DOMESTIC INTRUDER SYSTEM

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Abstract- **Throughout history, humans have sought to protect their life, property and possessions. In early societies, guards, watchdogs, traps and even noisemakers provided security. Fire was used to baffle wild animals and keep them at bay. As centuries passed and human accomplishments became more noteworthy, some rather engaging and sophisticated devices were developed to insure man's security. But until the discovery and harnessing of electricity, no device or protection scheme could be expected to provide any real degree of assurance or consistent peace of mind. Now when everything is available to us why not design something that provide us complete security .The very basic of this started with the simple alarm system and today it include capturing image , notifying suspicious activities etc.Commercially available Security systems are too expensive to be used by common population. We are trying to present a security system that provides all the facilities needed for security like activation of an alarm, capturing an image of intruder, along with sms and email notification at a very low cost.**
Keyword : noise makers, intruders, activation alarm

1. INTRODUCTION

Security is the degree of protection against danger, loss, and criminals. It must take into account the actions of people attempting to cause destruction. There are different types of security mainly **IT realm** (Application security, Computing security, Data security) , **Physical realm** (Airport security, Port security/Supply chain security, Home security, Physical security) , **Political** (Homeland security, Human security, National security) ,**Monetary (**Financial security).

The need for Security systems have rapidly grown from being specialized for high-risk areas (like banks, companies, governmental institutions), to be available and demanded rapidly by the average public. Some of the common characteristics of a home security system as follows 24 hour monitoring, Ease of use, Difficulty to hack, Reliability, Heat, motion sensors, Ability to control doors, gates, etc , System that monitors burglary, fire and medical emergencies, Efficient, fast and precise notification system.

All people value security. They like to feel safe. We note that people, both at home and at the office, spend a large factor of their budget for security. Statistics show that in 2000 every 50 out of 1000 households in America was robbed (www.ojp.usdoj.gov). This was mainly by means of illegal entry by force, such as breaking a window or slashing a screen or by entering through an unlocked door or an open window. Therefore, we have seen a trend in the increasing need for home security systems. There are various wireless and wired alarm systems. Typically a home alarm kit will include a control panel, alarm/siren, window and door sensors, plus at least one motion detector. Depending on the type of home alarm system, the price can range from just under a $100 to hundreds of dollars. In recent years, technology of such systems has allowed for lower prices. In addition, some home alarm systems can incorporate home automation, smoke detectors, freeze alerts, and glass break detectors. Small businesses have rapidly grown and expanded and the need of reliable, cheap and effective security system is becoming a must, not only for the business owners, but also at homes. Well, here the problem arises, despite their commercial success, most if not all commercially available devices target large corporations and companies, neglecting the need for this system to the home residents and small business owners .This doesn't mean that it is not available for them, but it is way pricy for normal consumers. Here we are trying to present a security system that provides a security system basically for homes and at a very low price.

Now a day there is a lot of burglary happening across the city, the reason behind that is police can't make out the exact location of burglary for example if burglary is happening inside any area in the city, police will get information after the incident had happened, and then they can't find out the way the thieves had went. Now so many alarm system and security systems are emerging in our markets using high-tech techniques, but still these systems have some of the limitations.

2. RELATED WORK

As discussed above, there are various home security systems designed and also working properly as per the need of the requirements of the owner. The earliest home security systems date back to the early 1900's. These systems were generally expensive and very hard to monitor. In the past 100 years as technology has changed, home security systems have also changed. Early home security systems were very expensive and surprisingly ineffective. They were very similar to car alarms. If the security system was tripped it caused a loud siren to sound, but in order to monitor these systems you had to be within hearing distance. As time passed and more and more consumers purchased these local alarm systems false alarms increased at such a rate that many times when an alarm would sound it would be neglected. Intruders quickly learned how to defeat these systems making the home security system essentially useless.

Previously, simple alarms systems are there which were placed at doors, windows, lockers, automobiles etc and gets activated on any type of intrusions. [3]. Research in security systems has gained momentum in recent years. There was high increase in need of security and as per the new requirements of the customers, high tech security systems that include alarms, sensors on Passive Infrared (PIR) based technology, electronic access control systems, or Video Surveillance System (VSS) cameras, security systems using email notification, sms using GSM technology etc. are being designed. A number of publications focus on the security and privacy implications in various applications [1], [2], [4]. Ahmad Masri has used an inexpensive Ethernet chip called the WIZ5100 to create a simple and flexible Ethernet based security system which senses human movement using PIR sensor and immediately sending email notification to the owner.[7]. A web based home security system is also exists where all home appliances can be remotely controlled by the owner via internet .This can be an innovative security system that works properly even in absence of the owner. [4].

Many alarm system and security systems are emerging in our market that also uses GSM. GSM is one of the latest mobile technologies that uses smart MODEM which can easily interfaced to embedded microcontroller and everything can be automated using this technology, we can access the devices remotely. Using GSM and GPS now we can identify the people, vehicles etc in any where of the world. []. We can see so many varities in the technology but all these are stand alone systems. If anyone wishes to acquire each of these systems then the total cost will be in big numbers. But if we get the above mention varities in a single system which is both efficient and cost effective then it will perfectly within the budget of the user. This is the main objective of our work, i.e., to design a system that senses human movement, buzzes an alarm. Along with this captures an image of the intruder which is further compared with the images of owner and if it is not matched, the system automatically sends the captured image to desired email address and also a sms notification on the user's cell phone in his absence.

3. SECURITY THREATS AND VULNERABILITIES

Necessity is the mother of invention, i.e. as human get use to present technology, the expectations to get more better arises and day by day there is an advent in the technology. Let us take the example of the security systems available in the market. There is variety of them with different costs to fulfill the needs of the human. The security threats can be of any form like Domestic thefts (in houses, private buildings), thefts in small business areas like shops, offices, etc, thefts in banks, government offices or any automobile thefts. The loss can be ordinary or sometimes very rigorous. These danger and risk possibilities with the belongings and valuable things are everywhere that baffles their owners at each point of time. Everyone has to take some of the safety measures like fencing the area with anti thefts equipments like spikes on walls, security guards at the doors, electrifying the exits, etc. But all these are common technologies and burglars or criminals can easily deactivate them as they are now fully aware of the weakness of these systems. These systems are just to prevent the mishapenings but if in case any kind of threat happens barring all the setups then the present technology is useless. For this our proposed work can be taken into consideration that will sense the intruder and buzzes the alarms as the normal security systems and also further provide information like image of the intruder, sms notification that can be used as the evidences of the incident and for the identification of the intruder. Now the valuables are safe even in the absence of the owners.

4. REQUIREMENTS

For developing a well organized and intelligent Intruder Detector system that senses the presence of humanly bodies and notifies this to the owner in his absence. The system should provide a very cost effective security system that can be placed anywhere in the house with very less or no maintenance cost. Our work is divided into two parts, i.e., Hardware and Software part.

The Hardware part consist of Microcontroller **(AT89C51)** which is the main component having following features like 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, three 16-bit timer/counters, six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. It is programmed that switch on the PIR sensor to detect human movement and as the result ringing an alarm. It works on 5V so main power supply used for it is given through step down transformer that transforms 220V to 5V.It also generates the interrupts as human movement is detected and sends signals to computer to switch on the web camera attached to the computer. We are using **MAX232 IC** as Classic TTL computer logic operates between 0V ... +5V .But Serial RS-232 (V.24) communication that is used between microcontroller and computer works with voltages (-15V ... -3V for high) and +3V ... +15V for *low*) which are not compatible with normal computer logic voltages. So MAX-232 is used to adapt the RS-232 signal voltage levels to TTL logic. It became popular, because it just needs one voltage (+5V) and generates the necessary RS-232 voltage levels (approx. -10V and +10V) internally. Now **7809IC** (Three Terminal Positive Voltage Regulator IC) is used to provide a constant power supply of 5V to the microcontroller with get transformed from 220V using a step down transformer coming from main power supply. The **pyroelectric infrared sensor (PIR)** detects infrared radiation on the basis of the characteristics that the polarization of pyroelectric material changes with temperature. The PIR sensor consists of ambient temperature, temperature of moving target, target distance of Fresnel lens, ambient humidity, amplifier gain and comparison voltage that detects human movement to an extent.
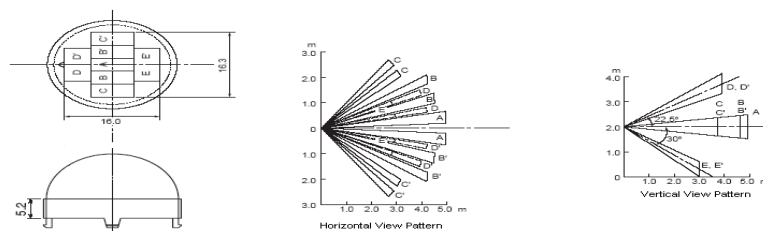

Fig 1. Working of PIR Sensor

Other components are Computer with basic configuration, Video capturing device (web cam), GSM modem (any cell phone   Bluetooth enabled), Alarm or buzzer, Step down Transformer, Few leds, resistances, capacitors, etc.

The software part consists of **WinAVR or CVAVR** use to program the microcontroller so that it can automatically sense human movement by activating the PIR sensor, **MATLAB** for processing the captured image (discussed later) and Java enabled environment for performing latter operations like sending email and short service message.

5. FRAMEWORK

In this section we discuss the design framework of the intrusion detection system for detecting malicious behavior of the intruder. The basic architecture can be given as
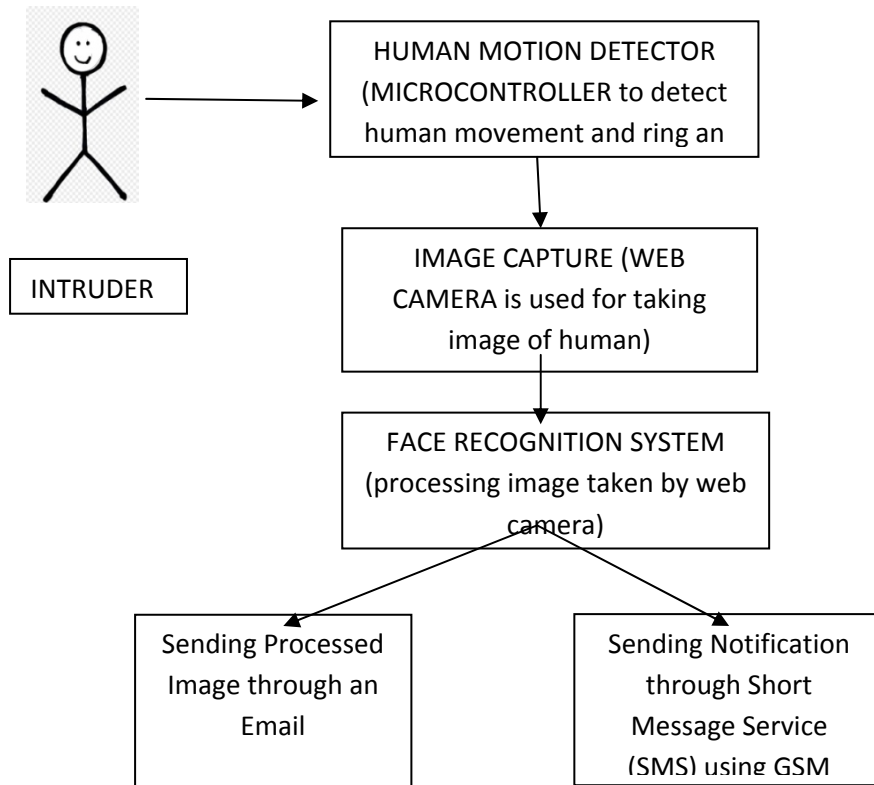
Fig.2 Basic Architecture of Domestic Intruder Detector

The core of our proposed security framework consists of the following components as shown in fig. 2.

1. Human Motion Detector
2. Image capturing Subsystem
3. Face Recognition Subsystem
4. Emailing Subsystem
5. Sms Sending Subsystem

5.1 HUMAN MOTION DETECTOR

This is the main module of our work that will sense the human movement through the designed hardware which is installed at the exit points, i.e., doors, windows, etc. The components like microcontroller, IC's, PIR sensor, transformer, leds, resistors, capacitors, etc are connected to each other on a PCB forming a well designed circuit. This setup is connected to a computer with DB9 connector and USB connector.
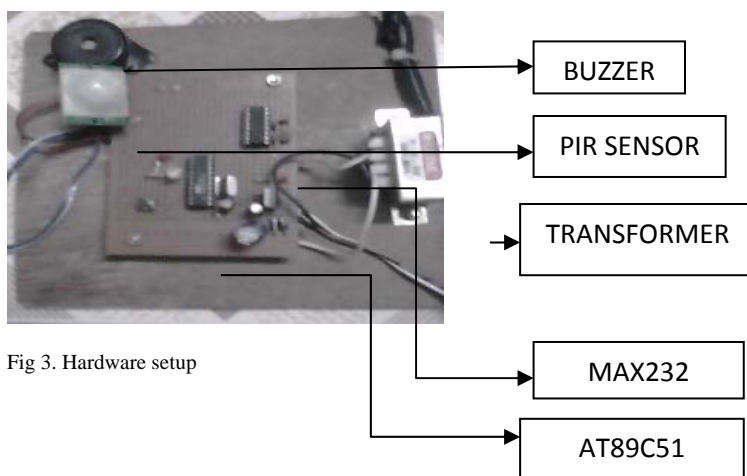

Fig 3. Hardware setup

The microcontroller (AT89C51) has 40 pin configuration to which all other components are connected with each specified pin that is programmed to activate PIR sensor, transforms its analog signals to digital signals and thus transfers it to the computer.

5.2 IMAGE CAPTURING SUBSYSTEM

This module is designed in JAVA language. Its prime function is to receive the signal from the microcontroller and then capture the image by switching on the web camera attached to the computer. We are performing these functions by using two java file. First file is to receive signal and the other one is to start camera and take picture.

5.2.1 Receiving signal from Controller:

This code interfaces our controller with the computer. In this program we are initializing the connection using COM port serial connection. The microcontroller senses any human interruption and sends signal to the serial port. We then read data from this serial connection and perform desired operation.

To perform these operations we are using basic java packages like

Java.util: This package provides basic utilities required for java. Using these utilities we are establishing the COM connection.

Java.io: This package is used for reading and writing data from COM port to the code and for other data flow inside the code**.**

5.2.2. Capturing Image:

After receiving the signal form the controller now the job is to process the data and capture the image. The WEBCAM used is initialized and it continuously captures the frame. Now the job is to grab the frame when ever any signal is received, when any signal is received the code call the function **Takeshot** this function grabs one of the continuous frames and convert it into a still image .We are performing these operations using JMF(Java Media Framework), this is a package designed for handling Media.

Various packages used in this code are

Javax.media: This is the most important package used to import all necessary components for working with audio and video. It is the super class for all other classes like Javax.medai.control, javax.media.format etc.

Javax.Media.Control: This package consists of classes that are used to control the devices used for capturing media. It identifies the available devices and notifies the best suitable one.

Javax.Media.Format: This package is used to identify the formats available and the format we can use. It helps in compressing the data received into desired format and uses it the way we need.

5.3 FACE RECOGNITION SUBSYSTEM

MATLAB (an abbreviation of Matrix Laboratory) is a popular Mathematical Programming Environment which is considered as one of the most effective tool to work with images. Images can be conveniently represented as matrices in MATLAB. We are using basic image processing methodology to process our captured image. The steps used are as follows:

- Set no images in the image set needed for training.

- Choose a standard Mean and Standard deviation that is close to all images.

- Create a matrix and design a training set that takes in the entire available image and store each of them in matrix.

- Now we normalize each image, this is done in order to remove the lighting effect from the image if any and to remove image parts that are of no use.

- Obtain mean for each image and store it row wise and then create a transpose matrix.

- Then we use Eigen-value and Eigen-vector for each image to find the deviation of each image from the mean.

- The same above steps are performed with the input image.

- The Eigen-values found are then used to find the difference in the images ,if the difference is within certain threshold then the image is said to b recognized else the image is unrecognized .

5.4 EMAILING SUBSYSTEM

Java provides an efficient and reliable method for sending mail, using various SMTP Servers available to us. Here we are using **Gmail's SMTP Server**. Gmail offers are a portable SMTP server to send mail from any network for any email address.

The packages to be imported are **JAVAX.Mail, JAVAX.Activation, JAVA.Net, JAVA.Io.**

JAVAX.MAIL

This Package provides us various mail requirements like choosing SMTP Server, setting from and to address and setting various mailing requirements. This package also provides a Transport class for sending mail.

JAVAX.ACTIVATION

This package is used for the validating the FROM and TO address used for sending email.

JAVA.NET

This package is used for adding basic mailing components like creating the connection, setting port address, setting Inet address, URL connection etc.

Using above packages we are creating **an Gmail SMTP server** ,we are creating a object of properties and adding various components like SMTP server name , port number(465 for Gmail) , user id of Gmail ,and password of Gmail. We also need to set various flags to true or false based on the requirement .Then using the Session class we create a session object, above set properties are added to this session .At the end using object of transport class we send email from an Gmail id to any other mail id. The image is attached using the file input stream object.

5.5 SMS SENDING SUBSYSTEM

This module is used to send SMS to the owner's mobile number when ever any intrusion is detected. To perform this operation we are using a GSM modem, using Bluetooth we are connecting this modem with the serial port of computer, we then use the AT commands to send SMS. To perform this operation various AT commands are used for initializing and setting the mode of GSM modem. Required AT commands to do this job are

AT: This is the basic AT (Attention) command used to initialize the modem to receive further AT commands. After this command only we can configure our modem to send SMS.

AT+CMGF: This command is used to set to text mode, this mode is used to send text message from the modem.

AT+CNMI: This command is used to store the SMS-DELIVERS and the SMS-STATUS-REPORTs are displayed.

AT+CMGS: This command sends SMS to the mobile. This command is like the submit button or the send button as we use in mobile phones to send SMS.

6. IMPLEMENTATION

Object oriented methodology is used in our work to provide flexibility and independence in working of each module. Our programs must be well synchronized so that they can work properly with the hardware part. The system is like a contraption any mismatch in sequence may lead to complete failure. So each and every part of the system must be implemented properly and should finish their process in specified time. The whole

implementation of the system starts from the detection of the human movement and finally we get the result as the image of the intruder in the email and SMS on the user mobile. A main java class is designed in which the classes designed for the modules is called by creating respective objects in this main class. The system can be divided into certain steps and these steps must be executed in this order only.

STEPS

1. Firstly hardware part after getting the power supply, switches on the PIR sensor to detect any intrusion. Detection doesn't mean mere playing of buzzer, it must also send signal to the computer to perform further operation. Whenever any such intrusion is detected a signal is sent to the serial port of the computer. We are setting a delay of about a minute so that all functions performed on the software part will execute properly. After detection signal is sent to COM port, the signal sent here is **'A'**. This character is further used by the software program to perform further operations.

2. Now the job is to read the received signal i.e. 'A' from the COM port. A server program run continuously and waits for signal from the hardware. There are following functions that help in execution.

    a. **void get(String port)** defines the COM port through which signal is read.
    b. **Buffer grabFrameBuffer ( ) on** receiving the signal the camera is switch on and continuously capturing the video of the surrounding.
    c. **Image grabFrameImage ( )** when the intruder comes in range of the PIR sensor, this function grabs the respective frame and transfer to the function defined below.
    d. **void TakeShot(String st)** This method converts the grabbed frame into still image. Then we provide a delay of about 30 seconds, during this time our job is to process the captured image.

3. After capturing the image our job is to match the image with the stored images. We are performing this operation using MATLAB. Firstly no. of images that has to be stored in the image set is defined. Matlab code superimposes the stored images and the input image is used to find the Eigen difference between the stored images and the input image. If the Eigen difference is between certain value then the image is identified else not. If the image is identified a temporary text file is created and a text saying image identified is stored. If image is not identified temporary file stores not identified. Incase the image is identified no further action is taken and server waits for further signals from the sensor. Incase the image is not identified we will run the codes for sending SMS and sending Mail with the captured image. The whole procedure can be summed up in following steps:

Step 1:
Let   m   = No. of input images.
     (nxn)   = Size of the individual image
Each of the input images that need to be fused are arranged as a row vector (order $1x\ n^2$).
Image-1 : $(1x\ n^2)$
Image-2 : $(1x\ n^2)$
Image-3 : $(1x\ n^2)$
…………………
Image-m : $(1x\ n^2)$
The resulting matrix is $DM_t = (mxn^2)$
Step 2:
The $(m\ x\ n^2)$ matrix computed for m images is transposed to obtain the Data Matrix DM (n^2xm) as:
$$\text{Vector } (n^2 \text{ x } 1) \text{ for image } 1$$
DATA MATRIX DM = Vector $(n^2$ x 1) for image 2Vector $(n^2$ x 1) for image 3
$$\text{Vector } (n^2 \text{ x } 1) \text{ for image } m$$

Step 3:

The mean for each row of DM is calculated. The mean vector is of size $(n^2$ x 1).

Step 4:
Mean vector is subtracted from each column of DM. The order of DM remains same i.e., $(n^2$ x m).
Step 5:
Covariance matrix (C) is calculated as:
C = DMT * DM

Where DMT is the transpose of DM.

Order of Covariance matrix $C = (m \times n^2) * (n^2 \times m) = (m \times m)$

Step 6:

Eigenvalues and Eigenvectors of C are computed.

Here, v = eigenvector (m x m) and d = eigenvalue (m x 1)

Step 7:

Eigenvalues are sorted in descending order and the eigenvectors are accordingly arranged.

Let v = eigenvectors sorted.

Step 8:

Eig is calculated by multiplying eigenvectors with data matrix DM

$\text{Eig} = DM * v$

$\quad = (n^2 \times m) * (m \times m)$

$\quad = (n^2 \times m)$

$E = \text{Eig}^T = (m \times n^2)$

Step 9:

Norm of each eigenvector is calculated and E is divided by the norm. E(i , j) = E(i , j) / norm(j) [Norm is the maximum of each column vector].

$E = (m \times n^2)$

Step 10:

The First column of data matrix DM is considered.

The resulting vector X is obtained As: X (of order $n^2 \times 1$) = First column of DM (of order $n^2 \times m$)

STEP 11:

Calculate PCA using the formula

$PCA = E * X$

$\quad = (m \times n^2) * (n^2 \times 1)$

$\quad = (m \times 1)$

The PCA so obtained using the first column of the data matrix DM is the first principal component.

Step 12: Reconstruction of the fused image

Fused Image $F1 = PCA^T * E$

This is of order $(1 \times m) * (m \times n^2) = (1 \times n^2)$

This row vector is arranged as a matrix of (nxn) and is displayed.
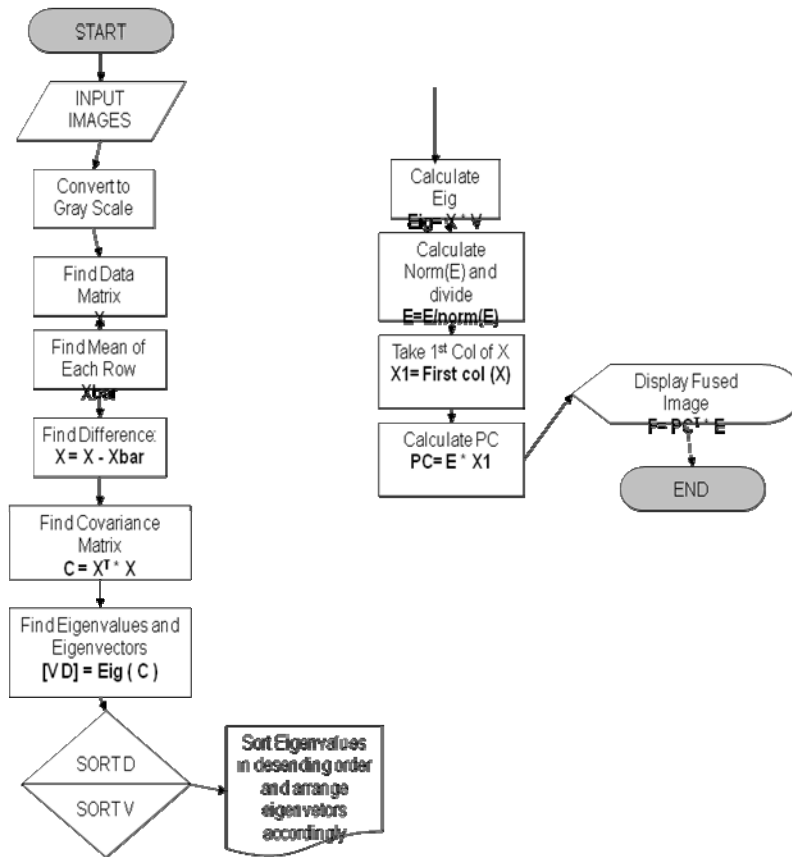
The flowchart can be shown as follows:

Fig 4. Flowchart for calculating Eigen value and processing image

4. Once the image is not identified the owner must be informed about the intruder. In order to inform this intrusion we are sending a mail and a SMS to users Mailid and mobile number respectively. Sending mail is performed using GMAIL SMTP sever defined as **String mailHost="smtp.gmail.com"** in the code.

Fig.5 Snap shot of the sent mail

Further the same Code intake all the information about the user account on respective SMTP (gmail in our case) server and then after authenticating the user profile the image is uploaded and the mail sent to the owner's mail differ this various method are used like

void sendMail() This is the main method where the specifications like email server name, port number, mail session, internet address along with sender and receiver address is defined through which a session is created between sender and receiver and thus the data(processed image in our case) is delivered .

5. After the mail is sent the job is to notify user about the intruder by a SMS. We are performing this operation using GSM modem connected with the computer. Using AT command we initialize the GSM modem. We then configure the GSM modem to text message sending mode. Then using another AT command a SMS is sent to users mobile number. A code with few methods is designed to define all the specifications needed in the process.

a. void get(String port)this method is used to define a COM port through with our GSM modem is connected. It is generally used to set a communication between the computer and the GSM modem (cell phone with Bluetooth enabled in our case).

b. void setup()this method is use to initialize and set the AT commands as per the specifications need by our code.eg.

c. void doo(String from,String msg) This method finally uses AT commands to send a sms to the user's cell phone. In this method both senders' cell phone and receiver cell phone number is defined.

7. CONCLUSION AND FUTURE IMPROVEMENTS

Our work presents a possible solution to the real-time problem of protecting are valuables in our absence. Here a successful system is designed that senses the presence of any unknown person and notifies this to the owner of house in his absence through mail and SMS. More over we are fulfilling the most important motto of making a low cost security system and we are successful in making one.

Human requirements never achieve a saturation point; every one needs something more than what they have. Same is case here we can add many things to our proposed system. Some of these future improvements that can be achieved are

1. We can provide storage for storing the video of the intruder so that we can refer it at latter stages and find the intruder.

2. We can also provide facility that the owner can receive a call along with an SMS, as call is much more efficient then SMS.

8.REFERENCES

[1] Schatz, David A., et al. "*Video safety curtain*". U.S. Patent No. 6,297,844, Issued Oct. 2, 2001.
[2] Trimmer, H.William (1981). "*Understanding and Servicing Alarm Systems*." Stoneham: Butterworth
[3] Weber, Thad L. (1985)." *Alarm Systems and Theft Protection* (2d ed.)." Stoneham, MA: Butterworth.
[4] Walker Philips(1985) " *Electronic Security System* " Cambridge , UK : University Press
[5] Aii, N.Clifton. "*Broadband CSV, XML Alarm data Standards*" Auckland NZ, (2002)
[6] Task Committee (1999). "*Structural Design for Physical Security*". ASCE. ISBN 0784404577.
[7] Ahmad masri (2004) "Ethernet Based Security System For Hmes and Small Landcapes"