# Smart Locking and Surveillance System

**S. Prasanna Bharathi, G. Chamundeeswari, S. Srinivasan**

***Abstract--- The paper aims to detect the motion and to simplify the process of motion detection and to send prompt notifications to the user when the motion is detected. The locker gets the control through various sensors connected to it. The locker has three steps of authentication to prevent unauthorized entry. First the person's fingerprint is scanned which is followed by the facial feature recognition. If anyone tries to access the locker, camera will capture the image, process it and send a mail to the particular person along with an One Time Password (OTP). It is only on typing the OTP by the person, will the locker open. When an unknown / unauthorized person enters the locker area, the sensor detects and captures the image and mails it to the authority as well as producing electric shock outside the locker for further security. The concept of Smart Lock is to automate the process of person identification.***

***Keywords--- IoT, Motion Detection, Image Processing, Raspberry Pi2.***

## I. INTRODUCTION

Internet of Things [1] (IoT) is one of the latest developments that has happened in the technological domain. The IoT aims at maximum connectivity between the things as it involves different types of Sensors in communication. The IoT has revolutionized the way of looking into the data. The IoT is used to interconnect the Systems, Sensors, devices, equipments etc that enables these devices to receive and send data. IoT has tremendously reduced the Machine – to – Machine Communication. The IoT has provided unique identifiers to each and every device and these devices has the ability to transfer the data over a wired / wireless network reducing the interaction between the Humans and the Computer. The Internet of things has now found its applications in almost all the fields viz agriculture[2], Weather Forecasting, Surveillance, Automobiles, Smart homes, Logistics, Health care, Smart buildings, Transportation, Medical etc. The IoT has in many places replaced the traditional high cost devices; rather it uses devices, which are low-cost. This results in less power dissipation, which in turn increases the performance of the overall system. [3]

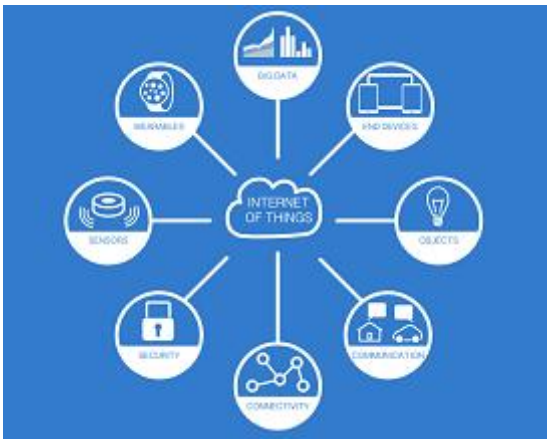


**Fig. 1: Internet of Things**

The Raspberry Pi is a small pocket sized device which has the same features / capabilities as a computer and it can play high definition videos of the resolution of 1080i without any time lagging. It is highly economical compared to the various System on Chip (SoC) boards available in the market today. It can be powered by very small portable batteries which can be used as an uninterrupted power supply during power cuts. The network administrators are intimated about the power cut that has happened. Alternatively, by default the snapshot / Video [4] is stored locally in the server which can be customized by the user to be sent to the FTP Server. The Python script plays an important role in analyzing the video which keeps on comparing the last frame which occurred with the new frame and if any difference / abnormality are detected, the video would be recorded and it can be monitored. This application is used in various surveillance / security applications.

Another important entity in our paper is the Raspberry Pi. Advantage of using Raspberry Pi is its ease of application when clubbed with the Concept of IoT. [5]


**Fig.2: Raspberry Pi 3**

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## II. OBJECTIVE

The Internet of Things has now found its applications in various fields like health, agriculture, Transportation, Security, Safety, surveillance etc and this paper aims to integrate the IoT to detect the motion in security systems. The system captures the image of the person entering and mails it to the authority. This paper is being developed from the perspective of 2 business partners trying to access the same locker but not without the authentication of the other even when the partner is not nearby. This is also being developed to get notified of the intruder(s) trying to access the locker along with their picture and tighten the security of the locker by generating electric shock outside the locker to prevent the intruder from accessing the locker. [6]

## III. MOTION DETECTION

Motion Detection is carried out with the help of a Passive Infrared Sensor connected to one of the GPIO ports of Raspberry Pi. A Python script would be running in the background which would analyze the captured video. Each and every frame is compared with the preceding frame in the video. If there is a marked difference between the 2 frames it would be flagged and the system initiates the process of video recording and snapshot generation [7]. The database would have the snapshots of the people who are authenticated to operate the locker. A new person's face is compared with all the data that is stored in the database. The user can customize various settings like Frames per Second (FPS), contrast, brightness, saturation, resolution and sharpness. [8]

In our paper, the code is loaded for capturing the image of the person who is trying to access the safety locker and mail it to the authority that further decides on whether authenticating his partner to access the locker or inform the police in case of a trespasser. The happenings at the location can also be viewed by using the IP address of the LAN connected to the Raspberry Pi.

## IV. IMAGE PROCESSING

The most important part in security and surveillance is the real time human identification and detection system. The difficulty to detect / recognize[9] persons is more pronounced in heavily crowded places like Shopping malls, markets, airports etc. Using various biometric informatics like palm veins, palm prints, fingerprints, iris etc… we can detect the humans. The most suitable biometric parameter for fast and convenient person recognition is facial information. So we go for face recognition using image processing. The database is created in such a way that the authenticated user's photos in various angles are taken and stored in it. Any new person's image is compared with the already stored images in the database. As an additional authentication we have also incorporated fingerprint scanning to detect the authenticated users. The Face recognition system and the Fingerprint scanner are placed at the entrance of the electromagnetic door to recognize the persons [10]

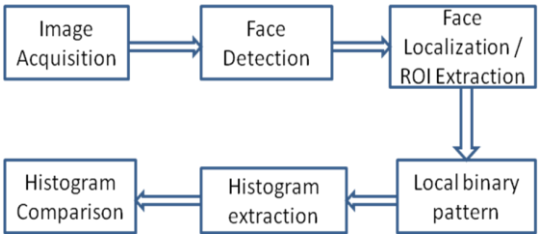


**Fig 3: Face Recognition Steps**

As mentioned in the block diagram there are 6 steps which are involved in facial recognition. The first step is acquiring the image. Next step is to find whether the face appears in the captured image or not which is nothing but Face detection. After Face detection we need to locate the position of the face in the image. Haar feature-based cascade classifier is used for face detection and face localization. The features which are needed for the Haar classifier are computed using an intermediate representation for the image which is called an integral image. The fourth step is to locate the image with the binary pattern. Then we go for analyzing the image using Histogram extraction. The final step is Histogram comparison of the image with the database which is already saved. For detection of the face accurately all the 6 steps should be systematically followed.

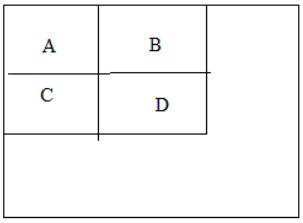


**Fig 4: The sum of the pixels within rectangle D can be computed with four array references. ((A+B +C +D)+ (A)-((A+ B) + (A + C))**

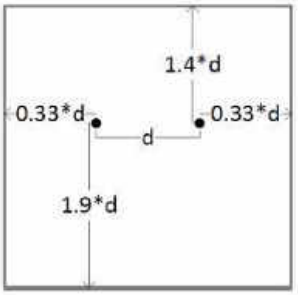


**Fig 5: Face Region Extraction - Coefficients**

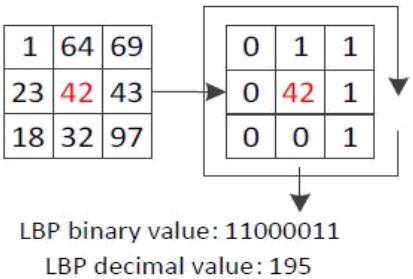


**Fig 6: LBP example of 3x3 neighborhood, (P = 8, R = 1)**

We will be using eight references for computing the difference between the two rectangular sums.

The above mentioned two-rectangle features involves adjacent rectangular sums which can be computed in six array references, eight in the case of the three- rectangle features, and nine for four-rectangle features.

$S(x, y) = s(x, Y-1) + f(x, y)$…… (1)

$I(x,y) = I(x-1, y) + s(x,y)$……(2)

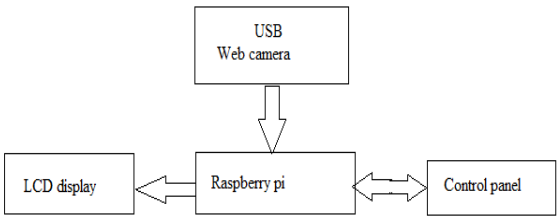


**Fig 7: Hardware Setup**

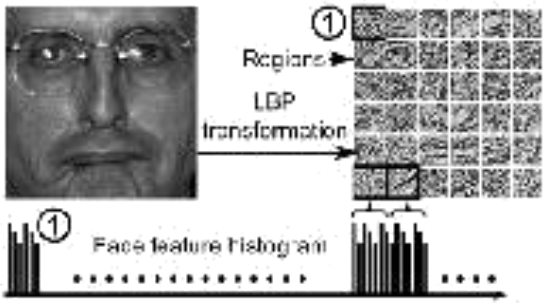


**Fig 8.Example of LBP transform and formation of face feature histogram from 6x6 regions**

The first step in analyzing any facial image is to fix up the location and positioning of the eyes. The Haar Transform is used to determine the approximate location of the person's eyes. This Transform is used to calculate the ROI based distance between the eyes, which is specified as 'd'. The coefficients which are shown in Fig. 4 is used for calculation of distance to each of the sides. This paper's approach does not localize the position of the eyes; hence it cannot correct the rotations of the face. After the final region of interest is found, we perform LBP transformation. The image is divided into 4 quadrants for convent identification of the image as shown in fig 3. We consider 3x3 rectangular image and apply the LBP transformation for that image as shown in fig 5. The Binary value is converted to a decimal number and it is stored in the center pixel position of the image output. The descriptor of the images is the histogram of labels which is taken after the LBP Transform. LBP Transform is performed by considering the sampling circle and using different amount of pixels P and different radius R from the central pixel. Example of radius R = 1 and R = 2 with P = 8.

Feature histogram is the descriptor for each of the given images. Many methods can be used to compare the two feature histograms such as Chi-Square Bhattacharya distance, Histogram intersection, distance correlation of the histograms etc. In our algorithm we chose histogram intersection for two-histogram comparison as shown in fig 6.

## V. PAPER ARCHITECTURE

This paper uses a triple-layered architecture. The first layer is the motion detection layer. This is the outcome of the python script with respect to the PIR sensor. The second layer is where the image recognition is done for identifying whether the person entered is one of the 2 partners or some other intruder. In the third layer, the necessary actions are triggered either as mail to the other partner with an OTP or an alert mail to the consumers about the intruder and thereby initiating the shock circuit[11]

The important entities of the paper are described as below:

1. Detection of motion using Python script.
2. Handling the request using Python complier.
3. Temporary file storage.
4. Internet connection
5. External server to store files - FTP server is used in this paper.

Hardware requirements are as mentioned below:

1. Raspberry Pi Microcontroller
2. PIR sensor for motion detection
3. High definition camera for image/video capturing
4. Fingerprint Scanner
5. LAN cable for Internet connection
6. Keyboard, monitor & mouse for configuration of board
7. Keypad for tying the OTP

The users can login on the move to the Raspberry Pi device and check the status of the Smart Locking system. The user would also get the notification if any motion is detected [12] and the live camera output is verified to analyze the reason behind the motion. The captured Photos are continuously uploaded to the external server to reduce the storage on the local device. [13]

## VI. IMPLEMENTATION & RESULTS

While working on the methodology it is imperative to decide and finalize the architecture that has to be considered. It is vital to decide on the Hardware(s) to be used for the successful implementation. In this paper we have used a [14] SoC Board - Raspberry Pi Model B which is used to capture the footage through a High Definition Camera interfaced with the Raspberry Pi which in turn is connected to the Internet via an Ethernet port for sending and receiving the images. The data is analyzed and executed by the Raspberry Pi. Based on the outcome of the execution the SoC decides on the action to be taken and sends an email to the user regarding the detection of the motion or uploading the videos and images onto the FTP Server [15]. The scripting is done in such a way that it executes in a repetitive loop and continuous snapshots are recorded from the camera whenever any motion is detected.

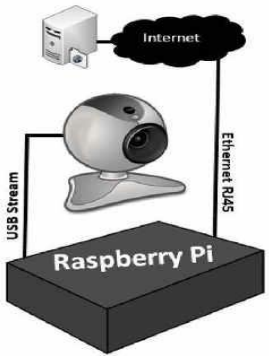


**Fig 9: Architecture**

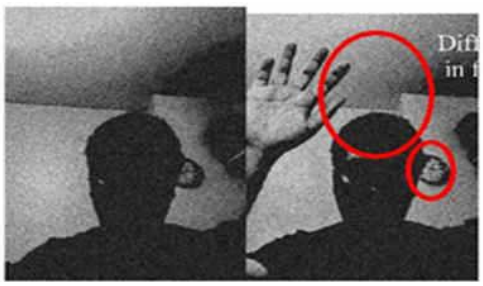

**Fig 10: Frame a (left) and Frame b (right)**

**Fig 11: Images saved in Raspberry Pi locally**

## VII RESULTS

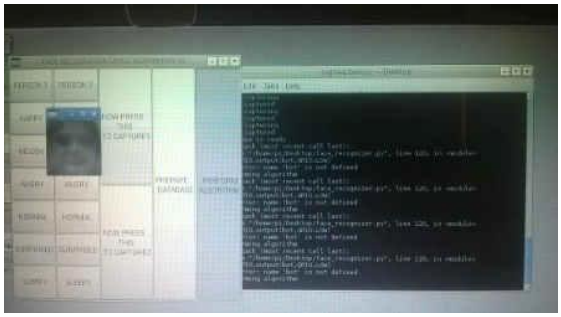

**Fig 12: Performing algorithm for recognizing the person**

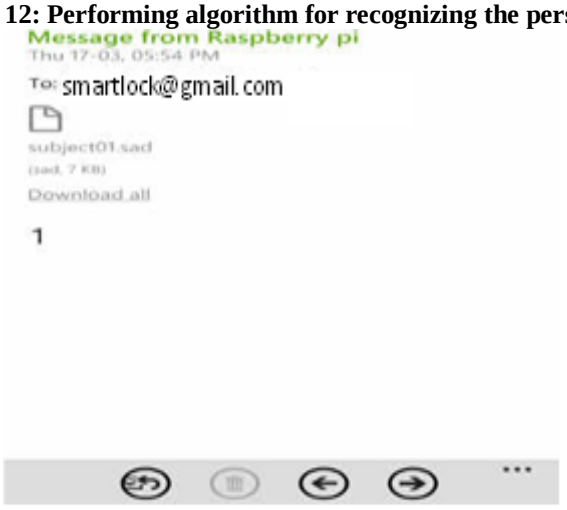


**Fig 13: Emailing the consent person with captured photo for authentication**

## VII. CONCLUSION

Henceforth, the Smart Locking system can be used to contribute to the existing security system by improving and enhancing the capabilities of these systems and their related technologies. This system would be less expensive compared to the already existing systems. This Smart Lock & Surveillance system does not involve any special modifications to the infrastructure & it can be implemented in the present day scenario without much hassles.

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