Home Automation System using IOT

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ABSTRACT

In this era of digitization and automation, the life of human beings is getting simpler as almost everything is automatic, replacing the old manual systems. Nowadays humans have made internet as an integral part of their everyday life without which they are helpless. So, internet of things (IOT) provides a platform which allows devices to connect, sensed and controlled remotely across a network infrastructure. The scope of IOT is developing gradually with new technologies like smart grids, smart homes, smart cities etc. IOT permits internet connectivity for all kind of physical objects and devices. In this paper an attempt is made to remotely control all the functions and features of home appliances using IOT, Raspberry Pi and Computer from anywhere around the world using the internet connection.

Keywords

Internet of Things, Automation, Raspberry Pi, Arduino UNO.

1. INTRODUCTION

Nowadays, automation plays a crucial role in all work places and living homes. Automation is a technique of controlling a process by electronic devices with reducing human involvement. These days, automation techniques are implemented either using microcontroller or computer. With the use of microcontroller it is difficult to control both the appliances and surveillance at a time. To achieve this with the computer, this is very expensive for this purpose and consumes more power. But, the Raspberry Pi is a single board computer and it can be used to overcome such problem. It contains GPIO and USB ports which can control the appliances with the sensors as well as interface the camera for surveillance.

Sougata Das et al. proposed SMS based home automation system. It makes the use of SMS technology to control household appliances from certain distance. The entire system will be fail, when user makes any mistakes while typing the message, is the main drawback [1]. DTMF based home automation system is developed by Md. Tanvir Ahammed et al. The DTMF tone is established by the mobile phone that resides at home. The received DTMF tone is further interpret to digital values using DTMF decoder. A microcontroller based control algorithm was developed according to the output logic of the decoder for the function of controlling home applications from a remote place [2].

Jaypal Baviskar et al. elucidate Zigbee based home automation system [3]. Zigbee is a capable short range wireless technology which was execute using star topology, the normal latency of the system was 58.5msec. Whereas the average Round Trip Delay (RTD) time involved in the operation is around 92msec. Bluetooth based system has the drawback of short working range. Any control in home applications examines and controlling system was implemented by Dongyu Wang et al. which support only infrared controlled appliances

[15]. Jaypal J. Baviskar et al. explained Zigbee based control systems for home appliances control. zigbee covers a distance of 90m [7]. The concept of Bluetooth based control systems for home appliances control has been projected by Er. Vikram Puri and Mohammud Asadullah. This thesis shows complete description of various components used and working of all the components integrated with each other. The system also makes use of Android App titled "Smt Home Control" which provides flexible and easy to use GUI for interface [4], [12].

Kennedy Okokpujie et al., proposed speech recognition based home automation system. When there is a background noise, system performace is less accurate [5]. Five appliances are automated through the use of Siri's speech recognition capability developed by Ana Marie D. Celebre et al. [17]. Voice command to control any electrical tool has been developed by Syarif Hidayat et al. In which the system could only examine digital state of the switch. Hence, this system could not manage ambient device. Every computer in the workspot RF module based home automation system using FPGA has been developed by B. Murali Krishna et al. [10]. Mario Collotta et al. elucidate Novel Energy Management Approach for Smart Homes Using Bluetooth Low Energy. RF transmitter covers a distance of 400m [9].

Nadeem Tariqet et al. proposed Wi-Fi based home automation system. An overview of systems with home automation has been presented in the UWB. Wireless USB and IR wireless covers up to a distance less than 10m and 10m respectively [11]. SarthakJain et al. elucidates Raspberry Pi Based Interactive Home Automation System through E-Mail. In which Wi-Fi technology covers a distance of 12 to 91 meters. Due to many spam messages, the emergency mail could not be viewed and user has to login with E-mail ID and password which causes a time delay, is the main drawback [13]. The authors P Ravi Babu et al. proposed a system for smart home automation technique with Raspberry Pi using IOT and it is done by integrate cameras and motion sensors into a web application [18].

IOT-based monitoring system using a tri-level context making for context aware services in smart homes has been proposed by Byeongkwan Kang et al. [16], which provides context aware services. Soumya S et al. proposed Home automation based on Internet of Things. This designed system not only monitors the sensor data but also actuate a process according to the requirement. But Raspberry Pi cannot read data from a lot of sensors [20]. Home automation application using Raspberry Pi and GSM has been developed by Shrikrushna Khedkar et al. Authors have used the Python environment for Raspberry Pi operation [19]. Various open source hardware such as Arduino, Raspberry Pi etc. used to build smart and secure homes has been described by Ayush Panwar et al. [21]. This proposed system makes use of NRF 24L which overcome the limitations of Wi-Fi and Bluetooth. Syed Ali Imran Quadri et al. [22] designed a system using ARM-11 architecture and Linux OS based Raspberry Pi-3 board, USB camera and DC motor. In this case, microcontrollers send data into the cloud server and this information is shared on cloud server, which can be accessed by using android application was proposed by P. Sanjeevi et al. [23]. Here the proposed system makes the use of Arduino, which is not powerful when compared with Raspberry Pi3. Control and monitoring of home appliances using android application over internet has been described by P. Siva Nagendra Reddy et al. [24].

The objective of this paper is to develop a monitoring system by using Raspberry Pi which acts as an interface between user and the devices. The Raspberry Pi is a low cost microcomputer that is able to run on Linux and it does not contain any radio transmission which may require high power radiated that is harmful to the human body. The system is designed to achieve a simple and user friendly interface thereby the system does not depend on manual initialization. Normal remote control system can work within a few meter ranges like home automation using Bluetooth. But, IOT technology can be used anywhere of the world, if internet is available. The IOT technology helps the user to operate different home appliances from remote place using a computer or a smart phone.

2. HARDWARE DESIGN

In this section, various components used for the development of the proposed home automation system are elucidated. The proposed work is based on a smart home automation system using Raspberry Pi board that gives a reliable and efficient method for automating electronic devices. This system allows the user to operate several devices using single device from one place where users can control lights, fan, etc. In case of lights, system will turn on the lights if motion sensor is active and natural light is below the required density. If user forgets to switch off any device, the device will automatically turn off after a certain time limit if motion sensor is active. Hence, the system benefits the electricity consumption by consuming minimum amount of energy.

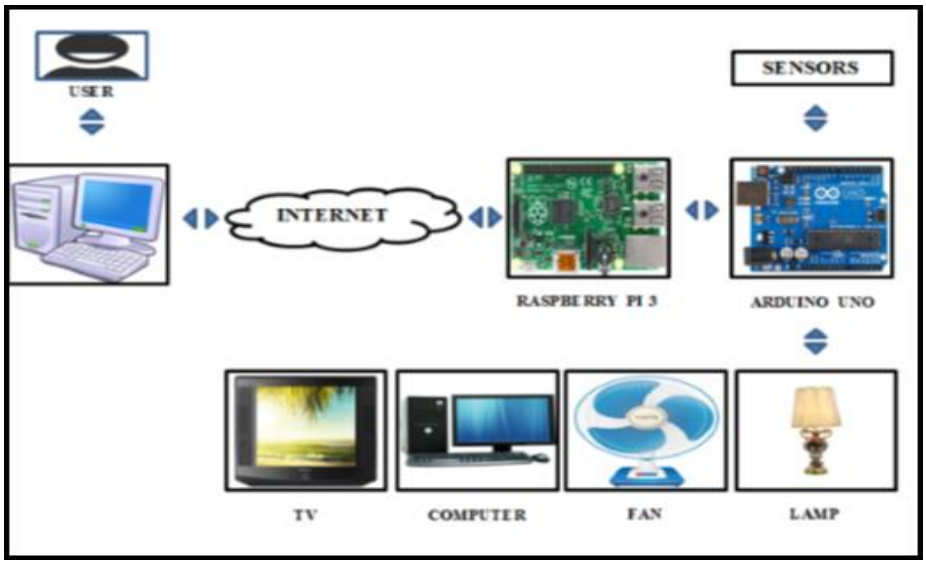

Fig 1: Proposed Home Automation System using IOT

A Raspberry Pi will serve as a master device, Arduino UNO will act as a controller, which takes command from the Raspberry Pi 3 and operates on specific device. The Raspberry Pi and all Arduino UNOs are connected together using USB cable and all Arduino UNOs act as slaves. The Fig 1 shows the animated view of home automation system along with components being utilized behind the development of the system. Considering room scenario, an Arduino UNO will control devices and reads sensor data. Periodically, Raspberry Pi requests for the sensor data collected by Arduino UNO. Each room have multiple controllable devices such as Lights, Fan and Wall Sockets using one Passive IR to detect human presence in the room and LDR to detect light intensity near room window.

2.1 Raspberry Pi3

The Raspberry Pi 3 is a low cost, credit-card sized computer that plugs into a computer monitor or TV and uses a standard keyboard and mouse. There are different types of Raspberry Pi model available such as Model A, Model B, Model B+ out of which Model B+ i.e., Raspberry Pi 3 is used in this work. The Raspberry Pi has a Broadcom BCM2837B0 system on a chip, which includes an ARM Cortex-A53 1.4GHz and has 1GB LPDR2 SDRAM. It does not include a built-in hard disk, but uses an SD card for booting and storage. In this system the Raspberry Pi model is used as a controller.

Fig 2: Raspberry Pi3 model B+ Top view

2.2 Ardunio UNO Microcontroller

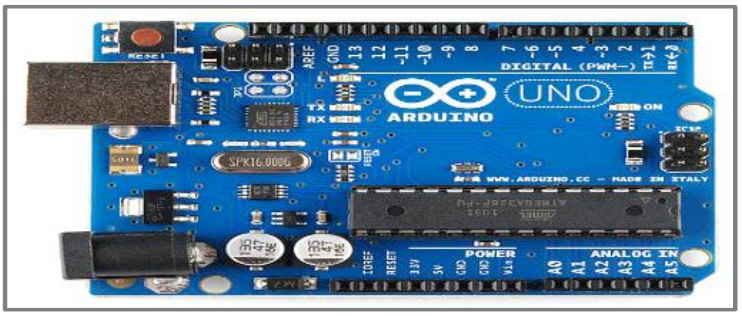

Fig 3: Arduino UNO Microcontroller

Arduino UNO is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins of which 6 can be used as PWM Outputs, 6 analog inputs, 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to interface the microcontroller to a computer with a USB cable.

2.3 LDR (Light Dependent Resistor)

LDR is a component that has a variable resistance that changes with the light intensity that falls upon it. Hence, it can be used in light sensing circuits.

Fig 4: LDR (Light Dependent Resistor)

2.4 PIR Motion Sensor

A Passive Infrared Sensor (PIR sensor) is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. It is generally used as motion sensors.

Fig 5: PIR Sensor

2.5 Relay Module

The relay module is a separate hardware device used for remote device switching. Using this devices can be remotely powered on or off with commands coming from the Clock.

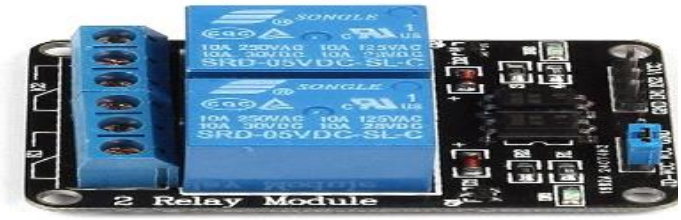

Fig 6: Relay Module

3. SOFTWARE IMPLEMENTATION

There are four softwares are utilized in developing the proposed system namely, Debian operating system, Cloud access sqlyog, Cloud database mysql and Microsoft visual studio 2010. When user start the application, establish internet connection between devices. Computer sends command to other connected devices. Then, check the override rule (condition or status of sensor). If it allows, perform the operation as per the user command. Otherwise read the sensor values. If sensor values are greater than or equal to threshold value, then process it in Raspberry Pi and send it to the cloud. Then perform the operation as per the user command. If the condition of sensor value less then threshold value, directly perform the operation as per the user command. These steps are indicated by the flowchart as system operation in the Fig 7.

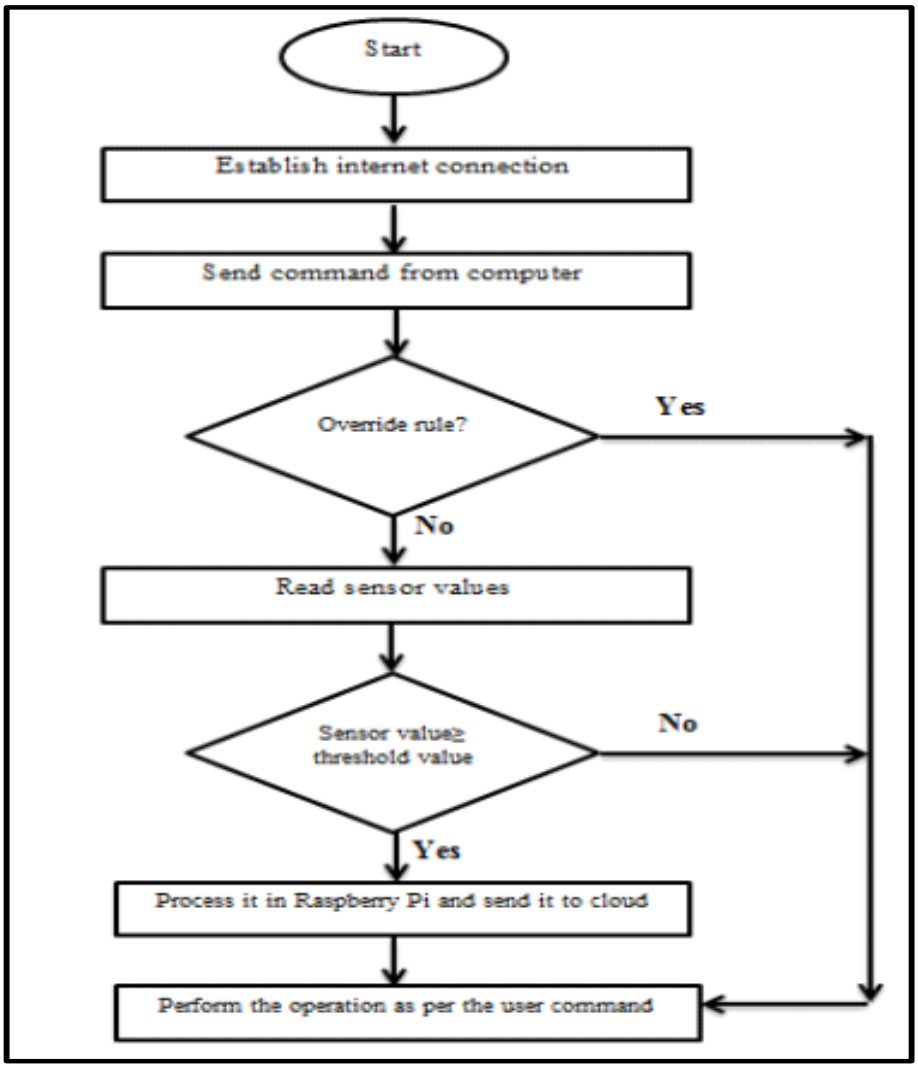

Fig 7: Flow Diagram of the System Operation

4. EXPERIMENTAL RESULT ANALYSIS

4.1 Designing of a Security protocol for the Internet of Things:

This will cover the authentication of each client by providing an efficient authentication mechanism that prevents misuse of accessing the home appliances. Designing a security protocol for the Internet of Things involves: user Registration, admin approval user Request to Control, Certificate Generation, Certification Comparison to Execute User Command.

4.2 The registration process involves the following steps:

The IoT server admin software application is accessed by the right click on the iotserver.sln folder and then opens it with the Microsoft visual studio version selector. To run the IoT server software, first build the solution followed with the notification of build succeeded message compile software using the ctrl+F5.

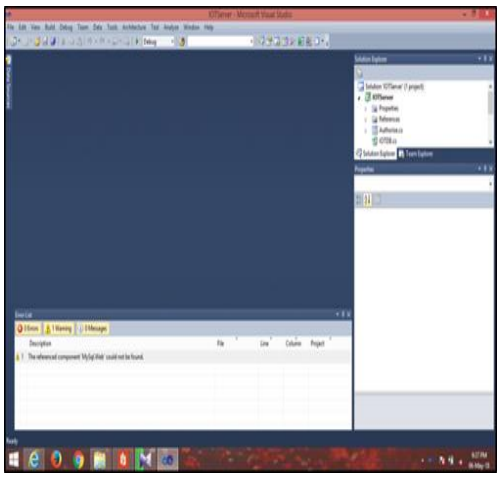

Fig 8: Microsoft Visual Studio Version Selector Window

Fig 9: IoT Server Home Page

The following screen will appear as soon as compiled to accept or reject the request of the user by the admin. Now enter the appropriate PIN number. If the entered PIN number is incorrect, a dialogue box will appear showing the error message as "invalid PIN!!". If the entered PIN is a valid one then following screen will appear and admin gets right to control the approval requests. Similarly, the client application software is accessed by right click on the clientapplication.sln command and opens it with Microsoft visual studio selector. To run the client application software, first build the solution followed with the notification of build succeeded message, compile the software using the command ctrl+F5 following screens will appear.

Initially for the user to get register, go to the options Register and user can login through an application by providing processor id, MAC id, user name and email id. After providing the user information such as processor id, MAC id etc. click on Enter. Now a dialogue box will opens, here click on OK.

Fig 10: Client Application Home Page

Fig 11: User Registration Page

Once the user registers, the request is sent to the admin to accept or reject the request. The following screen will show the IoT server application software for admin approval in which go to options and click on Approve. After the approval from the admin, the security pin is sent to the user email id.

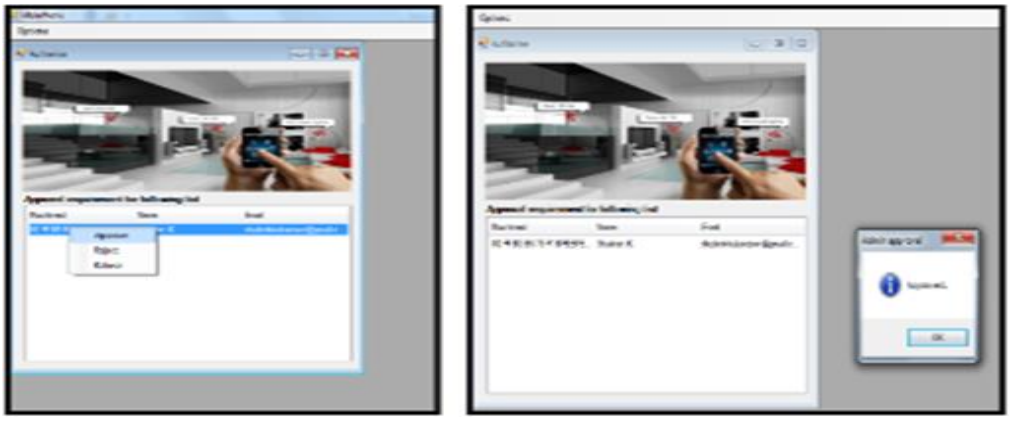

Fig 11: Admin Approval Screen

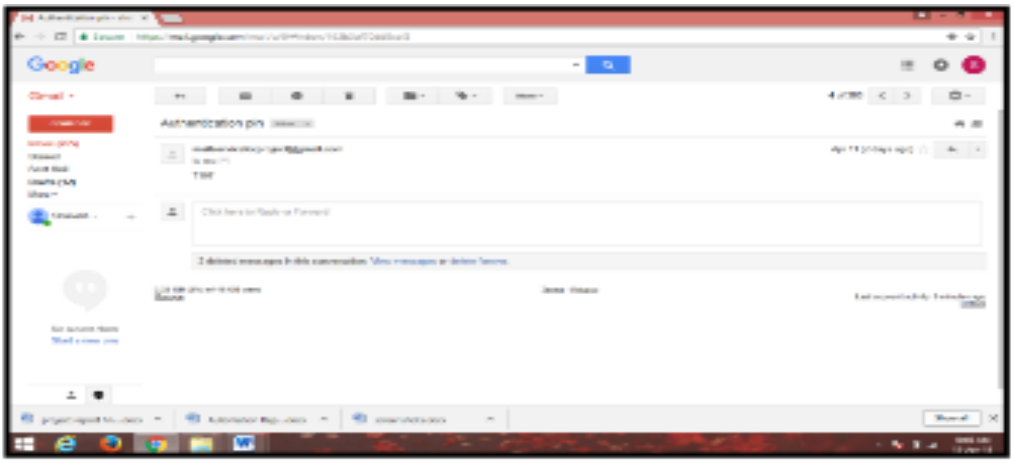

Fig 12: User Mail Box

Now go to options control IoT in client application software to control the home appliances. Enter the security pin which is sent to the user email id, if the entered security PIN is incorrect then error message will appear as shown in below screen.

Fig 13: User Switch Controller Screen

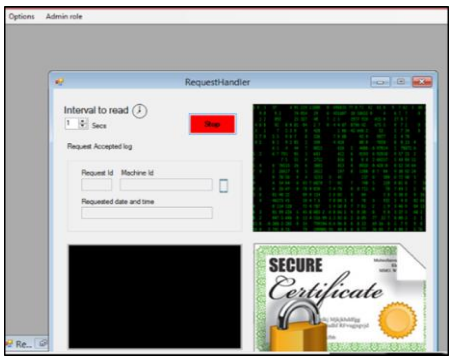

Fig 14: Admin Start Service Screen

OK button. After the authentication process user request for using the services and request for the certificate is submitted. Now go to options start service in IoT server application software for the admin to generate the certification for the requested user.

Once the user request for a service then request is forwarded to Authority node, it then generates a certificate and sends it to both user application and home PC. Suppose the user click on status check button before the certificate generation then it produces the error message as “Sorry certificate not yet generated for your request!!”. Once the certificate is generated and received, then click on the check status button this enables the control switches to control the appliances with reference to the current status of the devices.

Fig 15: User Switch Controller

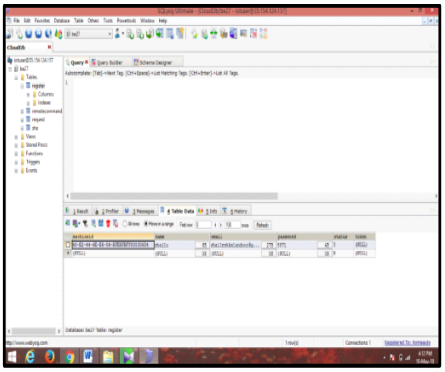

Fig 16: Cloud Database Screen

Once the user is registered, the every register details, certificate details are stored in the cloud database at port be 27. All this information is stored in the cloud which can be checked by the user any time when away from home. The model is developed with the elements like Raspberry pi, Arduino Uno and relays etc. and collectively known as home pc.

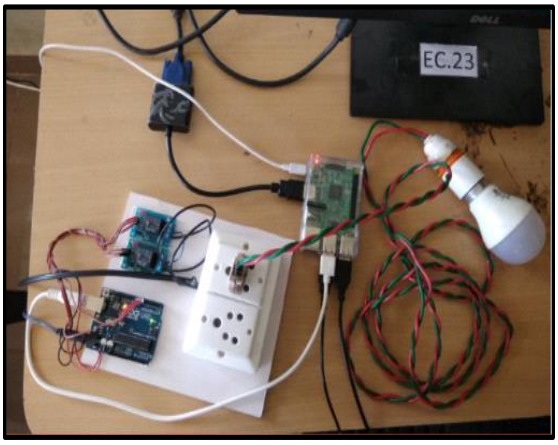

Fig 17: Home PC Model

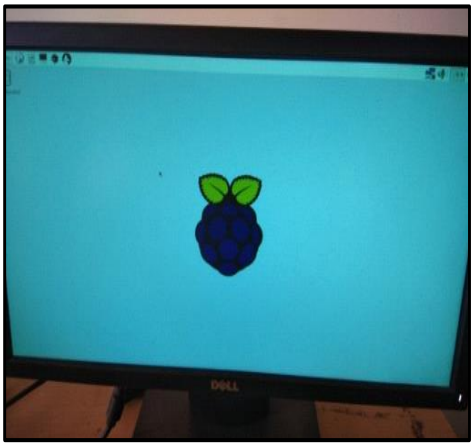

Fig 18: Raspberry Pi Home Page

The Raspberry Pi is connected to the display like TV or monitor for the user interface and it is logged in by providing the user name and password. Then following screen will appear as in Fig 18.

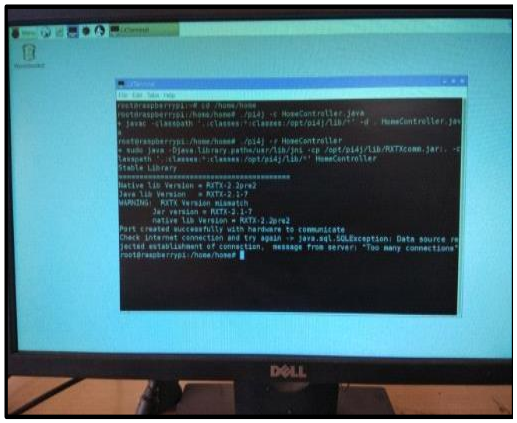

Fig 19: Lx Terminal Screen of Raspberry Pi after Compiling

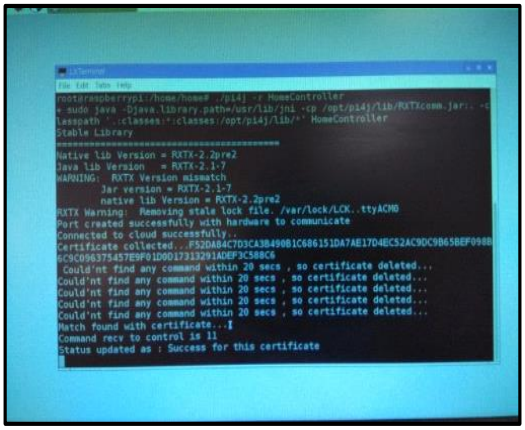

Fig 20: Lx Terminal Screen of Raspberry Pi after Complete Process

Click on the Lx terminal tool bar and after the initial change directory command execution, compile the software that results with the message "port created successfully with hardware to communicate" and it is successfully connected to the cloud.
Once it is connected to the cloud, further run the software and it collects the certificate sent by the admin. If match found with the user request and the certificate collected, the user gets the control for IoT devices and the corresponding status are updated as per the user command.

The following Fig 21 & Fig 22 shows the output of the appliances connected to the relay for different user commands provided.

Fig 21: Output of the Devices when the User Command is True for both Relays

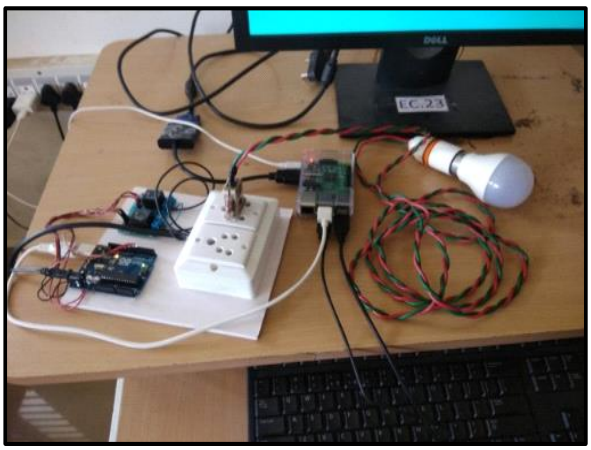

Fig 22: Output of the Devices when the User Command is False for both Relays

5. CONCLUSION

The goal of the paper was to design a home automated system using Raspberry Pi, in order to help the people to easily operate the home appliances. This automation work was implemented based on the Raspberry Pi and the language used for communication of kit is Java which can be easily configured. Implementing smart home ideas, interfacing it with

the kit is easy and using this system at home we can perform automated operations to monitor the home appliances was successful.

ACKNOWLEDGEMENT

Acknowledgements are due towards beloved students Sevanthi K R USN: 4GL14EC049, Shailesh K USN: 4GL14EC050 and Pooja T G USN: 4GL15EC404. Special thanks to teaching and non-teaching faculty of GEC, Kushalnagar for their encouragement and guidance.

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