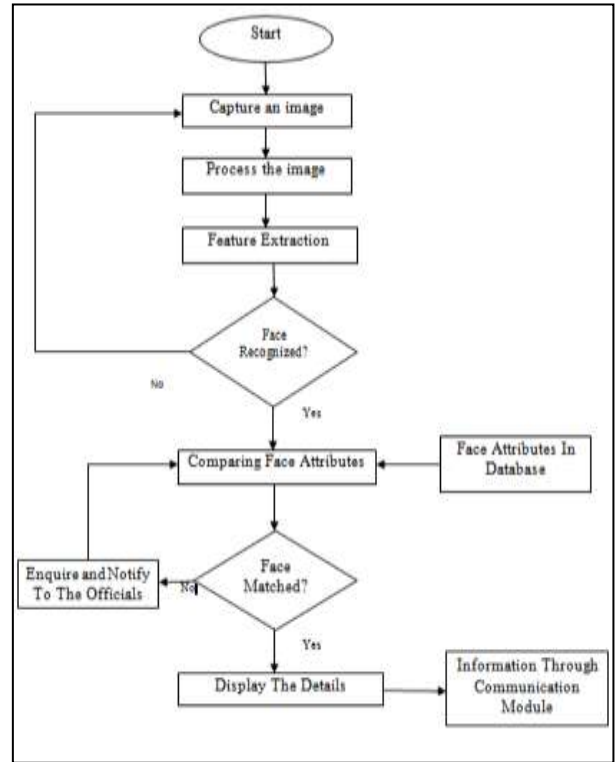


Fig. 2.1: Flow Diagram for Face Recognition

III. METHODOLOGY

A. Hardware Description

The unit consists of 8051 microcontroller which is AT89s52 and it is connected with the 28BYJ-48 unipolar stepper motor, with the help of ULN2003A driver circuit. The driver circuit is mainly used to interfacing 8051 microcontroller kit with stepper motor. The ULN2003A actually supports seven input/output pairs. The GSM module is connected to AT89s52, here GSM module and microcontroller communicates in between using serial communication and it can be controlled by microcontroller to perform different task in networking such as calling, sending messages etc. The standard camera is fixed on the stepper motor in order to capture the images for every few seconds. When 5V of supply is given to the microcontroller unit the stepper motor starts to rotate in counter clockwise and anticlockwise direction, the standard camera is fixed on the motor which captures an image for an every few seconds and the captured images is send to the image processing unit for analysis. The message is send from the GSM module to the respective police stations.

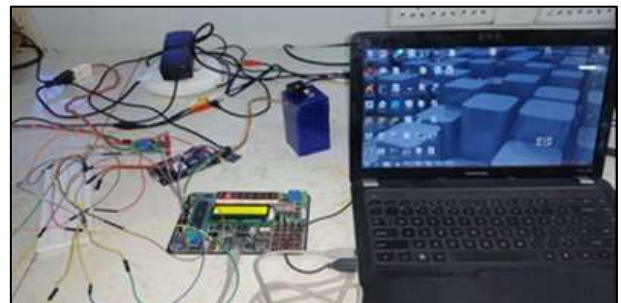


Fig. 3.1: Hardware Setup

B. Software Description

1) Face Recognition Concept Description

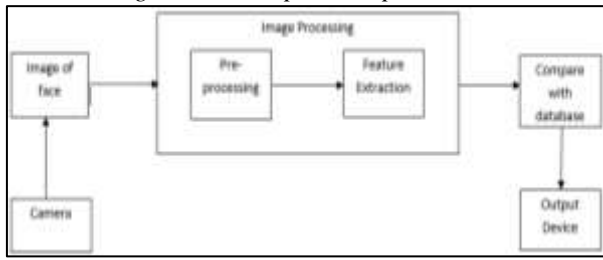


Fig. 3.3: Block Diagram for Face Recognition System

A face recognition system is an application capable of identifying or verifying a person from digital image or video frame through video source. This project receives input data as face image captured using a camera. These input data are preprocessed using image processing techniques and required features are extracted. These attributes are then compared with face features in database. If details match, the corresponding details are displayed and the person is allowed to enter. Else respective officials will be notified. Many algorithms have been evolved for face recognition.

The face is captured through camera, and then undergoes an image processing techniques such as preprocessing and feature extraction. The preprocessing image commonly involves in removing of low frequency background noise, reflections, masking portions of an image. The feature extraction involves filtering, screening of an image, then the analyzed image is compared with data base which consists of country server and the details of an image is forwarded to the output device.

2) Cascaded Classifier

The basic principle of the Viola-Jones face detection algorithm is to scan the detector many times through the same image – each time with a new size. Even if an image should contain one or more faces it is obvious that an excessive large amount of the evaluated sub-windows would still be negatives (non-faces). This realization leads to a different formulation of the problem. Instead of finding faces, the algorithm should discard non-faces. The thought behind this statement is that it is faster to discard a non-face than to find a face. With this in mind a detector consisting of only one (strong) classifier suddenly seems inefficient since the evaluation time is constant no matter the input. Hence the need for a cascaded classifier arises. The cascaded classifier is composed of stages each containing a strong classifier. The job of each stage is to determine whether a given sub-window is definitely not a face or maybe a face. When a sub-window is classified to be a non-face by a given stage it is immediately discarded. Conversely a sub-window classified as a maybe-face is passed on to the next stage in the cascade. It follows that the more stages a given sub-window passes, the higher the chance the sub-window actually contains a face. The concept is illustrated with two stages in fig 3.4

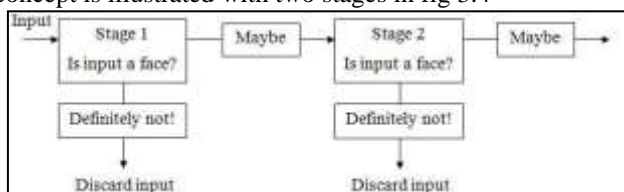


Fig. 3.4: Flow Chart of Cascade Classifier

In a single stage classifier one would normally accept false negatives in order to reduce the false positive rate. However, for the first stages in the staged classifier false positives are not considered to be a problem since the succeeding stages are expected to sort them out. Therefore Viola-Jones prescribes the acceptance of many false positives in the initial stages. Consequently the amount of false negatives in the final staged classifier is expected to be very small. Viola-Jones also refer to the cascaded classifier as an attention cascade. This name implies that more attention (computing power) is directed towards the regions of the image suspected to contain faces.

IV. IMAGE DETECTION

A. Face Detection

The image processing techniques is used to identify and trace specific people or object based on the needs. In this system the camera is used to capture image with high resolution. The image size is been normalized for analysis. The image processing unit is programmed to perform image detection as well as registration plate detection of an object to be scanned. The image is captured in a periodical fashion. The captured images are analyzed for the face detection using a suitable algorithm. A simple face detection diagram is shown in Fig 4.1.



Fig. 4.1: Face Detection

In the same manner, the registration plate numbers are also scanned and analyzed. Image normalization is done based on the given facial expression and pattern. Feature extraction module is performed to detect eyes and nose, which is useful to distinguish faces, non-faces and stable with respect to the geometrical variations. Finally face and non-face images are classified based on the extracted features. Viola-Jones algorithm is used for face detection application.

1) The Viola-Jones Face Detection

The Viola-Jones face object detection is used to provide competitive object detection rates in real-time. The Viola - Jones method for face object detection contains three techniques:

Integral image for feature extraction is done using Haar features that is rectangular type obtained by integral image

Ad a boost is a machine-learning method used for face detection, the word ad a boost means that, the classifiers at every stage of the cascade are complex.

Cascade classifier used to combine many features efficiently. The word cascade classifier means that the

resultant classifier consists of several stages. Finally, the model can obtain the non-face region and face region after cascading each with the strong classifiers.

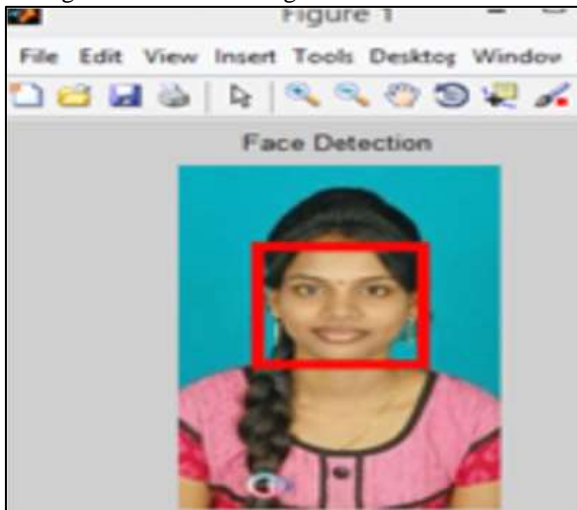


Fig. 4.2: Output for Face Detection

2) Viola-Jones Upper Body Object Detection

To reduce the challenging task of object detection and upper bodies from still images and video, the cascade object detector uses the Viola-Jones face detection algorithm to detect people's upper body and face object detection, which is defined as the head and shoulders area as well as recognition of upper body. The model uses Haar features and object detection to encode the details of the head and shoulder region.

- Create a detector object and set properties.
- Read input image and detect upper body.
- Annotate detected upper bodies.

3) Viola-Jones Face Objects Detection

Early efforts in face object detection is the beginning of the 1970s, where simple techniques are used. Face detection techniques can be categorized into two major groups, feature and image based approaches. Image based approaches use linear subspace method, neural networks and statistical approaches for face object detection. Face feature based approaches can be subdivided into low level and high level analysis. Face detection is controlled by special trained scanning window classifiers. Viola-Jones Face Detection Algorithm is the first real-time face detection system.

4) Viola-Jones Eye Detection

Eyes are detected based on the regions that are darker than other part of the face. A pair of potential eye regions is considered as eyes if it satisfies some constraints based on anthropological characteristics of human eye. To discard regions corresponding to eyebrows, the model uses the fact that the center part of an eye region is darker than other parts. The simple histogram analysis of the region is done for selecting the eye regions since an eye region should exhibit two peaks while an eyebrow region shows only one. The final constraint is alignment of the two major axis and eye region belong to the same line. This study proposed a new algorithm for eyes detection that uses Iris geometrical information for determining the whole image region containing an eye, and then applying the symmetry for selecting both eyes.

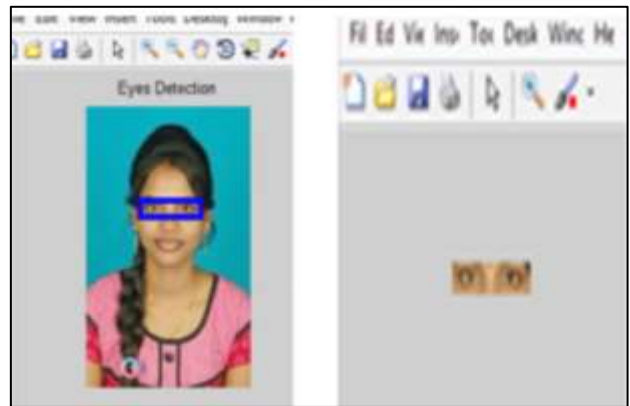


Fig. 4.3: Output for Eye Detection

5) Pupil Detection in Iris Recognition System

The pupil is dark circle at the center of eye. It is surrounded by iris and colored part of eye. Most commercial iris recognition system use patented algorithms that are able to produce perfect recognition rates. The boundary of pupil is not quite circle and a small error in detecting this boundary will lead to lose some information. Another problem that makes iris segmentation fail, is to detect the pupil boundary when the head rotation or the eye rotation.

6) Viola-Jones Nose Detection Algorithm

Nose has three different local characteristics used as follows similarity of both sides. The left and right sides of nose are similar in a front-view face. This property of similarity can be measured using Euclidean distance between both sides.

Dark-White-Dark (DWD) property: The lower part of nose region is characterized by two dark nostrils and a light sub region due to the reflection of light on the nose.

The variation in lower/upper parts property: When the face is rotated some degrees for these two properties are despaired and the only clear property is the variation between lower part and upper part. This variation can be measured by the variance in each part. Based on this analysis, a search is done for a certain region detected due to reflection of light at nose tip. The region is very bright as compared to other part of nose region. Due to the presence of very bright region, the region appears as black in binary image and is generated by marking only dark pixels as white. To locate this region the algorithm finds a large connected black region in center of localized nose image. Once this region is identified, then lowest tip of the region is considered to be nose tip. On both sides of nose tips, same binary image is searched for nose edges and distance between them is considered as nose width.

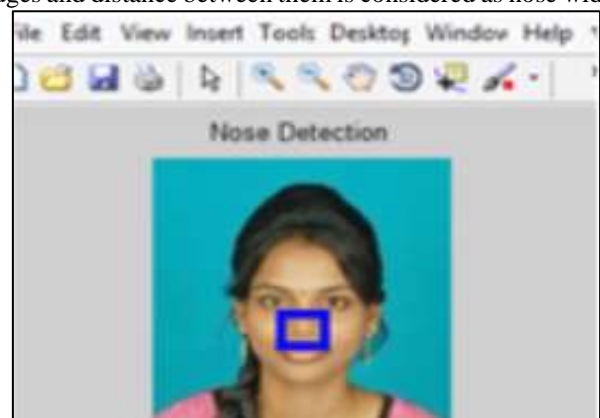


Fig. 4.4: Output for Nose Detection

7) Viola-Jones Mouth Detection Algorithm

This algorithm is used to detect and extract features from the mouth region. The model is composed of weak classifiers, which uses Haar features to encode mouth details. The result shows that the algorithm is Face image division based on physical approximation of eyes, nose and mouth on face. It is useful in a wide range. Moreover, it is effectual for complex background such as public mouth detection.



Fig. 4.5: Output for Mouth Detection

The concept of lip detection is to extract and to verify the desired components including skins, lips, by applying some kind of color segmentation in addition to some geometry. Based on the color distribution of the lips and normal skin the lip detection method in RGB chromaticity diagram is used to separate lip color from other colors (face skin color) by a simple effective color segmentation method. From the perspective of human visual perception, the lips are very easy to differentiate from the face skins for any people because of their different contrasts in color. One of the advantages of these color spaces in skin detection is that they allow users to intuitively specify the boundary of the skin color in terms of the hue and saturation. Similarly, RGB to YCbCr color space conversion is performed to find out threshold for skin region. In order to detect skin color some set of rules have been found to be more accurate than other models.

B. Graphical User Interface

In this work a GUI is designed for the system using guide. The components are used such as text boxes, push button, pop-up menu, static text, axes. Push buttons generate an action when clicked. For example, an OK button might apply settings and close a dialog box. When you release the mouse button, the push button appears depressed; when you release the mouse button, the push button appears raised. Static text controls display lines of text controls display line of text. Static text is typically used to label other controls, provide directions to the user, or indicate values associated with a slider. Users cannot change static text interactively. Pop-up menus open to display a list of choices when users clicks the arrows. Axes enable your GUI to display graphics such as graphs and images. Like all graphics objects, axes have properties that you can set to control many aspects of its behavior and appearance.

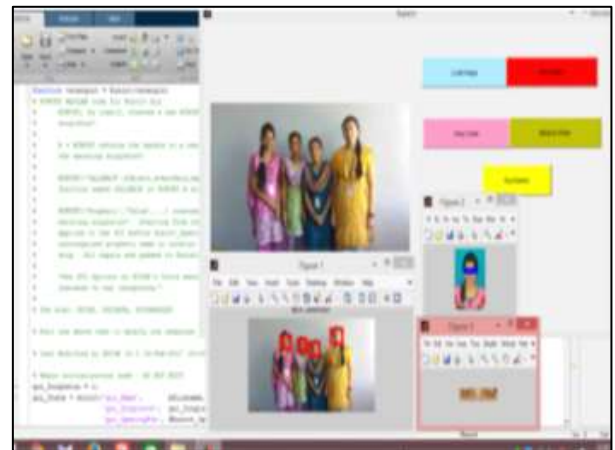


Fig. 4.6: Output of GUI Implementation

V. NUMBER PLATE DETECTION

Number plate detection is used for identifying a vehicles all over the nations. An image processing technique plays a vital role for identifying vehicles with their number plates. Number plate detection is also used for the purpose of effective traffic control and security applications such as access control to restricted areas and tracking of wanted vehicles.

A. Image Acquisition

Image acquisition is the first phase in number plate recognition process. Image can be acquired using a digital camera. Our proposed methodology uses a high resolution camera with 500×375. The format of the image may be jpeg. The image can be acquired under illumination conditions (Sunshine, shadow) and various environments (Parking lot, roadside, street).

B. Number Plate Extraction

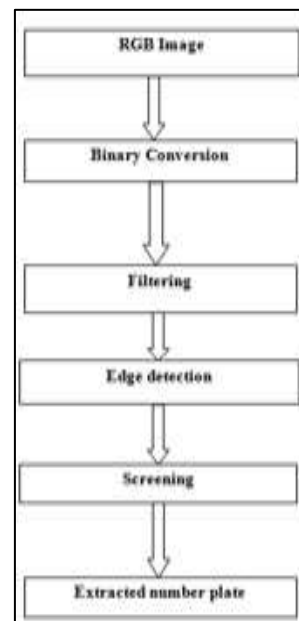


Fig. 5.1: Flow Diagram for Number Plate Extraction

1) RGB Image

Color digital images are made of pixels, and pixels are made of combinations of primary colors. A channel in this context is the gray scale image of the same size as a color image,

made of just one of these primary colors. For instance, an image from a standard digital camera will have a red, green and blue channel. A grayscale image has just one channel. An RGB image has three channels: red, green and blue. RGB channels roughly follow the color receptors in the human eye and are used in computer displays and image scanners. If the RGB image is 24-bit, then each channel has 8 bits for red, green and blue. In other words, the image is composed of three images (one for each channel) where each image can store discrete pixels with conventional brightness intensities between 0 and 255. If the RGB image is 48 bit (very high resolution), each channel made of 16-bit images.

2) Binary Conversion

Binary images are images that have been quantized to two values usually denoted as 0 and 1. Pixel values 0 and 255 represent black and white respectively. Binary images are typically obtained by thresholding a gray level image. Pixels with a gray level above the threshold are set to 1 (equivalently 255), while the rest are set to 0. This produces a white object on a background. The negative of a binary image is also a binary image with the reversed pixel value.

3) Filtering

Image filtering is useful for many applications including smoothing, sharpening, removing noise, and edge detection. When the input image to an algorithm is too large to be processed and it is suspected to be notoriously redundant (much data but not much information), then the input image will be transformed into a reduced representation set of features or features vector. If the features extracted are carefully chosen, then it is expected that the features set will extract the relevant information from the input in order to perform the desired task using this reduced representation instead of the full size image. Filtering is a process used to eliminate objects having area less than a specific value. The filtered image has a higher quality that is suitable for further detection process.

4) Sobel Edge Detection

Edge detection is a fundamental tool in the image processing particularly in the areas of feature detection and feature extraction which aim at identifying points in a digital image at which the image brightness changes sharply or more formally has discontinuities. The result of applying an edge detector to an image may lead to a set of connected curves that indicate the boundaries of objects. Thus, applying an edge detection algorithm to an image may significantly reduce the amount of data to be processed and may therefore filter out information that may be regarded as less relevant, while preserving the important structural properties of an image. If the edge detection step is successful, the subsequent task of interpreting the information contents in the original image may therefore be substantially simplified. The sobel operator performs a 2-D spatial gradient measurement on an image. Typically, it is used to find the approximate absolute gradient magnitude at each point I of an input grayscale image. The sobel edge detectors uses a pair of 3×3 convoluting masks, one estimating gradient in the X-direction and the other estimating gradient in Y-direction. A convolution is usually much smaller than the actual image. As a result, the mask is slides over an area the image manipulating a square of pixels at a time. The mask is slides over an area where the input image changes with that pixel's

value and then shifts one pixel to the right and continues to the right until it reaches the end of the row which automatically starts again at the beginning of the next row. It is important to note that a 3×3 mask cannot manipulate pixels in the first row as well as the first and last column. This is because when placing the centre of the mask over a pixel in the first row. For example, the mask will be outside the image boundaries. The G_x mask highlights the edges in the horizontal direction while the G_y mask highlights the edges in vertical direction. After taking the magnitude of both the resulting output detects edges in both directions.

5) Screening

Screening is the process of removing noise from an image. There are several methods of noise reduction and edge enhancement in image processing. An exemplary method comprises extracting a plurality of pixels from the image, evaluating measures of edge existence in a plurality of directions within the extracted pixels, determining a level of variation from the measures of edge existence with a predetermined value, performing noise reduction and edge enhancement on the extracted pixels.

6) License Plate Extraction

In the image obtained from edge detection process, the exact location of the license plate is determined by horizontal scanning process. Then the plate is extracted by cropping the desired region by specifying the height and width of the plate. The height and width of the license plate used in this project is of a standard value.

VI. RESULTS

The 8051 microcontroller is interfaced with stepper motor using UNL 2003A driver circuit as shown in the fig 6.1,

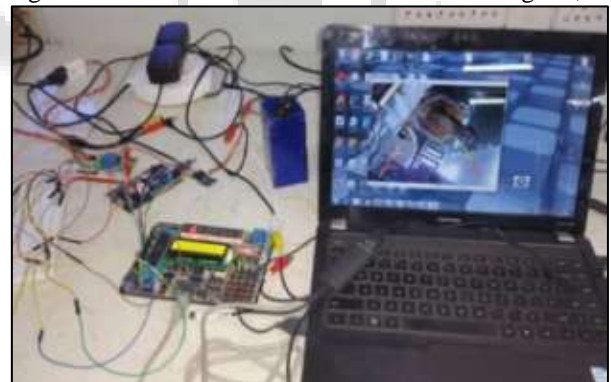


Fig. 6.1: Final Setup

The final setup consists of 8051 Microcontroller connected with GSM and stepper motor respectively, while camera is fixed above the stepper motor and output image is displayed in the computer as shown in the fig 6.1

The identification of a person in a group image is analyzed and the output is shown in the fig 6.2

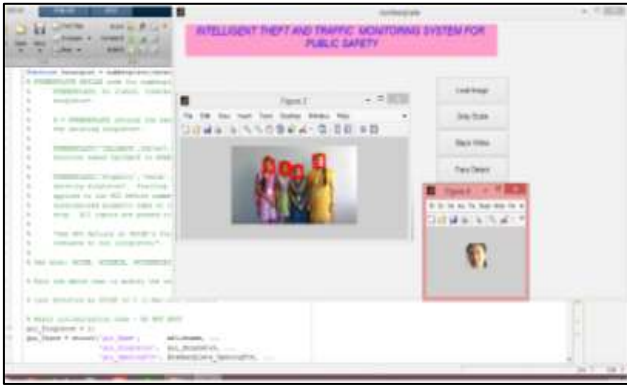


Fig. 6.2: Group Detection

The number plate detection of a vehicle is also implemented in MAT LAB and the corresponding output is shown in the fig 6.3

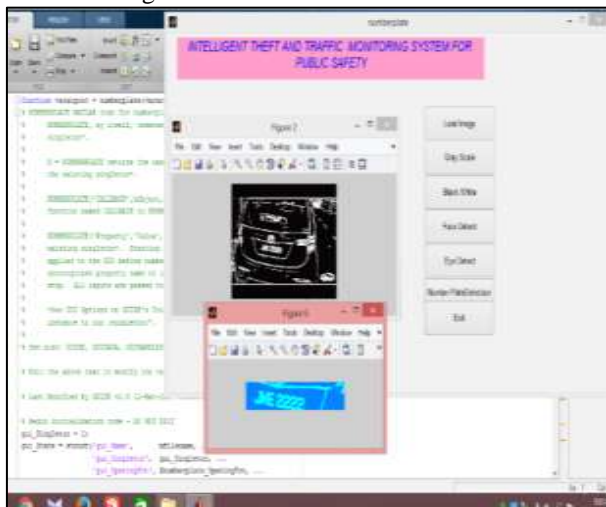


Fig. 6.3: Number Plate Detection

Finally, GUI implementation is used to compare both face detection and number plate detection as shown in the fig 6.4

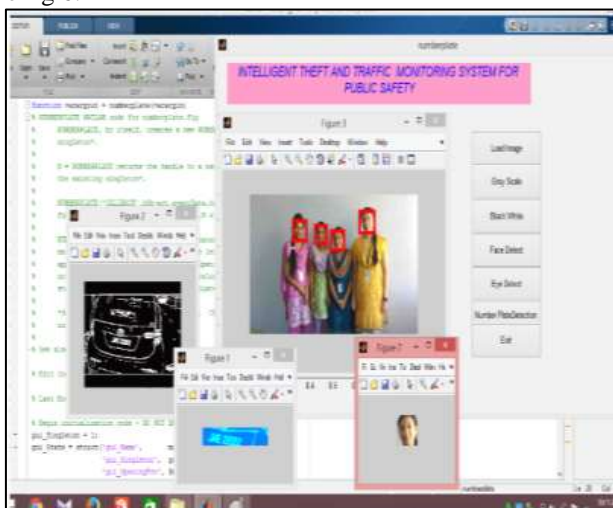


Fig. 6.4: GUI Implementation

VII. CONCLUSION AND FUTURE SCOPE

The system is developed for the theft and traffic monitoring on a real time environment to provide public safety. The system was integrated together with a hardware and software

unit. The hardware unit developed with a controller interface the camera connected to a stepper motor for capturing the image. This camera is controlled intelligently by the controller through the program. The control of the camera can also be changed to manual for easy scanning. The camera act as scanner to monitor public continuously with image capture option performed in periodical intervals to analyze the any threat in the public. The image processing systems interfaced with hardware analyze the input image received through camera and compare the input image with the database image which is kept as reference. The uploaded reference image of threat creating person is compared continuously with input image. If the image matched with live scan, then the hardware gives a beep alert and image detection will be informed through the GSM unit to all controllers to actively monitor and capture the threat creating person from public. The system is added with the number plate detection to enhance the security further. If the threat person is identified with the vehicle, its number plate details scanned too will be sent to controllers. The image processing tools were used with viola Jones algorithm for accurate detection of the image. Thus this integrated monitoring system ensures continuous monitoring through patrols.

VIII. FUTURE SCOPE

The integrated hardware unit can be added with GPS unit to identify the threat creating persons location and time of detection to precisely predict the searching person and capture him in safety eliminating the threat to the society.

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