# Smart Home Intruder Detection System

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***Abstract*— Enhancing a home security is becoming major issue in society. Traditional systems like Surveillance Cameras or GSM based systems provide live feed as well as gives some kind of warning in form of siren or alarm to the users. But these standalone applications need some intelligent mechanism. In this paper we are focusing on implementing a robotic home security system using image processing technique for intruder detection. Robot movement, signboard recognition, Face detection and notification techniques are provided in this paper.**

***Index Terms*— face detection, OpenCV, raspberry pi, signboard recognition**

## I. INTRODUCTION

The concept of smart surveillance without or minimal human intervention is a main area of interest for so many decades in order to avoid and minimize the theft and malicious activities. Even though there exist an event-driven surveillance camera, it might get into action because of the activities going in front of it, which may not be suspicious and requires a person to analyze the footage to confirm it. This kind of surveillance system usually does not have a feature of alerting the owner and even if they do, it will be costlier and needs to use particular application to get the alert information. So, it is important to build a smart system which is much cheaper for implementation and that would not only requires a minimal human intervention but also capable of assisting us in case of intrusion. Such system can be built easily if it can recognizes the intrusion on its own and alert us in our absence.

## II. EXISTING SYSTEM

There are many existing systems available nowadays for the surveillance and security purposes. But they either require human intervention to detect intrusion or needs to go through lots of tedious work for the installation. Here is the brief overview of traditional surveillance system and how it provides security to the users.

### *A. Surveillance system*

In traditional way of surveillance, the video recordable cameras are installed and are stored in an external storage disks to analyze them later if an event of theft or any crime occurs [2]. But in this traditional implementation, a huge investment is needed to install, store and monitor the activities. Even though the occurrence of any malicious activity in a day is least, the surveillance footage has to be stored in the disk until we examine them thoroughly and delete the footage later. It consumes a lot of man hour to watch over and over and this manual method of analysis is prone to miss or neglect the small details because of human failure during the analysis. It requires more than one camera to provide complete security to the home and needs to be placed in such a way that, each camera can see in the direction of other camera to provide the security to camera's as well. In spite of huge investment and man hour spend, most of the surveillance system does not provide complete security because of the limited area of coverage i.e. they can't capture activities happening above the certain angle and beyond distance range.

## III. PROPOSED WORK

Considering all the weak security measures exists to detect or prevent the intrusion, we propose a method to develop a smart home intruder detection system which will alert an owner in case of breach at any vulnerable places of home and transmits an image to his mobile application if any intruder is found inside the home. We think of using motion detection sensors at every place inside the home where there is a chance for an intruder to enter and all of these sensors are connected to Raspberry Pi wirelessly. Further, Raspberry Pi is mounted on a robot capable of moving around the home and has a camera fitted to it. Raspberry Pi is capable of controlling the robot movement and directions through Arduino and has a predefined path to reach all of these sensors in case of motion detected.

The sensors unit consists of battery to power the sensor and WiFi transceiver which connects sensor to the Pi and are placed in their particular position. A robot having a Raspberry Pi mounted on it will be place in its pre-defined position and are turned on when the user is going out from home. The robot has an ultrasonic sensor to avoid the obstacles in the course of path and is capable of re-entering it even after diverting to avoid the obstacle. If there is a motion detected by any of the sensors then Raspberry Pi will get the

HIGH signal from that sensor and the robot will start moving towards that sensor.

## IV. System Design

System architecture for smart intruder detection is shown in Fig.1 below.

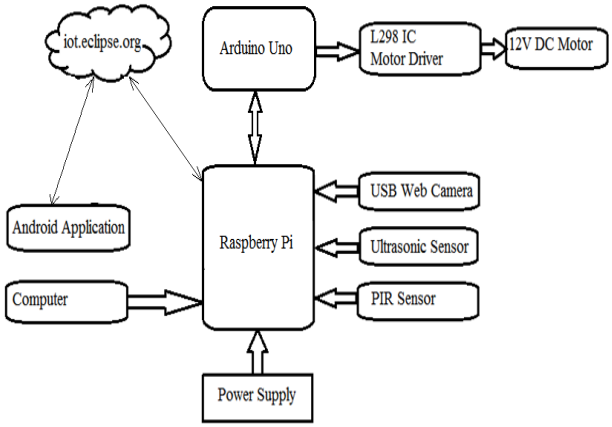


Fig.1 System Design for Smart Intruder Detection

This system is broadly divided into five modules based on the work each does. Namely,

A. ***Robot Movement:*** Robot movement in all direction is controlled by using Arduino which has the program boot loaded into it to do so. Arduino is connected to L298 IC which is a H-bridge motor driver and has two 12volts DC Motors connected to it.

B. ***Obstacle Detection:*** Obstacles are detected using ultrasonic sensor. It can be connected to the Arduino or Raspberry Pi and program is written in such a way that when an obstacle is detected, it computes the distance between the obstacle and the robot. If it is very close, robot changes its direction to avoid the obstacle.

C. ***Signboard Recognition:*** There will be a printed signs such as left turn and right turn arrows on a sheet of paper which is pasted to the doors or corner edges of the wall (see Fig. 2(i) and Fig. 2(ii)). OpenCV libraries are used to do recognize these signboards.

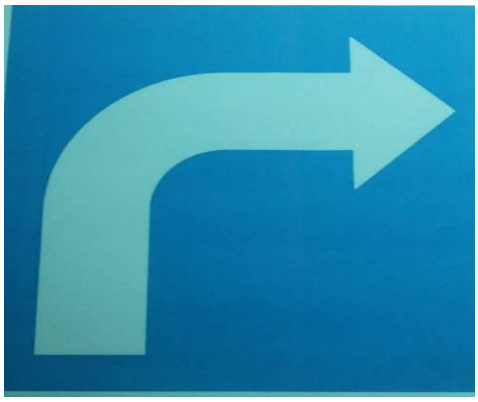

Fig. 2(i) Signboard having a right direction arrow

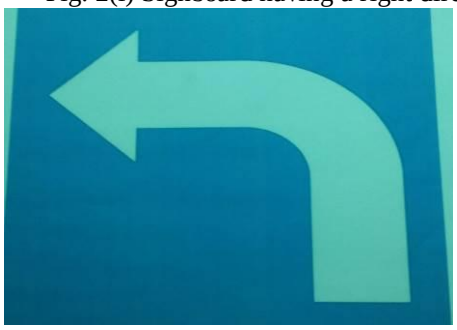

Fig. 2(ii) Signboard having a left direction arrow

D. ***Face Detection:*** Viola-Jones algorithm in OpenCV is used for face detection. This algorithm will detect the face from the frames obtained from the camera in real-time and save the image into the Raspberry Pi's disk [6].

E. ***Notification:*** Once an image is stored into the disk, program will transmit this image through internet to the owner's Android application. It will create a notification about a new image obtained and can be used to view an image of an intruder and to take necessary actions.

## V. Implementation

Fig. 6 Implemented robot using all the required hardware's

We are developing a robot system which works with a bond of both hardware and software method simultaneously. The system uses image processing for face detection, signboard recognition and also uses PHP or cloud based technique for image transfer and storage as a software parameter. It uses Raspberry pi, Arduino Uno, Motor drivers, USB webcam and sensors as hardware parameter for robot construction and for obstacle or motion detection (see Fig. 3). Each processing concept is explained as a module in this section.

### A. *Robot Construction Module*

Robot can be constructed using either Raspberry pi or an Arduino board. In our system we are using Arduino board to drive two 12volts DC motors for the robot movements. Using L298 H-bridge IC as a motor driver, we designed a circuit with Arduino and it is programmed in such a way that robot can be moved in all directions (see Fig. 4).

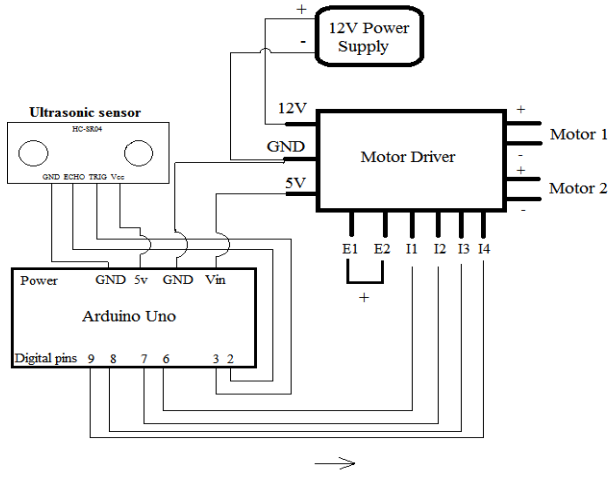


Fig. 4 Circuit diagram for Robot construction

### B. *Obstacle Detection Module*

Robot is fitted with an ultrasonic sensor for obstacle detection. Ultrasonic sensors are based on the measurement of the properties of acoustic waves with frequencies above the human audible range, often at roughly 40 kHz [5]. These sensors generally operate by sending high frequency pulse of sound continuously, if any object occurs, these sound waves hits that object and rebounds. Then it evaluates the distance travelled by the echo pulse. By using the resulting distance robot takes decision whether to process or to change the direction.

### C. *Face Detection Module*

In our system we are using Viola-Jones algorithm for Face detection [1]. A human can do detection of face easily, but a computer needs precise instructions and constraints. The first object detection framework in real-time for the competitive object detection rates was proposed in 2001 by Viola-Jones. The primary motivation of this framework is the problem of face detection. But variety of object classes can also be detected with the help of training classes. This algorithm is implemented in OpenCV as cvHaarDetectObjects().

The algorithm has four stages:

a. ***Haar Feature Selection:*** All human faces share some similar properties. These similarities can be matched using Haar Features.

A few properties common to human faces:

1. The eye region is darker than the upper-cheeks.
2. The nose bridge region is brighter than the eyes.
3. Location and size: eyes, mouth, bridge of nose
4. Value: oriented gradients of pixel intensities.

*Rectangle features:*

Value = Σ (pixels in black area) - Σ (pixels in white area)

Viola & Jones used two-rectangle features. Each feature is related to a special location in the sub-window [4].

b. ***Creating an Integral Image:*** An image representation called the integral image evaluates rectangular features in constant time, which adds speed advantage over alternative features. The integral images are an array which consists of sums of the pixels(see Fig.5). intensity values located directly to the left of a pixel and directly above the pixel at location (x,y) inclusive. Here, A[x,y] is the original image and Ai[x,y] is the integral image [1].

$$Ai[x, y] = \Sigma A[x', y'] \quad \text{where } x' \leq x, y' \leq y$$

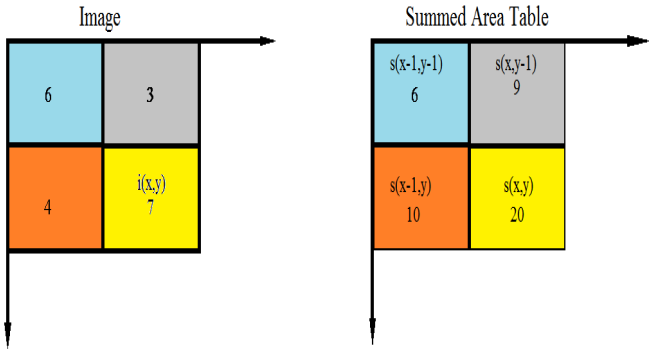


Fig.5 Integral Images

c. ***Adaboost Training:*** The speed with which features may be evaluated does not adequately compensate for their number, however. Thus, the object detection framework employs a variant of the learning algorithm, AdaBoost to both select the best features and to train classifiers that use them. This algorithm constructs a "strong" classifier as a linear combination of weighted simple "weak" classifiers [3].

d. ***Cascading Classifiers:*** The cascade classifier consists of number of stages, where each stage is a collection of weak learners. The weak learners are simple classifiers known as decision stumps. Boosting is used to train the classifiers. It provides the ability to train a

highly accurate classifier by taking a weighted average of the decisions made by the weak learners.

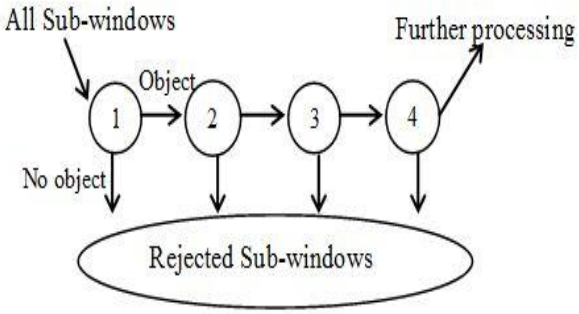


Fig.6 Cascade Classifier

Each stage of the classifier shows the region defined by the current location of the sliding window as either positive or negative. Positive indicates an object was found and negative indicates no object.
If the label is negative, the classification of this region is complete, and the detector shifts the window to the next location. If the label is positive, the classifier passes the region to the next stage (see Fig. 6). The detector reports an object found at the current window location when the final stage classifies the region as positive. It is used to eliminate less likely regions quickly so that no more processing is needed [3]. Hence, it is speeding up the overall algorithm.

## VI. Applications

The proposed system in this paper can be used in real-time monitoring and data transmission from remote location. It can also be used for theft control using OCR and face recognition mechanism. This system is easily controllable from any android phone. It is flexible to move in any direction and has a compact size and hence it is portable and video streaming can be provided to see the objects. It can also be upgraded to specific application.

## VII. Output Snapshot

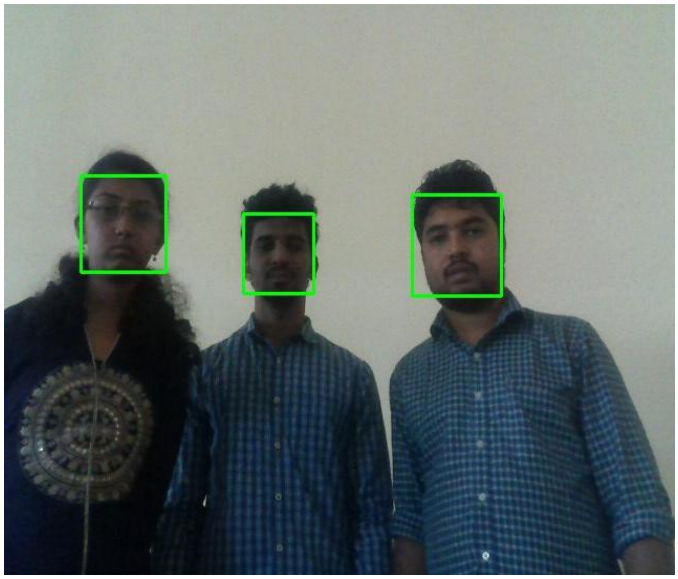

Fig.7 Multiple Face detection and bounding of faces

A face detection python program running in Raspberry pi with OpenCV libraries can capture and locally store the image in real time from usb camera when a face pattern in the frame is detected (see Fig. 7).

## VIII. Future work

This system requires internet connection for data transmission and hence it network down, the system cannot transmit or receive any data. An alternative of normal text message notification can be used in such cases to notify the owner and later transmitting an image once the network connection is being re-established. It runs on batteries and portable DC power supply and since Raspberry Pi and WiFi module will be running all the time even in an idle state, power consumption will be more. The rechargeable batteries charged using solar cells can be build and robot can be placed in the position where sunlight enters the home. It can only avoid stationary object found in front of it because of ultrasonic sensor's narrow range. More sophisticated sensors with wide and long range can be used to detect and avoid any obstacles exists on the path. Memory system with accelerometer can be used to compute the path to the sensor's location to avoid additional signboard recognition task required to reach the location.

## IX. Conclusion

Thus we have shown that building a robot system with existing hardware components along with software libraries such as OpenCV can provide an intelligent monitoring infrastructure. Yet a lot of work needs to be done to furnish and refine this intruder detection process. More features such as face recognition needs to be considered to avoid false information.

## REFERENCES

[1] P. Viola and M. J. Jones, "Robust real time face detection," International Journal Of Computer Vision vol.57,no.2,pp. 137-154, 2004.

[2] GV Balakrishna , B. Santhosh Kumar, ”Smart intruder detection using video surveillance,” International Journal Of Science Technology and Management, vol no.5,Issue no.2,February 2016.

[3] P. Viola and M. Jones, ”Rapid object detection using a boosted classifier of simple features,” IEEE Conference on Computer Vision and Pattern Recognition, vol. 1, pp. 511–518,2001.

[4] Shaily Pandey and Sandeep Sharma, ”An Optimistic Approach for Implementing Viola Jones Face Detection Algorithm in Database System and in Real Time,” International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 vol. 4 Issue 07, July-2015.

[5] K. Shrivastava, A. Verma, and S. P. Singh,” Distance Measurement of an Object or Obstacle by Ultrasound Sensors using P89C51RD2,” International Journal of Computer Theory and Engineering, vol. 2, No.1 February, 2010,1793-8201.

[6] K.S.Shilpashree, Lokesha.H and Hadimani Shivkumar,” Implementation of Image Processing on Raspberry Pi,” International Journal of Advanced Research in Computer and Communication Engineering, vol. 4, Issue 5, May 2015.