IMPROVISED HOME AUTOMATION SYSTEM WITH INCORPORATION OF WSN AND IOT

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Abstract : The need for automation in our day to day life and for our frequently used appliances, to make the efficient usability of the devices for better living, increases with the increasing technology. Humans thrive for automation and also for reducing the complex living. The present system is developed to reduce human effort by making day to day home appliances easily accessible and automating them. The system helps to control and use the devices remotely through mobile application. It also provides an intruder(burglar) system which avoids breaching into a private property without permission. The system can be accessed from anywhere using internet, or else with the help of Bluetooth within a specified range. The device can also be used or it can be useful for physically handicapped people to control switches of light fans using mobile application. The system is developed to improve the standard of living and to minimize the effort.

Keywords **- Internet of Things(Iot), Home Automation System(HAS), Wireless Sensor Network(WSN), Message Queuing Telemetry Transport(MQTT).**

I. INTRODUCTION

Home automation introduces anything we want it to be which enables us to use our devices or appliances automatically, efficiently and effortlessly. Automation is anything that gives us remote or automatic control of things around the home. It can be as simple as remote or automatic control of many devices, or it can be a whole system that controls all major parts of our home, customize according to personal preference. Automatic Control to electronic devices of household features and its activities also refers to home automation.It replaces the electrical switchboards situated in different rooms of our home which makes inconvenient for the members in the home particularly for elderly and physically handicapped to operate them.

Wireless Sensor Networks have become a stunning field for innovations as well as scientific and technological developments. This Home automation system incorporates wireless sensor network(WSN) which is network device used for the communication of gathered information from sensors wirelessly over a network. It establishes various sensors to monitor the occurrence of specific devices and its activities. In the living life of aged and physically handicapped people in real time, they generally tend to forget or unable to reach electronic switchboards activities like switching off the lights and fans. In some cases, they might be neglectful and not able to recollect to switch off the gas cylinder which may, in turn, cause an LPG gas leakage. Thus a WSN based improvised HAS is developed especially for such elderly and physically handicapped people to help them ease their work and its related operations to provide them a safe, effortless and secure living.
To reduce human efforts this system provides an innovative app-based application that offers intelligent control at an affordable cost. It is also called as “Smart Touch”.Smart Touch allows us to monitor and control fans, lights with just one touch.It ensures comfort and convenience
Internet of Things (IoT) conceives the idea of remotely connecting as well as monitoring real-world objects (things) via the Internet. When we think of smart home, this concept can be capably incorporated to make it smarter, safe and automatic. This IoT based HAS guided us to build up a smart wireless home security system which sends alerts to the owner as well as the user by using the Internet which raises an alarm in case of trespass. Similarly, it can be utilized same for home automation by using the different set of sensors. This system implements Raspberry Pi model with inbuilt Wi-Fi and Bluetooth module is the main advantage which helps to monitor, alert and sent the status by wifi and Bluetooth can be received by the user on his smartphone from any distance. The main advantage of Bluetooth is that the user can access the various appliances of the smart home in the non-existence of Internet connection within the specified range.

Integrated compatible smart devices and control, monitor, and manage our smart home from anywhere anytime with just one touch.We can control and showcase smart home elegantly, all with a single touch. Home automation system has the power of transforming the home into a smart home at our fingertips.

II. Literature Review

Suvadeep and Lakshmi presented an IoT based smart security and HAS which implemented the IoT project that focused on building a smart wireless home security system to send alerts to the owner via Internet and raises an alarm optionally. They also implemented the home automation by utilizing the same set of sensors. WI-FI connected microcontroller is used to send alerts and the status can be received on his phone by the user from any distance. The microcontroller TI-CC3200 Launchpad board is carried out with an embedded microcontroller and an onboard Wi-Fi shield rely on which all the electrical devices can be controlled and managed[1]. A .Alheraish executes design and implementation of remote control system by means of GSM cellular communication network. The design integrates the device to be controlled, the microcontroller, and the GSM module so that it can be used for a wide range of applications[2]. Amrita and Soumya had research on home automation adopting facial expressions which inject the angry, neutral,sad,fear and smiling. This system benefits us by controlling and making use of the devices remotely through innovative app- based mobile application. It also contributes an intruder(burglar) system which diverts violating into a private property without any permission. This system can be accessed from anywhere anytime via

internet. Optionally, it also serves Bluetooth if in case there is internet connection failure can operate within a specified range. This smart touch based mobile application offers smart control over HAS at cost effective for physically challenged people to control switches of light fans using mobile application. The system is implemented to improve the standard of living and to control your home elegantly with a single touch and reduce the humans effort.

III. Hardware Description

The hardware system consist of smartphone with Android application is a transmitter used to control lights, fan speed regulations and different home appliances. It also consist of Raspberry PI 3 model, relays, breadboard, wires, burglar and set of sensors which are receivers. Raspberry Pi 3 model provides inbuilt Wi-Fi and Bluetooth Module. It is connected to the Message Queuing Transport telemetry(MQTT) server as well as breadboard. We have used MQTT server where mobile commands will be published which is accessed by the user on android application based smartphone. The inbuilt Wi-Fi module receives the information from the gateway through UART serial port and sends the information to the server where it should be stored so that we can retrieve the information whenever needed in future. In this implementation Bluetooth module is optionally used to control home appliances on smartphone in the absence of Internet connection.

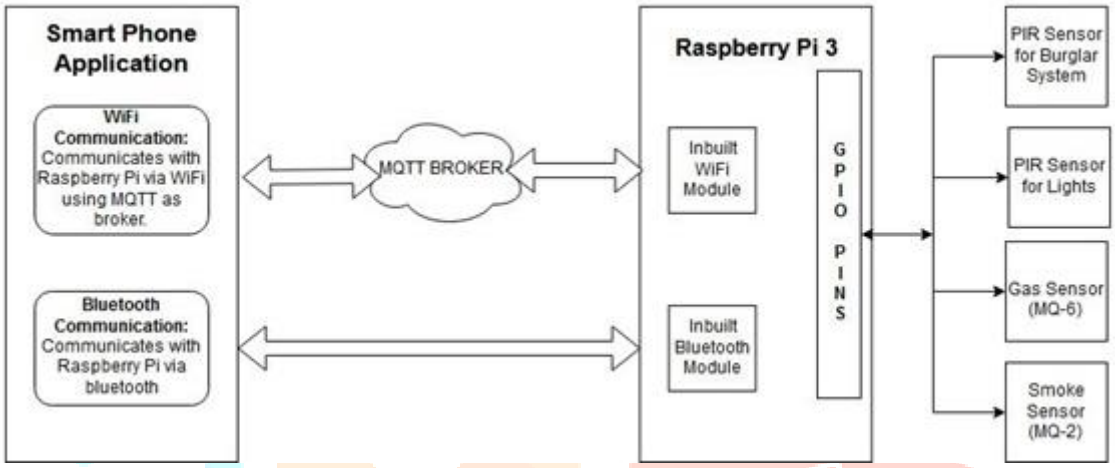

Fig 1: Block Diagram of improvised home automation system using WSN and IoT.

Relays consist of 3 pins which are GND, VCC and INS pins which are connected to Raspberry PI model using wires. GND is ground pin which is connected to the GND pin of this model, VCC pin is connected to 5V pin of Raspberry PI and IN is input pin which is also connected using GPIO pins of this model. Breadboard is used to make temporary circuits for testing is connected to the Raspberry PI model using wires. Positive and negative terminal of burglar is connected to the breadboard and the input taken through wires from the model is serially sorted to the +ve and -ve terminal using GPIO pins. The set of sensors as well is connected to the Raspberry PI according configuration of GPIO pins using wires.

PIR sensor is a motion sensor which pick up the infrared heat from human bodies and detects the human intrusion into the home. This motion sensor can alert the user with burglar alarm,the buzzer sets on when motion is detected. Fire sensor is a flame or fire detector and buzzer is used to alert about the fire when it is detected. This sensor turns on the alarm as soon as detected. The gas leakage sensor senses the seepage of LPG gas. The gas leakage sensors in HAS is important as it can avoid the risk of gas leakage, if there exist leakage it turns on the alarm and alerts. With the help of SEN-1327 gas sensor module from RhydoLABZ the gas leakage is detected. The threshold is set using preset in module. Interfacing is done via SIP header. The sensor can also sense combustible gases like methane.

A brief components description is driven in this section

3.1 Raspberry Pi 3

Raspberry Pi is a low cost ARM-based and credit-card sized computer.It allows the people to explore computing of all ages and teach us to do programming in languages like python.It has an capability to interact with outside world.

3.1.1 Specifications

Raspberry Pi 1 and zero has used BCM2835 Broadcom processor whereas Raspberry Pi 2 has used BCM2836 Broadcom 64 bits core processor.Here Raspberry Pi 3 model is used having BCM2837 Broadcom processor.

Fig 2: Raspberry Pi 3.

It has some features like 1GB RAM and inbuilt BCM43143 WiFi on board and Bluetooth Low Energy (BLE) on board with addition to it GPIO has 40 pins extended through which sensors are interfaced and it includes 4 x USB 2 ports. Operating system and storing data can be loaded using SD port is provided. It also includes the factor provided by Pi 2 model B.

3.2 Relay

Relay is a switch which is operated electrically. The main use of this relays is that their circuits are controlled by low power signal. This relays incorporates series of switches which includes:

Inputs: Vcc is a positive terminal connected to 5V Current on Raspberry Pi Board, GND is a negative terminal connected to the ground and digital inputs(IN1 and IN2).

Outputs: Normally Open(NO), Normally Closed(NC) and Common pins(COM).

Fig 3: Relay.

NC: IN1 is set to low when NC is interfaced with COM and disconnected when IN1 is set to high.

NO: IN1 is set to low when NO is disconnected with COM and connected when IN1 is set to high.

This implementation uses this module to switch on the lights and fans in the home.

3.3 PIR Sensor

PIR sensors are also known as “Passive infrared” motion sensors which are used to sense the motion of an object. This sensor captures the infrared signals radiated from the moving object and alerts by using burglar alarm.

PIR sensor is designed with three pins: Ground(GND), 3-5VDC input(VCC) and digital output(OUT). When the sensor detects no motion, the OUT stays low and when motion is detected, the logic is high which is sensed with the help of Raspberry Pi. In this paper, the PIR sensors are implemented for burglar system and Lights. Eg: When the person enters the room, the motion is detected and the buzzer is set ON for the burglar system and for lightening system when the motion is detected, Light of the room automatically turns ON. It detects the motion upto 20 ft away.

Fig 4: PIR Sensor .

3.4 Gas Leakage Sensor(MQ-6)

The MQ-6 Gas Sensor module is used to detect the gas leakage in the home. The gas sensors having MQ series uses a small heater inside with an electrochemical sensor. They are excitable to a range of gases and are used at room temperature. With its fast response time and high sensitivity, measurements are taken as soon as the event occurred. Feature of this sensor includes high sensitivity to LPG, iso-butane, propane ,Small sensitivity to alcohol, smoke. It also includes the features like Fast response, Stable and long life, Simple drive circuit.

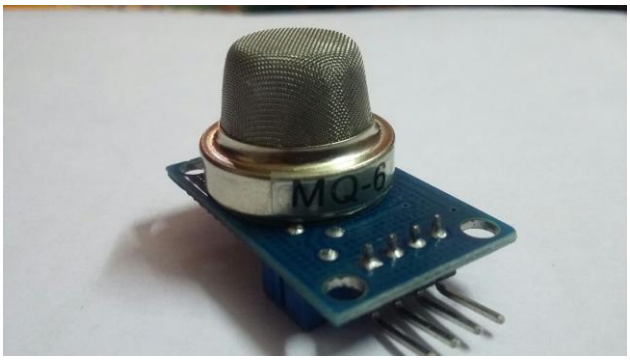

Fig 5: MQ-6 Sensor.

3.5 Smoke Sensor(MQ-2)

A smoke sensor is a smoke sensing device, which is an indicator of fire. In case of Commercial and residential security devices a signal is issued to a fire alarm control panel as component of a fire alarm system, while smoke alarms are well known for household detectors, generally issue a local visual or audible alarm from the detector itself. The Analog Smoke sensor (MQ2) module makes use of an MQ-2 as the sensitive component.

3.5.1 Specifications

Dimension: 32mm x 22mm x 30mm Specification:
Operating voltage: 5V
Detection Zone: 300 - 10000 ppmm
Characteristic Gas: 1000 ppmm
Sensitivity: R in air/ R in typical gas
Response Time: 10s
Recovery time: 30s
Heating Resistance: 31 ohm
Heating Current: 181 mA
Heating Power: 900mW
Measuring Voltage: 24
Ambient Temperature:- 20C - 55C
Humidity: 95%
Oxygen Content: 21%

Fig 6: MQ-2 Sensor.

IV. Software Design

Software design implements Android application based Smartphone which involves two schemes first is Wi-fi communication in which the Android application interacts with Raspberry Pi 3 via Wi-fi using MQTT as broker and second is Bluetooth communication in which the application communicates with Raspberry Pi 3 via Bluetooth. This communication can be used when there is no internet connection. Both the communications are used for controlling and monitoring the home appliances in their own ways.

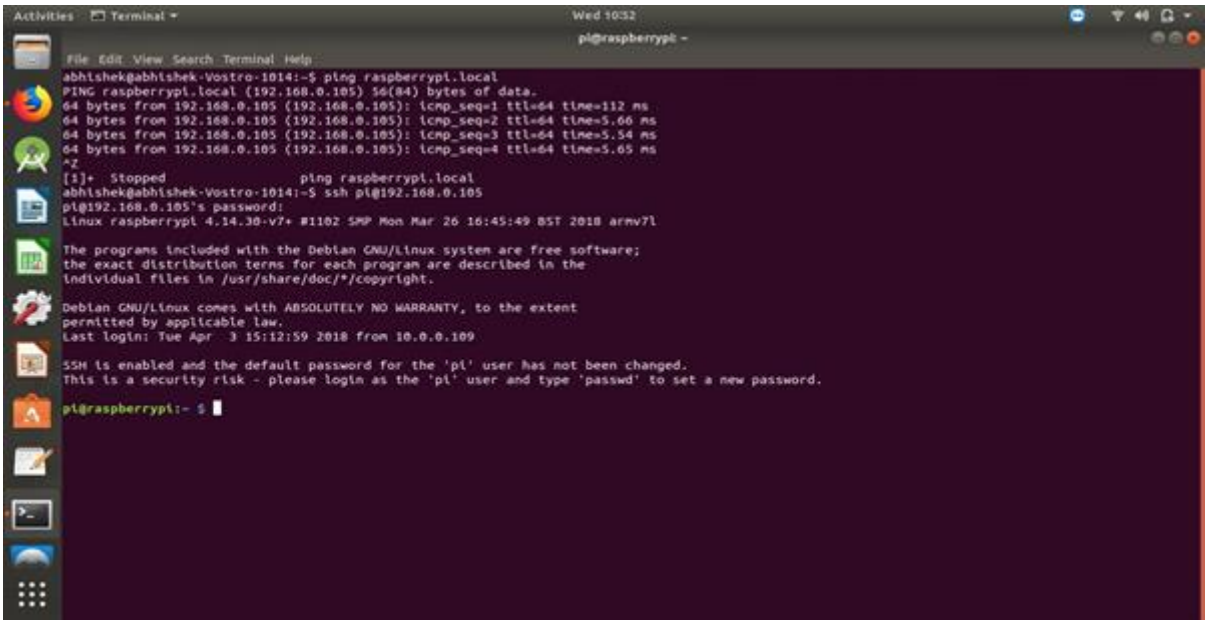

Fig 7: Communicating with Raspberry Pi through SSH.

This project model involves the Raspberry Pi 3 installation on terminal which supports operating system like linux and python 3 language which is used to develop code using commands that helps us to monitor and control the home devices through the sensors. As shown in Fig.7 ping command is executed to find the IP address of Raspberry Pi 3. After getting the IP, it is used to login the Raspberry Pi through SSH.

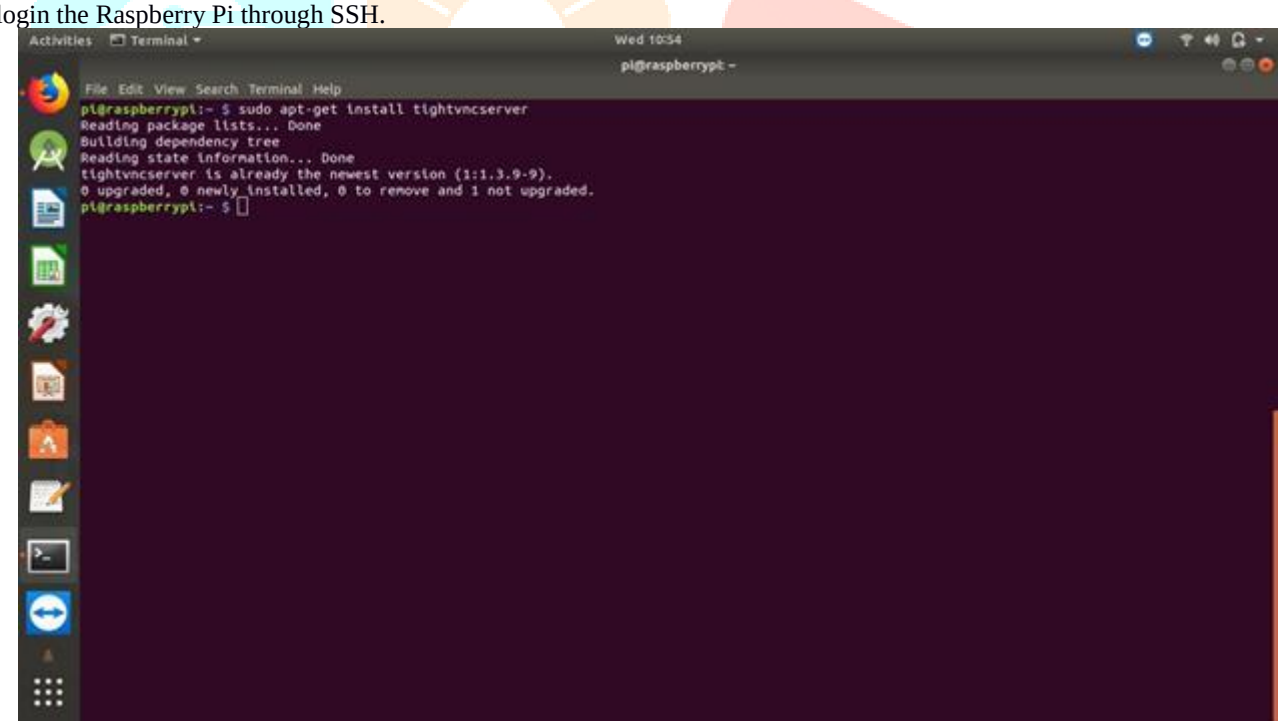

Fig 8: Installation of VNC Server.

After the Pi Login, Tight VNC server is installed on Pi to share desktop with remote computer for troubleshooting as shown is Fig 8. VNC is virtual network computer which works as client server architecture.This server is used for transmission of duplicate display screen of remote computer to the VNC viewer. Commands coming from the viewer are also interpreted by the server. This is used for the purpose when the Pi is not connected to Desktop Screen to view the working of Pi.

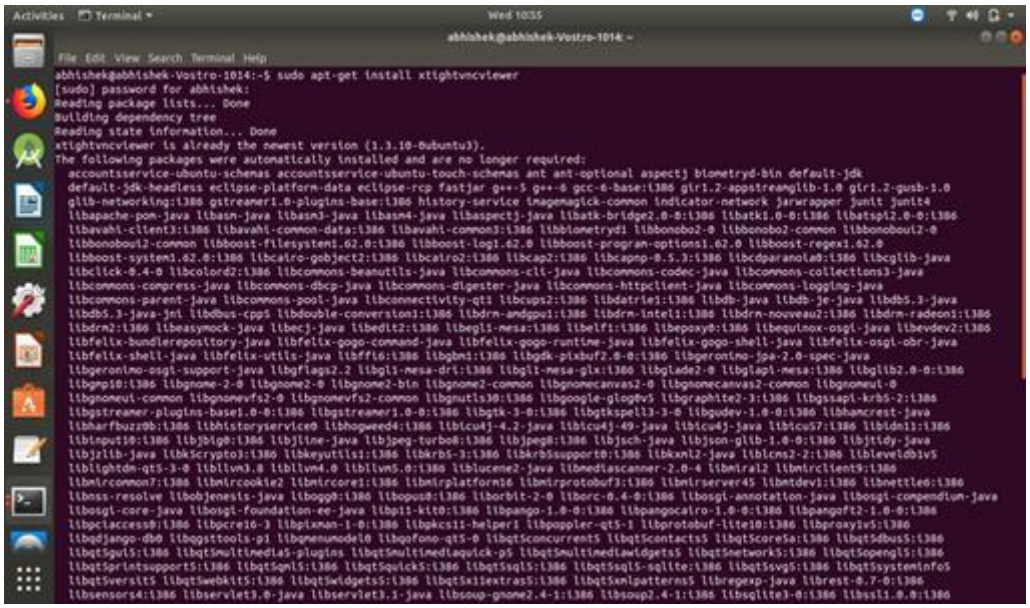

Fig 9: Installation of VNC Viewer.

Next is the installation of VNC viewer which is installed on local computer and connects to the server which is installed on remote computer. The need of VNC viewer is to access the desktop from other computers. Fig 9 shows installation of VNC viewer.

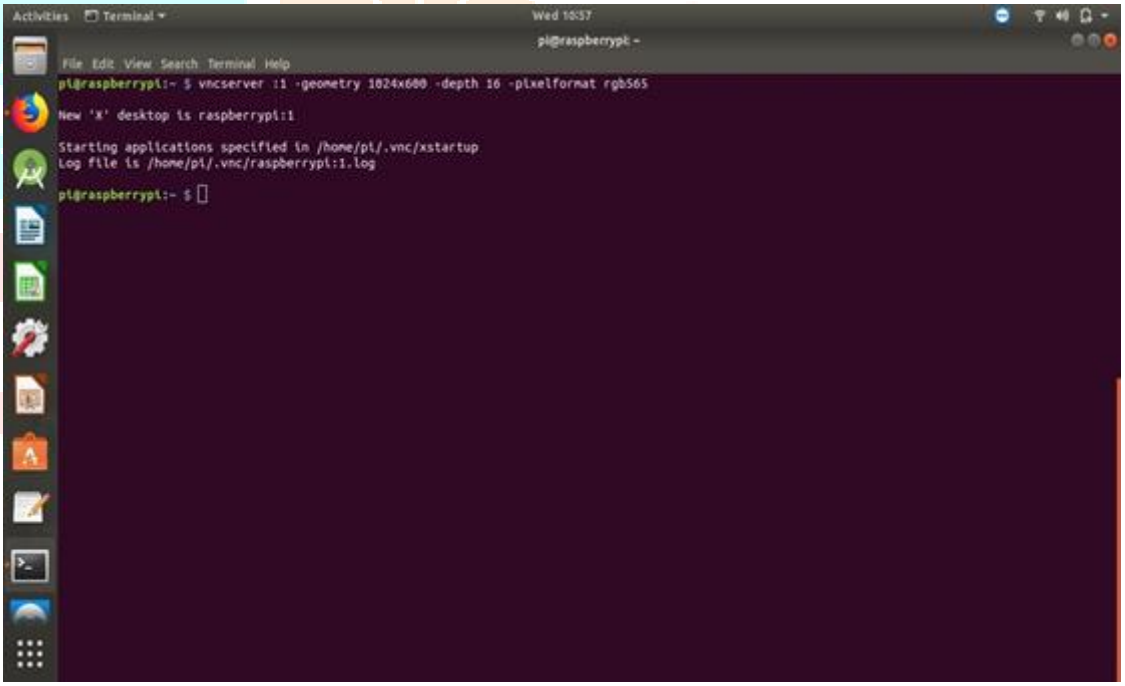

Fig 10: Creation of VNC Server on Pi.

In this step, in order to view the screen of Raspberry Pi we have to create and initialize the VNC Server. The above figure shows the creation and initialization of VNC Server.

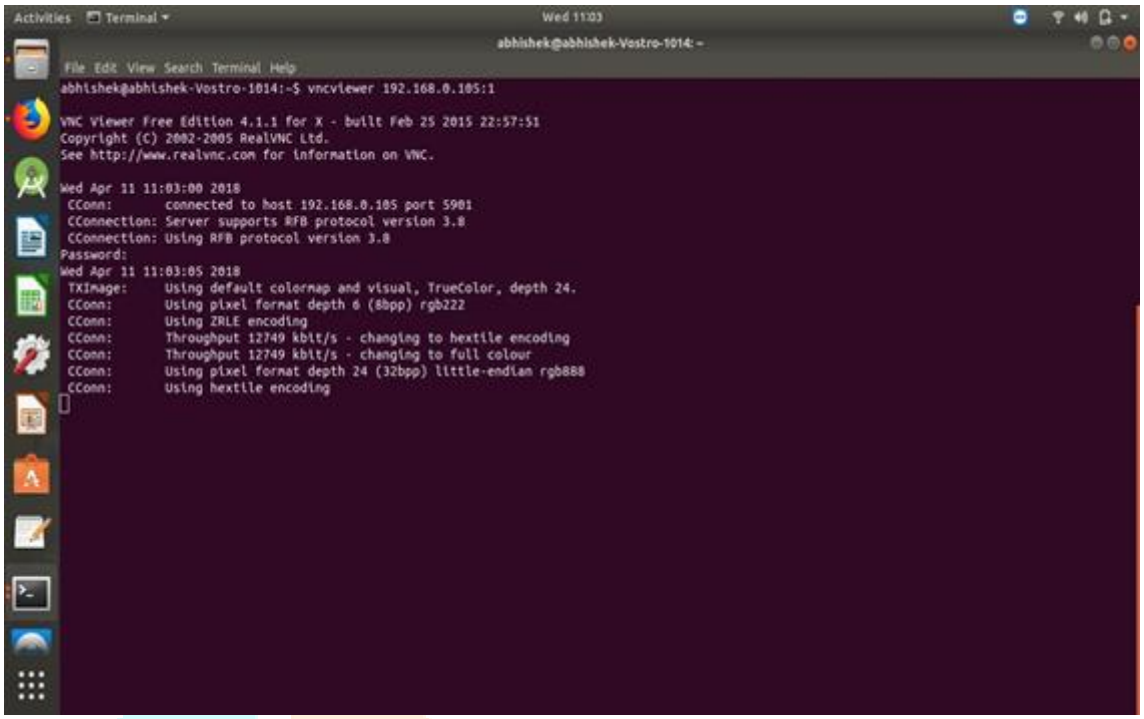

Fig 11: Login of VNC Server from client machine.

VNC viewer is a client-side viewer of host computer in which the viewer is logins using IP address of Raspberry Pi. Command is run on client terminal to display the Pi screen and to access the desktop as shown in Fig.11.

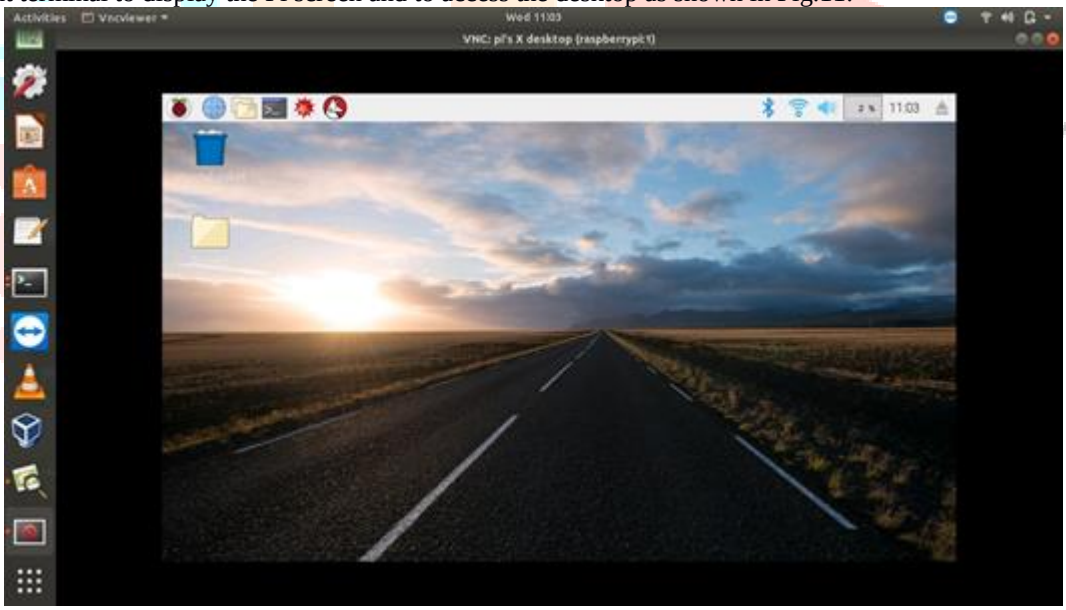

Fig 12: Desktop screen of Raspberry Pi.

Fig.12 displays the Raspberry Pi 3 desktop screen in the absence of HDMI cable connection. We have used VNC server and VNC viewer to share and access the desktop of remote computer.

V. Experimental Setup

This setup includes various modules such as relays, PIR sensor and Gas leakage sensor are interfaced with Raspberry Pi 3 board with inbuilt Wi-Fi and Bluetooth module as illustrated in Experimental setup in the Fig.13.

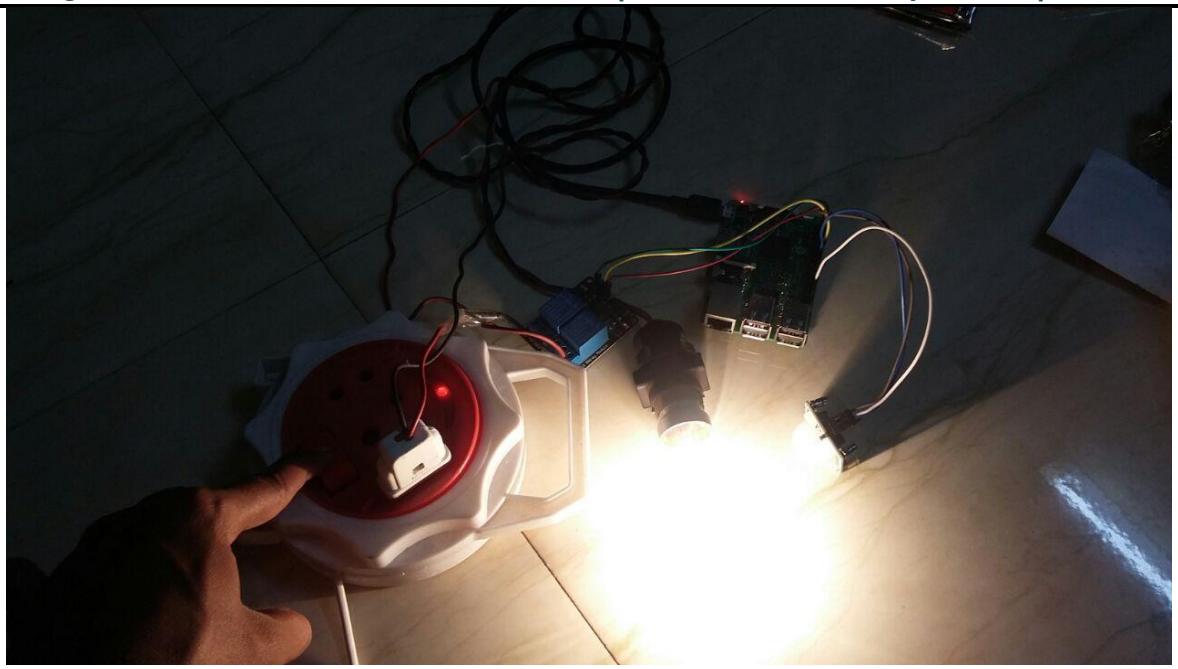

Fig 13: Home Automation System Light Module.

Figure.14 shows the flowchart of all the activities of the application that operates through Wifi or Bluetooth to provide all the functionality to the user. Handling of application is very easy to all the user.

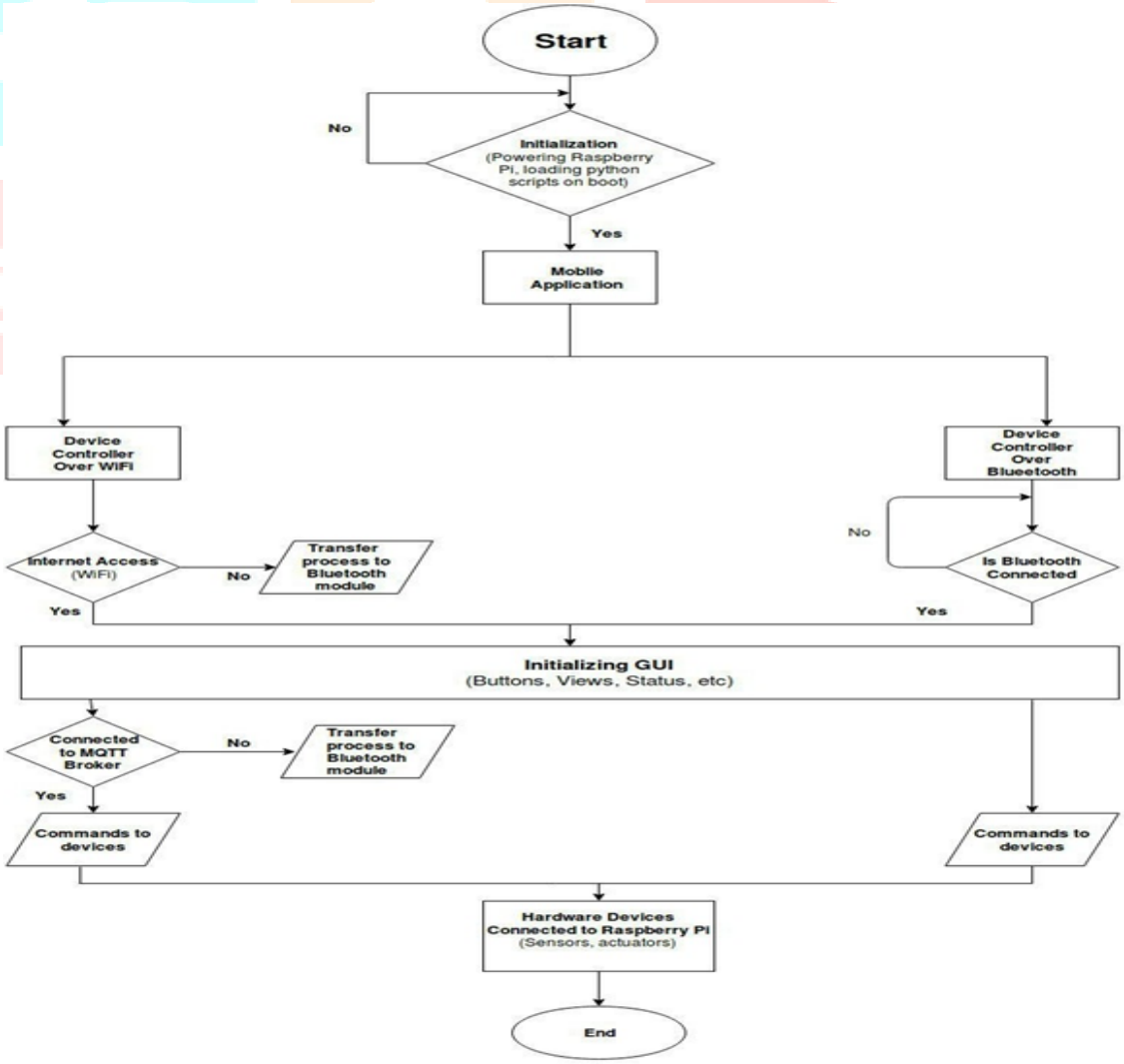

Fig 14. Flowchart Diagram of various events taking place connected to hardware devices.

VI. RESULT AND DISCUSSION

The system is ready to accept the mobile commands from the user through android application after the compilation and execution of python program.

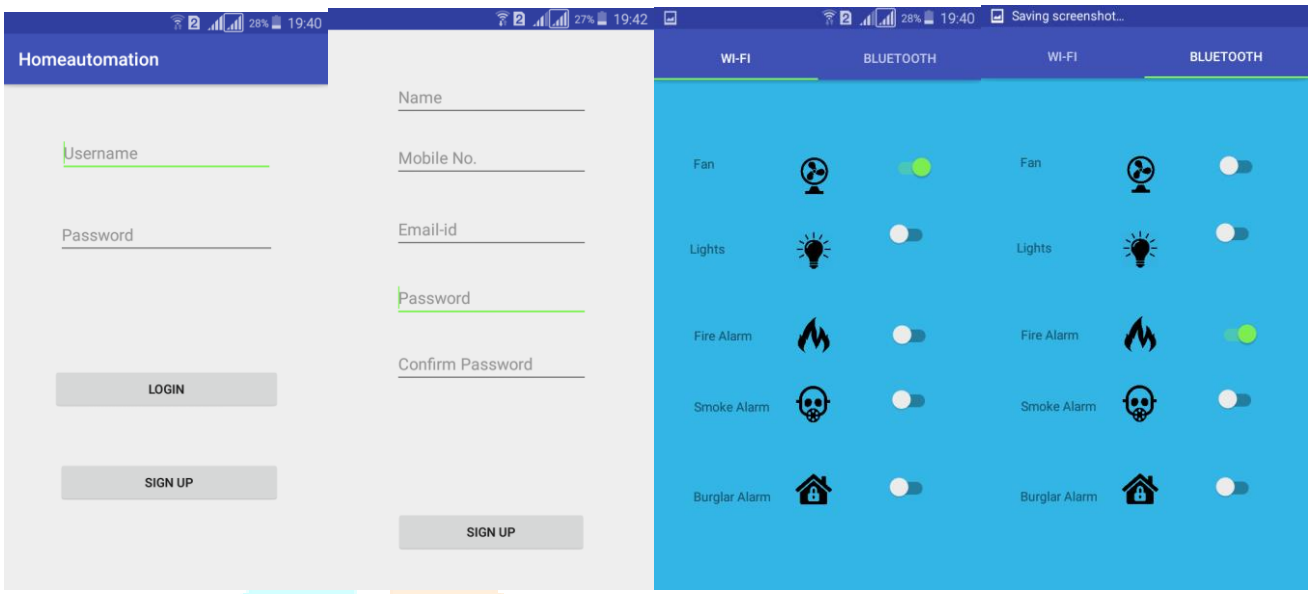

Fig 15: Android Application for Controlling Devices

Android Application:

Android application provides simplicity and an easier way to control and communicate with the Raspberry Pi 3. It provides an interface to the user for better and secure way to communicate with the Raspberry Pi.With the help of application the Pi can be controlled remotely through android smartphone.The user needs to create an account for which he has to register into the application for the access, once registered successfully he can then access the Pi remotely. This android application supports android phone having android version higher than 4.0. User can turn lights/fans on/off or he can also turn off burglar system, fire alarm, gas alarm.The buttons on the application directly send on/off message to the message queuing telemetry transport(MQTT) server, the server then signals Raspberry Pi and conveys the message in case of alarm sensors it is vice versa.

The application developed is developed in a simple way assist the user for better understanding. The user interface is simple but attractive. It is built in such a way that any armature user can use it. The application also provides security by allowing single user, multiple users can be made but to avoid the misuse it is best to be operated by a single user only. The application is build for the user so that it becomes easy to deal with the pi and other components.The application contains two modes of operating the Pi either through Wi-Fi in which internet connectivity is required or through bluetooth mode in which bluetooth connectivity is required and no internet connection is required. In the Wi-Fi mode the user is able to access the pi remotely i.e. from anywhere with the help of internet connectivity and in this mode MQTT plays an important role for transferring the messages over internet, the messages carried by the MQTT are lightweight so very less amount of data is consumed. In bluetooth mode the user can access only within the range of bluetooth which is 10m without any internet connection. The bluetooth mode is used to save the data that the user may use even when he is inside his house. Both the modes are build user friendly and the user can switch according to his convenience.

VII. CONCLUSION

The aim of this paper is to develop a Home Automation System with the backbone of IoT and WSN to monitor and control the home electronic devices with the flexible HAS Smart Android Application. A various type of sensors are used to capture the readings of temperature, gas and flame sensing devices forming it an effective system for security, controlling and monitoring. With the system specification and simplicity of implementation leads for large scale development. This system can be very helpful for physically challenged people, senior citizens and old aged homes.

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