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IoT Based Door Entry System

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Abstract

Objectives: This paper proposes a remote access controlled door entry system for homes and office buildings. **Methods/ Statistical Analysis:** A remote access control system comprises of the internet to control the devices and appliances at home or office with the person controlling them from anywhere around the globe. In our proposed system, a Raspberry Pi board is used as the platform for monitoring and controlling the door lock. The door entry system proposed here consists of a switch for guest monitoring, camera for guest authentication, solenoid actuator for opening of the door and a speaker set for making the system intimate the responses to the guest. Switch, speakers and camera for interaction with the guest are mounted at appropriate places at the door. **Findings:** Status of the switch can be monitored by the Raspberry Pi. As the guest presses the switch on arriving at the door, the door entry system enables the host to conveniently monitor and control the entry of people to the house through Internet. **Application/Improvements:** The main advantage of our proposed system is that it can be easily used in home without requirement of any new software installation and configuration. In future, Instead of monitoring switch status, interrupt driven method can be used to monitor the person.

Keywords: Email, Entry Control, Internet, Raspberry Pi, Remote Access Control

1. Introduction

Wireless access monitoring[1] and control system based on the digital door lock is proposed[2]. It was based on IEEE 802.15.4, specifically ZigBee wireless network protocol. To implement the system with ZigBee network protocol, four types of modules were developed, ZigBee module, digital door lock module, human detection module and ZigBee relay module. The ZigBee module designed was used to support wireless sensor network and also for the ZigBee tag to identify the access objects. Smart home system which used a mobile phone to remotely supervise household appliances and enable real-time monitoring of home security status[3–6].

All the information gathered by the system was transmitted through the GSM module. In a control unit had been implemented that could control the home appliances based on an internet enabled mobile phone. This system was composed of the gateway, the control unit and mobile. In order to test the operation, a door lock system, motor and an electric bulb had been used. If the mobile phone was connected to the gateway, the system confirmed the signal status of each element through the control unit and transmitted the signal information to the unit. After that, the mobile phone had control to all the elements. The development of a home security and monitoring system that worked where the traditional security systems that were mainly concerned about curbing burglary and gathering evidence against trespassing fail[7].

The design of this new home control and security system was implemented on a Field Programmable Gate Array (FPGA). Various home appliances and door locks were remotely controlled. A web-based interface was developed which helped the user to interact directly with the system. Control commands were sent by the user through the internet or via SMS messages. Feedback from the installed devices and peripherals were sent back to the user. Home automation system which used GSM, Internet and speech recognition was implemented[8,9]. The system developed was a wireless one. This system also

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made use of a web-based interface. Security of the system was maintained by using a login password based authentication technique.

Our proposed design incorporates features which have been proven to be advantageous in the past. Image based authentication has several benefits over speech based authentication. The use of email through smart phones has increased in the recent past which makes sure that the user can get alerts about the guests even on the go.

2. System Overview

In the system proposed, a switch, a webcam, speakers, the Raspberry Pi board and a solenoid actuator along with its driver circuitry are connected together. The functions required for the operation of the system are as follows:

- Switch Monitoring.
- Image Capture.
- Email Transmission.
- Email Reception.
- Command Extraction.
- Actuator Operation.

The button/switch press triggers the system to follow the sequence of steps mentioned above. The switch is monitored by polling any one of the GPIO pins like the GPIO 24 pin which is configured as an input. Once the switch is pressed, the system interacts with the guest using the speakers to comply with the next steps and the response received from the host is informed in the same manner. Figure 1 shows the functional block diagram of the system proposed.

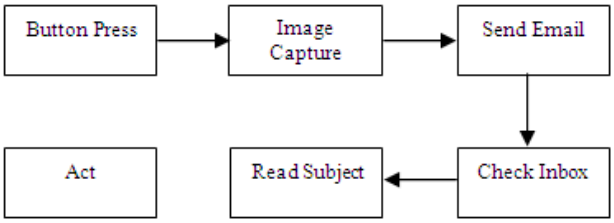

Figure 1. Functional block diagram.

The Raspberry Pi board supports all the features required by the proposed system. The switch is connected to the GPIO pin. The speakers are powered by a USB power source and are plugged into the 3.5 mm audio jack. The webcam is connected to one of the two USB ports available on the board. In the prototype developed on-board 10/100 Ethernet RJ45 jack is used to connect the system to the internet with the help of a CAT 5 Ethernet cable. The actuator is driven using the L293D IC. Any two GPIO pins are configured as output pins. The L293D IC provides isolation for the Raspberry Pi board from the

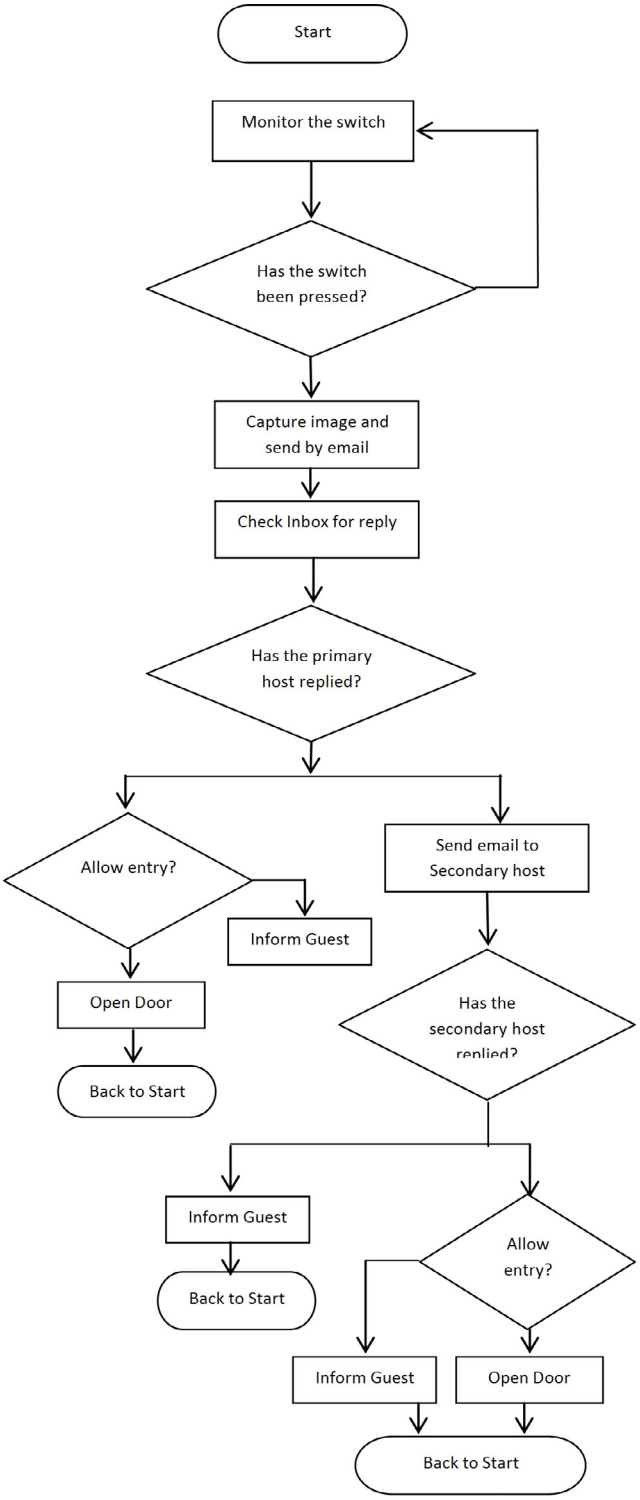

Figure 2. Control flowchart.

actuator. The GPIO pins can tolerate up to 3.3 V whereas the actuator used is a 5 V actuator.

3. Methodology

When a guest arrives at the home and finds the door to be locked, he/she presses the switch at the door. This switch has been implemented using a pushbutton switch in the system developed. The GPIO 24 pin to which the switch is connected is continuously monitored by the system. In case a key press is detected the system proceeds with the next steps of the program. The system designed interacts with the guest using a set of speakers. The board provides audio output via the 3.5 mm jack. Whenever the system needs to intimate the guest about the steps, it plays the corresponding wav file saved in its home directory. For example, when the guest presses the switch at the door a .wav file is played asking the guest to stand in front of the camera. The image of the guest is captured by the web-cam and sent to the primary host and if needed to the secondary host. The reply received determines whether the door is to be unlocked or not. The algorithm used for the implementation of the proposed system is shown in Figure 2 using a flowchart.

The implementation of the design of the proposed system was done using the Raspberry Pi Model B board. The Raspberry Pi is a single-board computer developed in the UK by the Raspberry Pi Foundation. It is a board with features which are very useful in electronics projects. The board features an on-board 10/100 Ethernet RJ45 jack, Dual USB Connector port, 3.5 mm jack, HDMI Audio Output and 26 dedicated GPIO pins, including a UART, an i2c bus, a SPI bus with two chip selects, i2s audio, 3.3 V, 5 V and ground. The board supports video output through the HDMI and RCA Video Ports.

The requirements of the project included switch interface, internet connectivity, USB webcam support, 3.5 mm speakers support and actuator interface. Hence, this board was a desirable choice for the system. It is powered using 5 V via Micro USB connector. Its power ratings are 5 V DC, 700-1500 mA. The software was developed on the embedded Linux based Raspbian OS. The programming of the Raspberry Pi has been done using the Python Programming Language. The scripts were written in the Python IDLE v2.7[10]. The different tasks have been accomplished by importing the necessary library modules and using the appropriate functions.

The flowchart shows the sequence of steps followed by the system depending on the different possible conditions.

3.1 Switch Monitoring

The pushbutton switch has been connected to the GPIO 24 pin. The RPi. GPIO library module has been imported and named as GPIO. The GPIO 24 pin has been configured as input. The value of this pin is checked to detect if there has been a key press.

3.2 Image Capture

The pygame and pygame. Camera library modules have been imported and a new function capImg () has been defined. In the function definition, a camera object is created. Upon calling this function a 640x480 image is captured with the name "person.jpg" and is saved in the "/home/pi" directory.

3.3 Send Email

The SMTP lib, mime types, email and email, mime, application library modules have been imported. The function defined is named send Email(x). It has an integer argument x which is used to specify the recipient of the email. The value 1 indicates the primary host and the value 2 denotes the secondary host. The directory containing the file saved is set as "/home/pi/ ". This function uses the file "person.jpg" as an attachment. The subject of the email is assigned the string "Someone at the door". The body of the email message contains the text "The image of the person at the door is attached".

3.4 Read Email

The Raspberry Pi is assigned a new email address *raspberrypi41@gmail.com*. The IMAP lib library module has been imported. After sending the email to the primary host, the system starts checking its inbox for the reply. The primary host's email address used is *rishabhkumar.gupta2010@vit.ac.in*. A new function named check Email(x) has been defined. The value of x denotes the host. First the reply from the primary host was checked. The prototype developed checks its inbox every five seconds for the next three minutes.

The mail is searched the inbox for an unread email from the address of the primary host. In case the primary

host's reply is received, the subject field of the email is read. The host on identifying the person in the image can reply to that email with the subject as "Allow person". If the subject matches the string "Allow person", the guest is allowed entry and the door is unlocked. If the host is not able to identify the person or does not want the person to enter, he/she can simply reply the email without changing or writing anything. In that case the system will intimate the guest at the door by playing a wav file saying that the guest's entry has been denied. If the primary host does not reply within the time allotted, the same email is sent to the secondary host.

The secondary host has been set as *rishabh.gupta777@gmail.com*. The guest is also informed when the primary host doesn't reply. The same email is sent to the secondary host. Similar to the primary host, the reply from the secondary host is also awaited and checked by the system. The interpretation of the reply is same for the secondary host also. In the rare event that the secondary host also does not reply, the system informs the guest about this by playing a wav file which says that there has been no reply.

3.5 Door Unlock

When the host grants permission to the guest to enter the door is unlocked. To unlock the door, a function called open-door () has been defined. In the prototype developed, a 5 V solenoid actuator has been used to demonstrate the unlocking of the door.

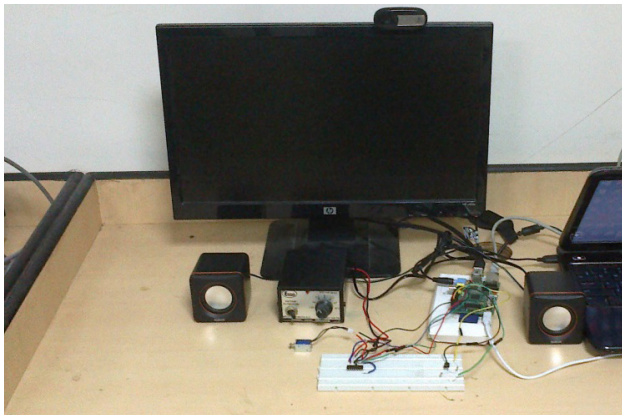

Figure 3. Complete hardware setup.

The GPIO pins 18 and 23 have been configured as output. When the open-door () is called, these pins are activated. These two pins are connected to the L293D IC input pins. The solenoid is connected to the L293D output pins. When the two pins 18 and 23 are set as True and False respectively the solenoid actuator runs and pulls the shaft in.

3.6 Audio Response

The system interacts with the guest at every step of the process through the speakers. The pygame mixer library module has been imported for this purpose. The required audio has been saved in the form of wav files. These files have been generated using text to wav conversion software. A sound channel named sound channel has been initialized. The respective wav file is played at every step of the process by using the sound Channel. Play () function.

4. Results

The complete hardware setup is shown in Figure 3. The webcam which is meant to be kept outside the door at the top is on top of the monitor. The door lock has been demonstrated using the solenoid actuator which has been powered here using a battery eliminator. The breadboard has the driver circuitry. The system is connected to the internet using a CAT5 cable through the Ethernet Port. In the system developed the internet from a laptop was shared with the system. The email received by the primary host is shown in Figure 4. The host can reply to the system whether or not allow the guest to enter the building by replying to the email received.

Figure 4. Email received by host.

5. Conclusion

In this paper, we presented a novel door entry system based on Email along with a sophisticated design also provides the flexibility of remote access control while ensuring security. Our proposed system uses a webcam for capturing the guest's image and sends to the host for authentication. The use of email not only adds conve-

nience but also ensures a level of security by means of an ID and password based authentication. The command to open the door is also known only to the host. This adds another layer of security. Since our proposed system is based on email, it is a device platform independent, flexible and easily installable system without any overhead such as application installation and configuration and hence can be used by any device with internet connectivity.

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