Smart Monitoring and Authenticated Door Access from Remote places

K. Gopalakrishnan, J. Dani Reagan Vivek

Abstract*: Securing our things is an important objective in our day-to-day life. If our belongings are not properly monitored, it may be stolen at any time. Hence the better way is prevention of theft than searching the lost belongings. Recently much importance is given regarding security of our home. There are situations where we may need to provide door access to people when we are away from our home. For example, while working at office, if you want to provide access to a plumber, then remote door access to be provided. By using our proposed work we can monitor our home from remote places and also we can have door access options. An embedded web server is used for the purpose of remote monitoring and control. The system for remote monitoring and control for door access is developed using Raspberry Pi embedded web server. The other components include Passive Infrared sensor (PIR), DC motor and Raspberry Pi camera module. Based on the PIR sensor and camera input, the secure access to the door for any person can be given through remote access. The access to the door can either be provided through application or the concerned web page. Both the application and the web page are password protected. The application is developed as an Android application and it can be installed in any android mobile phone. The web page is developed using PHP which is used as embedded server-side scripting language. After verifying the password the access to control the door is provided. This operation can be used in wide applications where physical presence is not possible all the time.

***Keywords* : Remote monitoring, smart door access, Raspberry Pi, camera, android app, embedded server..**

I. INTRODUCTION

Now-a-days, technology plays an essential role in our life, where several applications take advantage of emerging technology. Recently, computers and smart phones have significantly contributed to our daily life where numerous computations and calculations are being accomplished by such technologies. The new technology also helped in security enhancement and satisfies the basic safety requirements for people. Usually Security cameras are used for observing and monitoring an area for safety purpose. But they can be hacked if they lack strong password. A weak system password paves way for cyber-attacks on the surveillance system. Thus it may leave both the surveillance system and the Network connected vulnerable. Video management software also uses a lot of components beyond the operating system like database applications. Another major issue in this surveillance system is storage space. The camera will be recording all the time and the videos will be saved continuously leading to shortage of storage space. The security cameras are also subjected to physical vulnerability.

In our proposed work, monitoring is done by Raspberry Pi camera module and the images are captured only when the motion is detected. Thus it overcomes the disadvantage of storage space shortage. The camera is placed such that it can capture the image of the person in front of the door. When the visitor or intruder arrives at the door the motion will be detected using PIR sensor and the image will be captured using Raspberry Pi Camera module. After capturing the image of the visitor or intruder, notification will be sent to the concerned person through mail or application. He can provide access to the door for the respective person at the door with the help of web page or the application. The buttons for controlling the door are available in the application and the web page. Thus the controlling of door can be accomplished from the remote places. The main aim of the paper is to provide security to the environment by remotely monitoring and controlling doors. The system components, the system architecture and the development of web page and the development of application are discussed below in the respective sections.

II. RELATED WORKS

Several remote systems have been proposed for controlling appliances whether for the academic or business domain. Such systems were intended to provide a remote control and monitoring tasks. In the residential power monitor and control system [1], the home appliances are controlled from remote places using Small Programmable Object Technology. This resident power monitor and control system used a server in cloud to store real-time data collected from the resident's house. The cloud computing component in this system allowed the users to monitor and control the house power supply system anywhere and at any time. In the system [2] a password protected door system is developed. A keypad is placed in front of the door. The visitor can type the password to directly access the door. If the password is entered correctly then the door will be opened, otherwise it captures the image of the intruder and compare it with the available database. If the image is available in the database the access to door will be provided, else the captured image will be sent to the concerned person's mail.

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The system [3] is based on Near Field Communication door lock system. This system is based on the pattern recognition where the individual's face is analysed to identify their identity. The system developed by Sahani et.al. [4] used ZigBee based door lock access control and face recognition based authentication. The work done by Sandeep et.al [5] proposed a Home surveillance and automation system. It uses basic sensors to monitor the home environment and uses GSM module for sending messages. The design developed by Prasanna Bharathi et.al [6] uses face recognition using LBP to detect and authorize persons for accessing door. In system [7] an intelligent system for home security using illumination sensitive background model is presented. This system enables tracking and detection of intruder and it is based on providing home security. Here face recognition technique is used to identify the intruder and on finding him, the image is sent on the owner mail id for further action. The system described in [8] uses ZigBee Technology. They have also used multiple modules such as human detection module (HDM) which aims to detect the user at the door. Here the images can be captured using the camera module and also the video stream can also be processed. The works done so far used ZigBee technology, face recognition technology. A computer vision based approach is followed in [13] where a separate video server is maintained. The proposed system uses PIR sensor based motion detection and camera to capture the images. Hence it is comparatively lower in cost and provides security to the level of face recognition based approach.

III. PROPOSED WORK

The proposed technique provides a new approach different from the present strategies. In this method images are captured only when the motion is detected by PIR sensor. Unlike CCTV cameras, the Raspberry Pi camera module will not be continuously recording and this can considerably reduce the storage space. Hence it is suitable for low-budget applications. This face recognition technology used in [10, 11, 15] demands database maintenance. In this proposed method there is no need for maintaining database and hence it can serve as an effective system for monitoring. Thus it can be used in monitoring highly secured and prohibited places where any kind of motion is suspicious. When someone arrives at those secured place their intrusion can be detected with help of PIR sensor. When PIR sensor detects motion due to intruders, it captures their image and sends notification to the authorized person through the mail. In addition to this monitoring part, the authorized person can also control the door from remote places. The controlling can be done with help of web page or mobile application. On viewing the image the concerned owner can allow the arrived person to enter by controlling the door. The web page and the application contain buttons for controlling the door and by clicking those buttons the control commands for providing the door access. For ensuring the security both the web page and the application are password protected. Thus access to the door can be provided only after verifying the password.

IV. SYSTEM COMPONENTS

The hardware components used in this system include Raspberry Pi 3 Model B, PIR sensor, DC motor and 8MP Raspberry Pi Camera Module. The software used in this system includes Python, PHP and Android Studio. Raspberry Pi is an ARM based credit card sized single board computer developed by Raspberry Pi foundation. Raspberry Pi 3 Model B uses a Broadcom BCM2387 SoC (System on Chip) integrated with 1.2GHz 64-bit quad-core ARM Cortex- A53 ARM processor. This model has built-in USB Ethernet adapter and Bluetooth 4.1(24Mbits/s) and also equipped with 2.4 GHz Wi-Fi 802.11n (150Mbits/s). Thus for networking purpose both 10/100 Ethernet port and Wi-Fi can be used. This model has 1GB of RAM. Raspberry pi supports micro SD card for memory storage purpose. The raspbian Operating System Jessie is available in this SD card and the captured images are also stored in this SD card. It has 40 pin outs available and the following ports. Four USB 2.0 ports, one High-Definition Multimedia Interface (HDMI) port, one 3.5mm analogue audio-video jack, one Ethernet port one Camera Serial Interface (CSI) and one Display Serial Interface (DSI).

Passive infrared sensor (PIR) is used to sense motion and hence it can detect whether a human has moved in or out of the sensor's range. The actual detection range is between 6m and 12m. The delay of PIR sensor varies from 5s – 200s. This delay is the period till which the output of the sensor stays high. The PIR sensor has two knobs, delay knob and sensitivity knob which can be used to adjust the output delay and the range respectively. For this system both delay and sensitivity are adjusted to the minimum as per the requirements. The supply voltage of the PIR sensor is about 5V and it can be varied till 12V. The output of the PIR sensor is Digital output and the output voltage is about 3.3V.

Raspberry Pi camera module V2 is used to capture the images when motion is detected. This Raspberry Pi camera module is connected via a ribbon cable to the CSI connector on the Raspberry Pi. This camera module has resolution of about 8 Mega Pixel and its sensor is capable of generating 3280 x 2464 pixel static images. The Camera modules weight is about 3 grams, thus making it suitable for static applications and also other applications in which size and weight are main concern. Its lens size is about ¼ inches and the lens is of fixed focal length type. The system is powered with mains and LiPo battery[12] to make it run even in case of main power failure.

V. SYSTEM ARCHITECTURE

As shown in the block diagram Fig. 1, the PIR sensor and Raspberry Pi camera module are connected to the Raspberry Pi and the Raspberry Pi is also connected to the wireless network for remote monitoring and control of the door. The motor connected to Raspberry Pi is used for the actuation of the door. The raspberry Pi should also have the SD card inserted for utilizing the Raspbian Operating System and for the storage Purpose. The installation is done as described in [14].

The operation of this system is classified into two parts monitoring part and controlling part. The monitoring part is done in server side and it is an embedded server maintained with help of Raspberry Pi.

The controlling part which is performed from remote place is the client side. Here mobile application for controlling the door is included in addition to the web page because receiving notification in mail alone may not be an effective method as the authorized person may not check mail often. So the notification is received in the mobile application installed in the mobile phone which will be a better way to monitor.

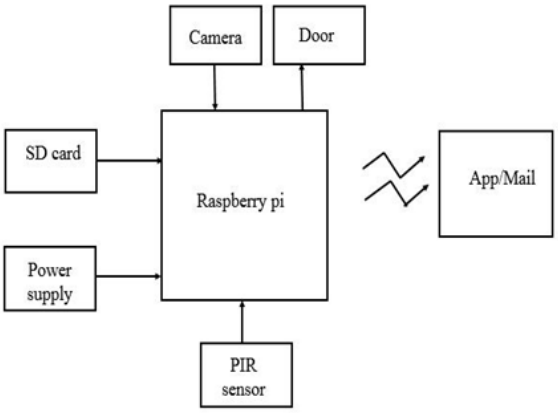

Fig. 1.Block Diagram.

A. Monitoring

The Monitoring part includes Raspberry Pi, PIR sensor and Raspberry Pi camera module. The Raspberry Pi is used for maintaining the embedded web server. As shown in the flow diagram for monitoring Fig. 2, the PIR sensor continuously checks for motion. When the motion is detected the image is captured using Raspberry Pi camera module. After capturing the image, it will send notification to the concerned person along with the captured image. This notification is received in the respective person's mail or the application installed in the respective person's mobile phone. For this purpose a static IP address is assigned to the Raspberry Pi as the notification and the image is sent through the wireless network.

B. Controlling

The controlling part as shown in Fig. 3 is done through the web page or the application. After witnessing the image received in the mail or the notification received in the application, the authorized person can provide access to the door for the visitor arrived using the web page or the application. If arrived person is an intruder, the authorized person may not provide access to the door. The authorized person can also close the door after the visitor left the place. Here electronic locks or electromagnetic locks can be used for security purpose and these locks can be controlled from remote places. For the actuation of the door DC motor is used which is also controlled from remote place using the application or the web page.

VI. METHODOLOGY

The operation of this system starts when the PIR sensor detects motion due to intruders or visitors. When the motion is detected by PIR sensor the output of the sensor will be high. When the output of the sensor is high the image of the person is captured using the Raspberry Pi camera module connected to the Raspberry Pi. The image is captured using the inbuilt capture commands of the Raspberry Pi. The captured image is stored in the SD card and the image is also sent to the mail and mobile application of the authorized person. The mail ID of the sender and the recipients, who may be the authorized person are mentioned in the code and thus the notification will be received by that respective recipient. After reception of the notification, the authorized person can also control the door from remote places and provide access to the door for the visitor. For controlling the door, the authorized person should type the IP address of the Raspberry Pi in any web browser and the web page will be displayed. By entering valid username and password to login the authorized person can control the door using open and close buttons available in the web page. Initially for web server implementation in the Raspberry Pi, apache2 needs to be installed followed by php5 as shown in Fig. 4 for designing web page to be displayed in the web browser[9]. By entering the IP address of Raspberry Pi in web browser, the web page for controlling the door is displayed.

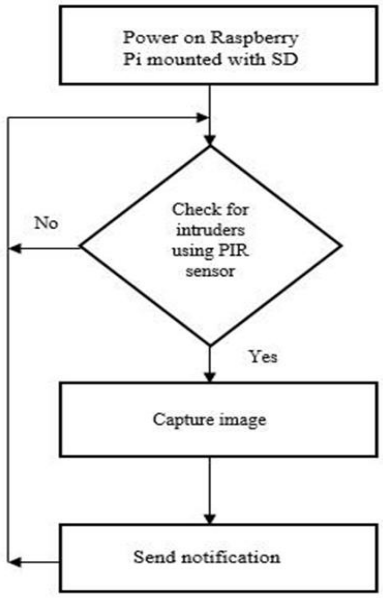

Fig. 2.Flow diagram for Monitoring.

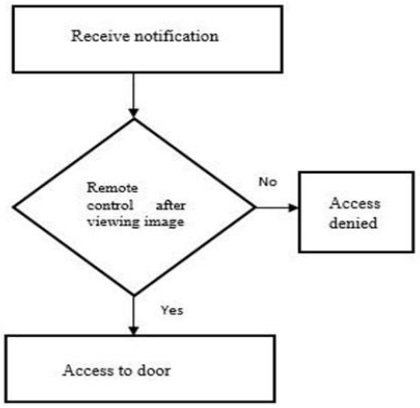

Fig. 3.Flow diagram for controlling.

The web page designed is available in index.php file which will run automatically when the Raspberry Pi is switched on. The design is done using HTML embedded in php. Thus the web page to control door is displayed. To control the GPIO pins of Raspberry Pi wiringpi package is installed and the wiringpi pin numbers are used in the php script. In addition to this, door control login page application is also developed using Android Studio for controlling the door using android mobile phone. An application is the much faster way to get connected. In some instances mail alone may not be the effective way to receive notification as the user may not check the mail often. For the mobile application, the minimum android version used is Ice-cream sandwich.

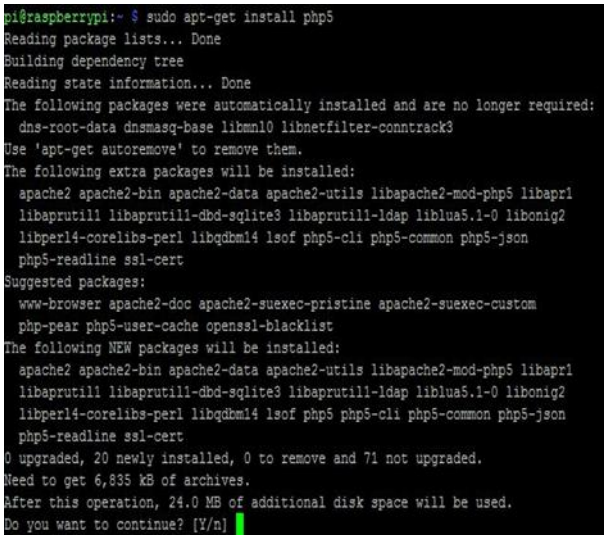

Fig. 4.Installation of required packages.

The concept of socket programming is used to send control commands from the application. A network socket is one endpoint in a communication flow between two programs running over a network. Sockets when used together with a set of programming request, then it is called the sockets Application programming interface (API). The java.net.ServerSocket class represents a server socket. It is constructed on a particular port address. Then it calls accept() method to listen for incoming connections. The communication between Raspberry Pi server and the application developed using Android Studio which acts as client is by means of socket communication. As mentioned earlier, Raspberry Pi is the server and the application is the client. After sending notification to the authorized person the server will wait for the connection establishment. The connection will be established when the client sends control commands to the server for controlling the door. Here the Raspberry Pi serves as a server side which executes the command using python script and the Android Studio will be the client side is developed using Java code. The web server triggers the Python code to control GPIO and the client side program will be the Java code to establish network connection with client. So there will be web server connection with Java client side. The mobile application also has the login page, after entering valid username and password the authorized person will be logged in. Then the page for controlling the door will be displayed. This page will contain the buttons for controlling the door. Thus the door can be controlled from remote places using the android application.

VII. EXPERIMENTAL RESULTS

The experimental setup of the proposed system is shown in Fig. 5. As explained earlier the image captured after detecting motion is sent to the mail of the authorized person. The notification received in the mail of the authorised person is shown in Fig. 6. After seeing the notification the authorized person can provide access to the door for the visitor by controlling the door from remote places. This controlling can be done from the web page or the mobile application. And for the controlling purpose, valid credentials are required. Hence the door can be controlled only if the credentials are known and thus unauthorized person cannot control the door by just knowing the IP address of the Raspberry Pi.

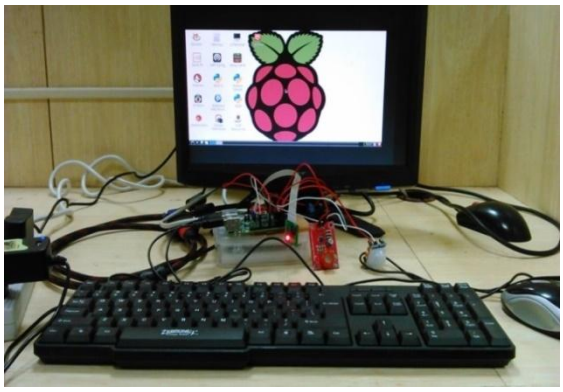

Fig. 5.Experimental setup of proposed system.

The Login page displayed when the IP address of Raspberry Pi is entered in the browser is shown in Fig. 7. The authorized person will be logged in only if the person enters valid log in details.

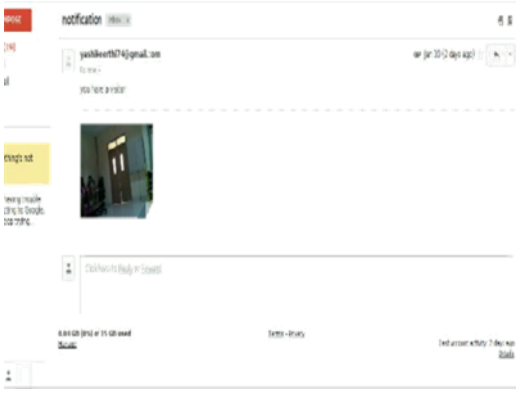

Fig. 6.Notification through mail.

Thus correct username and password is required for logging in. By having strong password for this system security can be enhanced and other cyber vulnerabilities or hacking can be prevented. Once correct username and password is entered, the user will be logged in and the next page will be displayed. This page will contain buttons Open and Close for controlling the door remotely shown in the Fig. 8. The corresponding pages displayed on clicking the buttons Open and close are shown in Fig. 9 and Fig. 10 respectively.

Fig. 7.Login page Output.

Fig. 8.Page displayed after the user is logged in.

The door can be opened and closed by clicking open and close buttons respectively. The web page also contains contain buttons for controlling the camera. So the cameras can be turned on from the remote places when required by using the button turn on displayed in the web page.

Fig. 9.Page displayed after clicking open button.

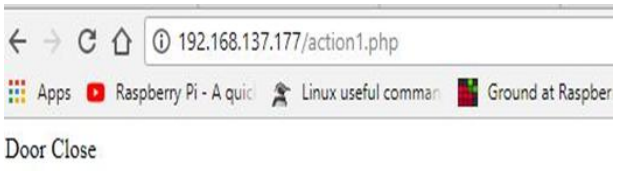

Fig. 10. Page displayed after clicking Close Button.

The application developed using the android studio has the login page as shown in Fig. 11. This login page requires the details like username and password. The authorized person will be logged in after entering the valid log in details. After logging in by entering valid credentials the authorized person can access the page for controlling the door. This page shown in Fig. 12 also has two buttons open and close for controlling the door. On clicking these buttons control commands will be sent to the Raspberry Pi server. By receiving these commands the door is controlled by the server.

Fig. 11. Application Login Page.

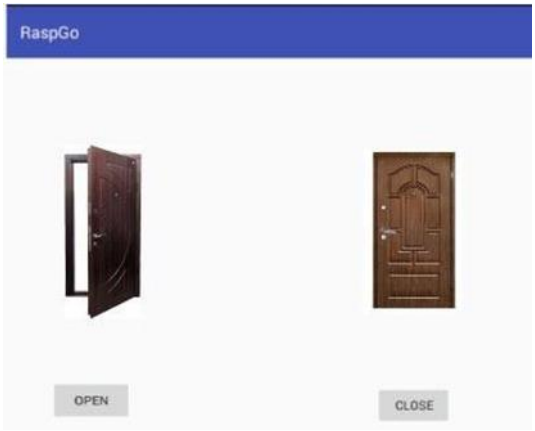

Fig. 12. Mobile App Output.

On clicking the open button in the mobile application, the door can be opened and the python program output is shown in Fig 13.

Fig. 13. Program Output.

VIII. CONCLUSUON

A smart monitoring and authenticated door access system is presented in this paper. The system designed is seen to be robust and successfully provides remote access to the door. The system utilized a web server and generated notifications to the user through email and mobile app. It also helps to monitor from remote places. The system is tested with different persons. From Experimental results our proposed work runs as described. It gives better security compare with existing work. It also minimizes the cost of the system when compared with other systems, as it uses reduced number of components. Thus the system developed has its unique advantages which make it more attractive for the user. In the future, the developed system may include GSM module. In case if the person is not connected to the internet, they can receive messages through GSM module.

On seeing the messages, they can open the Application and control the door. The system can also implement an added level of security using encryption and decryption algorithm[16]. The application can also include control for controlling the door lights.

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