SMART HOME AUTOMATION SYSTEM USING ARDUINO

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INDIA-799046
JUNE, 2020

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Report submitted to
National Institute of Technology, Agartala
for the award of the degree
of
Bachelor of Technology

by

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Under the Guidance of

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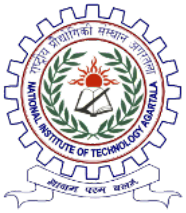

COMPUTER SCIENCE & ENGINEERING DEPARTMENT
NATIONAL INSTITUTE OF TECHNOLOGY AGARTALA
JUNE, 2020

Dedicated To

To our Project Supervisor Mr. Tribid Debbarma, Assistant Professor, CSED, NIT Agartala for sharing his valuable knowledge, encouragement & showing confidence on us all the time. Each of the faculties of the department to contribute in our development as a professional and help us to achieve this goal.
To all those people who have somehow contributed to the creation of this project and who have supported us.

REPORT APPROVAL FOR B.TECH

This report entitled "*Smart Home Automation System Using Arduino*", by Abalesh Debbarma (16UCS018), Prithiraj Mallik (16UCS019), Pirjak Debbarma (16UCS022) and Abhinandan Majumder (16UCS053), is approved for the award of ***Bachelor of Technology*** in Computer Science & Engineering.

Mr. Tribid Debbarma	Dr. Mrinal Kanti Debbarma
(Project Supervisor)	(Head of the Department)
Assistant Professor	Associate Professor
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Date:_____

Place:NIT, Agartala

DECLARATION

We declare that the work presented in this report proposal titled "*Smart Home Automation System Using Arduino*", submitted to the Computer Science and Engineering Department, National Institute of Technology, Agartala, for the award of the ***Bachelor of Technology*** degree in ***Computer Science & Engineering***, represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

JUNE, 2020
Agartala

Abalesh Debbarma	Prithiraj Mallik
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CERTIFICATE

It is certified that the work contained in the report titled "*Smart Home Automation System Using Arduino*", by Abalesh Debbarma(16UCS018), Prithiraj Mallik (16UCS019), Pirjak Debbarma (16UCS022) and Abhinandan Majumder (16UCS053), has been carried out under my supervision and this work has not been submitted elsewhere for a degree.

Mr. Tribid Debbarma	Dr. Mrinal Kanti Debbarma
(Project Supervisor)	(Head of the Department)
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Acknowledgement

We would like to take this opportunity to express our deep sense of gratitude to all those who helped us in this thesis work directly or indirectly.
Firstly, we would like to thank our supervisor, **Mr. Tribid Debbarma**, for being a great mentor and the best adviser we could ever have. His guidance, motivation and criticism are the source of innovative ideas, inspiration and the reasons behind this report's successful completion. For us, the confidence he gave us was the greatest source of inspiration. Over the past year, it has been a pleasure working with him.
We are very grateful to all faculty members of the Department of Computer Science and Engineering for their support and encouragement. We also thank **Prof. H. K. Sharma**, Director, NIT Agartala and **Dr. Mrinal Kanti Debbarma**, H.O.D, CSED for providing excellent computing and other facilities without which this work could not achieve its quality goal.

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Abstract

With modernization, Home Automation System is becoming a popular technology all-over the world because it is making our lives easier and minimizing the work load. Smart home basically refers to the problems-free machine control of electric and electronic appliances for smart and safe home tasks. Mobile devices are the most popular device of this era, and Iphone or Android phones are very common and a very important aspect of our lives. Using such device for the purpose of controlling and monitoring and controlling definitely makes our life secure, seamless and pleasant. So, this project is done in such a way that we can control, monitor and regulate our home through a single interface that ensures and enables a smarter and safer and healthier home. This project also presents the overall design of a Smart Home Automation System (HAS) using different modules to serve the purpose and also taking care of the cost and availability. We have used bluetooth connectivity for user to connect to the android application designed, WiFi connectivity for enabling Internet connection, arduino microcontroller and developed an android application for the controller.

Contents

CHAPTER 1

Introduction

"Home Automation Systems" are becoming increasingly popular in recent years. The terms "Smart Home", "Intelligent Home" "Automated home" etc., are used to describe an ecosystem in which common household appliacnces and other electronic devices used in homes are controlled remotely using one or more of a number of networking protocols. Home Automation System(HAS) also called Domotics has a huge potential in becoming ubiqutous in our lives in the near future. It is considered as the residential extension of a building automation. It usually includes centralized control of peripheral devices like lighting, heating, air conditioning, appliances, gates and doors security locks as well as sensors like fire,smoke detectors, motion detectors etc. It can provide improved convenience, energy efficiency and security. It essentially offers to the users access control to devices or objects in the house with great convenience. It also represents a great research opportunity in creating new fields in engineering, and Computing. HAS becoming popular nowadays and enter quickly in this emerging market. This project forwards the design of home automation and security system using Arduino which is secure, low cost, easy to use and scalable.

1.1 Motivation

Home automation system provides the platform to control our house-appliances in a sophisticated manner. As today human are becoming busy and fond of machine, it is not always possible to monitor our house for its security and managing the house appliances manually. If we are far from our home and we forgot to switch off our home-devices (fan, bulb, ac etc) or may bother about house safety then this system can surely omit our panic. People are now inseparable from their smartphones. A total of 5,000 people from the U.S., UK, China, India, South Korea, South Africa, Indonesia, and Brazil took a Time magazine smartphone survey. This survey revealed that the majority were highly attached to their phones, with 84 percent stating that without their phones they could not go a single day[1].And hence we are developing an application that will control our smart home system by monitoring home environment. If any unusual activity is sensed by our system it will alert the user available in remote station. Most of the HAS are based on IOT. This can be a problem if internet availability is inadequate. So we used bluetooth connectivity as well to make the system more robust, stable, secure and easy to use.

1.2 Goal

The main objective of the project is to develop an Android controlled Smart Home Automation which will be able to provide security to the home as well as control the home appliances wirelessly with effectively and efficiently.

1. Controlling and monitoring Home Appliances with an Android Application (Switch and Voice Mode): Developing an application that includes toggle and voice mode software functionality. For monitor the switches of home appliances, switch mode or voice mode can be used.

2. Secure Connection between Application and Arduino: Use of secure Bluetooth connection to prevent other devices from controlling the devices. Use of WiFi module to enrich the system with internet connectivity along with proper secured login mechanism enabling user to securely monitor home from anywhere in the world.

3. Portable and expandable platform for future enhancement: The software should be highly expandable, with the possibility of adding features as needed in the future.

1.3 Contribution of the Dessertation

- Home automation or smart homes can be characterized as the integration and implementation of home or work environment technology to provide its occupants with convenience, comfort, security, safety and energy efficiency.

- A system in collaboration with Wireless technologies using Arduino is proposed in order to provide a better living style and more secured home.
- The system intended to control electrical appliances and devices in house with relatively low cost design, user-friendly interface and ease of installation.
- The system incorporates the use of technology and making smart home automation. By the use of day to day gadgets we can utilize them for different prospective.

CHAPTER 2

Related Work

2.1 Home Automation Technology

There are many other projects done on home automation systems in all over the world. The differences in them come from their designs, features, devices, elements, algorithm, networking protocol, architecture etc. These rojects are designed to address individual needs and requirements and resource availability in the respective areas and regions. We discovered a lot of publications after a extensive search.. A number of the projects we found are done only for security purposes. Some of them are done only for controlling home utility devices using Arduino or Raspberry Pi. There are few Fingerprint Recognition System works for significant home safety problems.[2] All these projects use different networking protocols for communication between central hub, peripheral devices and user like bluetooth, RFID, GSM, Zigbee, WiFi etc

2.2 Types of Home Automation Systems

2.2.1 Bluetooth Based

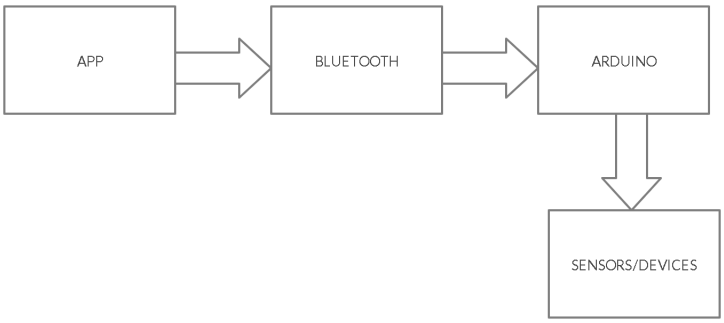

Figure 2.1: Bluetooth based HAS

Bluetooth-based HAS Smart home systems with mobile, Arduino platform and Bluetooth are secure and minimal-cost. A Bluetooth based home automation system has been proposed by R.Piyare and M.Tazil [3]. This project's design architecture comprises of the Arduino, Bluetooth and smartphone unit. Using Bluetooth technology, connectivity between Arduino and smart phone is rendered wirelessly.

2.2.2 Voice Recognition Based Home Automation

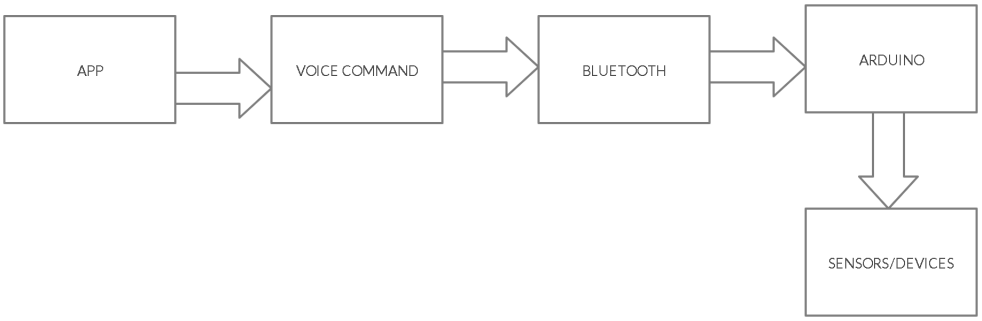

Figure 2.2: Voice Recognition based HAS

We can also implement a Home Automation System based on voice recognition. The system uses an Arduino and smartphone to control various devices. The wireless communication

between the smartphone and the Arduino is established via Bluetooth. In the smartphone application voice recognition is achieved by an in-built Android OS feature. Here the application converts the user voice command into text. This message is then transmitted to Bluetooth HC-05 module. This is connected with Arduino.

2.2.3 ZigBee Based Wireless Home Automation System

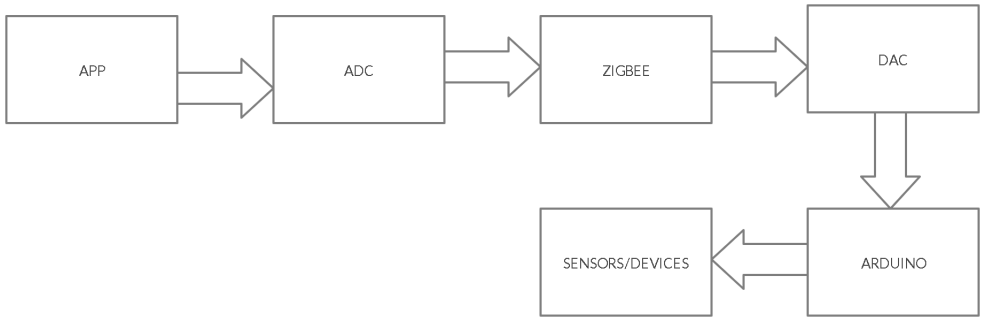

Figure 2.3: ZigBee based wireless HAS

We have also studied ZigBee based wireless home automation system[4], it consists of three main modules, handheld smartphone device, central controller hub and appliance controller module. The user Smartphone application uses ZigBee protocol to connect with the central controller.

2.2.4 GSM Based Home Automation System

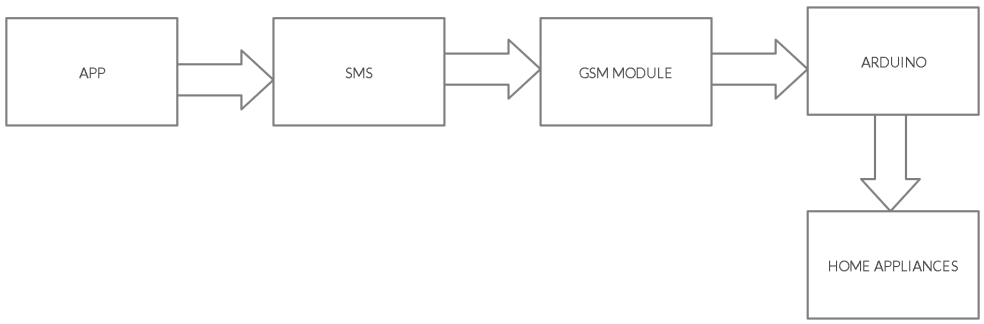

Figure 2.4: GSM based HAS

An HAS Smart Home can also be implemented by using Global System for Mobile communication (GSM)[5]. The system using this technology requires the following hardware at the minimum: GSM modem, Arduino(or any other microcontroller system) and a smartphone. The system involves a GSM modem to connect to the Arduino via SMS query to the installed microcontroller.

2.2.5 Internet of things (IoT) based Home Automation System

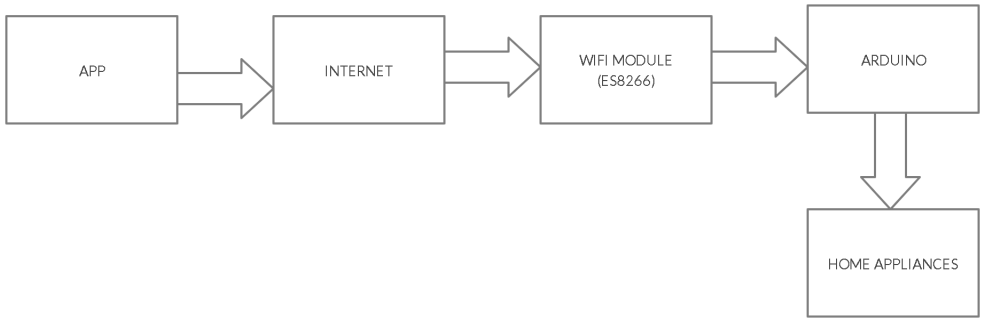

Figure 2.5: IoT based HAS

IoT-based HAS Internet of Things (IoT) is designed, developed and implemented using integrated micro web server, network control, smartphone and software application[6]. The whole project requires the following parts at minimum: wifi module(ESP8266), Arduino, Remote android app. The android app allows the users to control and monitor the home appliances using a smartphone, which supports Wi-Fi, 3G or 4G. The home appliacnces are connected to arduino via the wifi module(such as ESP8266 or nodeMCU).

2.3 Technology Exposures That Project Provides

1. Google's Android open source technology.

2. Bluetooth technology.

3. Interfacing Bluetooth Module to Arduino.

4. Interfacing relays with ac and dc power sources.

CHAPTER 3

Background

3.1 Overview of Work Previously Completed

We have achieved the following in our previous semester:

1. We have developed an android app that can control the Home Automation. We connected Arduino module with the Bluetooth module and a PIR sensor.

2. The system after proper connection can detect any motion through the PIR sensor within its range and then notify the user through the app.

3. We also added Vibration module with our system that can detect any vibration occurring within its range and notify the user through the app.

4. The app is added with voice recognition system thus can be controlled through voice as well.

3.2 Brief Introduction of all the Components

3.2.1 Proposed Hardware Requirements

1. **Arduino Board**: The Arduino board is an open-source microcontroller based on the Atmega 2560 microcontroller. The board is made of 54 digital electronic input / output pins, of which 16 pins are analog inputs, 14 are used as PWM outputs for serial hardware ports (UARTs), a 16 MHz crystal oscillator, an ICSP header, a power jack and a USB link with an RST button key. Hence, the Arduino board includes everything needed to support the microcontroller. The board can therefore be powered with the USB cable connected to PC. Sometimes, a battery or an AC-DC adapter are also used as a power source. The board can be used along with a base plate in order to protect it from the unexpected electrical discharge.[7]

2. **WiFi Module**: ESP8266 WiFi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to any WiFi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. NodeMCU is an open source LUA based firmware developed for ESP8266 WiFi chip. By exploring functionality with ESP8266 chip, NodeMCU firmware comes with ESP8266 Development board/kit. Since NodeMCU is open source platform, the hardware design is open for edit/modify/build. NodeMCU Kit/board consist of ESP8266 WiFi enabled chip. The ESP8266 is a low-cost Wi-Fi chip developed Systems with TCP/IP protocol. NodeMCU Development board is featured with wifi capability, analog pin, digital pins and serial communication protocols.[8]

3. **Camera Module**: Camera modules are basically small-sized image processor. OV7670 is one such Camera Module which provides all functions of a single chip of VGA camera and image processor. Despite of operating in low voltage, its sensor is capable of producing output of whole frame and the product VGA image can reach up to a maximum of 30 frames per second. USers can totally control the picture quality, information organization and transmission mode. All the procedure of picture handling capacities can through the SCCB programming interface, including gamma bend, white equalization, immersion and chroma.

4. **Dust Sensor**: GP2Y1010AU0F Dust Sensor Module is utilized to Sense Dust Particles in air and furthermore called as an optical air quality sensor. It is small-sized and is capable of recognizing the reflected light of the dust particles present in the air. Particularly, it is

very efficient in detecting exceptionally fine molecule like the tobacco smoke effectively. It can also recognize smoke from house dust by beat example of yield voltage and is usually utilized in air purifier frameworks. The sensor has an extremely low current utilization (20mA max, 11mA run of the mill), and can be fueled with up to 7VDC. The yield of the sensor is a simple voltage relative to the deliberate residue thickness, with an affect-ability of 0.5V/0.1mg/m3.

5. **Bluetooth Module**: Bluetooth is a wireless communication technology used for exchange of data over short distances. It is found in many devices ranging from mobile phone and computers. Bluetooth is a combination of both hardware and software and is intended to create a personal area networks (PAN) over short ranges. It uses a radio technology called frequency hopping spread spectrum. Bluetooth uses an adaptive frequency hopping (AFH) technology, which was designed in order to decrease the interference occuring between wireless technologies that share 2.4GHz spectrum. Hence, high degree interference immunity is acquired by this adaptive hopping among 79 frequencies(at 1 MHz). Thus, the Bluetooth divides the data that need to be transmitted into packets and each packet are transmitted on one of 70 designated Bluetooth channels. The bandwidth of each channel is 1 MHz. It is a packet based protocol with a master slave structure. Each member can communicate with up to 7 Slaves in a Piconet. The range of Bluetooth depends upon the class of radio using.

6. **Relay**: This unit is responsible for actual control of load. It consists of a 6VDC-240VAC relay and protection diode to protect against counter electromotive force (CEMF). Relay is used to switch power the power socket and is controlled via the Arduino. The appliances connected to the socket can be controlled from the user interface and the status can also be monitored.

7. **PIR Sensor**: PIR sensor or Passive Infrared sensor is an electronic sensing device which senses infrared (IR) light emitted from entities that exist in its field of view. It can also detect motion in its range. It is activated only in the security mode to detect any unwanted motion at the entrance. If any unwanted movement is detected then it will signal the microcontroller to take necessary steps.

3.2.2 Proposed Software Requirement:

1. **Arduino IDE:** Arduino Software (IDE) open-source, which helps develop software(code development) and upload it to Arduino-based boards that we have used for coding version 1.8.3.

2. **MIT App inventor:** An online-based android app development system that uses editor for block code technique that helps developing fast apk's for android.

3. **Circuit.io:** It is an online tool that helps in designing of circuits.

3.3 Arduino Mega 2560

3.3.1 Introduction

An Arduino board is a kind of kit based on a microcontroller. David Cuartielles and Massimo Banzi developed the first Arduino technology in 2005. The board provides to build devices for students, hobbyists and professionals with an easy and low cost microcontroller. Arduino board can be bought from the seller or, using different basic components we can build it directly at home. The Arduino Mega 2560 is an ATmega2560-based micro-controller module. It has a total of 54 digital input / output pins. Out of those 54 pins, 14 pins are designated for PWM outputs, 16 for analog inputs, 4 are reserved for UARTs (hardware serial ports). The Board also contains a 16 MHz crystal oscillator, a power jack, an ICSP header, a USB interface and a reset button. It also includes everything required to help the microcontroller function properly and it is user-friendly as well. The user just needs to connect its USB cable to a device or power it to get going with an AC-to-DC adapter or battery.

3.3.2 Features

Below are the some of specifications of Arduino Mega:

- The ATmega2560 is an microcontroller based device.
- This microcontroller operates at voltage of 5 volts.

- The recommended input voltage ranges from 7volts to 12volts.
- The input voltage ranges from 6volts to 20volts.
- Total digital input/output pins consist of 54 pin out of which 15 of these pins will supply PWM o/p.
- There are 16 Analog pins.
- DC Current for each input/output pin is 40 mA.
- DC Current for 3.3V Pin is 50 mA.
- Flash Memory like 256 KB need bootloader to use 8 KB of flash memory.
- The static random access memory (SRAM) is 8 KB in memory.
- The electrically erasable programmable read-only memory (EEPROM) is of 4 KB in memory.
- The clock (CLK) speed is 16 MHz.
- The MAX3421E is used as the USB host chip.
- Length of the board make up to 101.52 mm.
- Width of the board is 53.3 mm.
- Weight of the board is 36 g.

3.3.3 Pin Configurations

Arduino mega 2560 board's pin configuration is shown below. Each pin of this board is associated with a particular function. All of this board's analog pins can be used as virtual I/O pins. This boards have flexible work memory space is the more processing power that allows you to work without delay with different types of sensors. Such boards are physically superior when compared to other types of Arduino boards.

Pin 3.3V & 5V

These pins are used to supply approximately 5V of o/p controlled voltage. This RPS (regulated power supply) provides the power over the Arduino mega board to the microcontroller as well

as other components. Otherwise USB cable can be obtained from the board's Vin-pin or one more regulated voltage supply-5V, while 3.3V0-pin can provide another voltage regulation. Maximum power of 50mA can be obtained.

GND Pin

The Arduino mega board contains 5-GND pins, which can be used whenever needed in a project.

Reset (RST) Pin

This board's RST pin may be used to rearrange the board. By setting the pin to low the board can be rearranged.

Vin Pin

The range of input voltage supplied to the board is between 7volts and 20volts. Through this pin you can access the voltage provided by the power jack. The output voltage to the board through this pin, however, will be set to 5V automatically.

Serial Communication

This board's serial pins such as TXD and RXD are used for transmitting and receiving serial data. Tx means that information is transmitted while the RX indicates that data is received. This board's serial pins have four combinations In serial 0, it includes Tx(1) and Rx(0), in serial 1, it includes Tx(18) Rx(19), in serial 2 it includes Tx(16) Rx(17), and in serial 3 it includes Tx(14) and Rx(15).

External Interrupts

Using 6-pins such as interrupt0(0), interrupt 1(3), interrupt 2(21), interrupt 3(20), interrupt 4(19), interrupt 5(18) can form the external interrupts. These pins in a number of ways produce interrupts, i.e. Provide LOW value, edge up or down, or change the value to interrupt pins.

LED

This Arduino board includes an LED, which is associated with pin-13 called digital pin 13. This LED can be used depending on the pin's high and low values. This will give you real-time modification of the programming skills.

AREF

The term AREF refers to an analog reference voltage for analog inputs.

Analog Pins

The board contains 16-analog pins that are labeled as A0-A15. It is very important to know that all the analog pins on this board can be used as digital I / O pins. With the 10-bit resolution that can measure from GND to 5 volts, each analog pin is accessible easily. However, the higher value can be changed using the AREF pin and the analog reference function.

I2C

I2C communication can be supported by two pins - 20 21, where 20-pin stands for Serial Data Line (SDA) which is used to hold data and 21-pin stands for Serial Clock Line (SCL) which is mostly used to provide data synchronization between devices.

3.3.4 Diagram

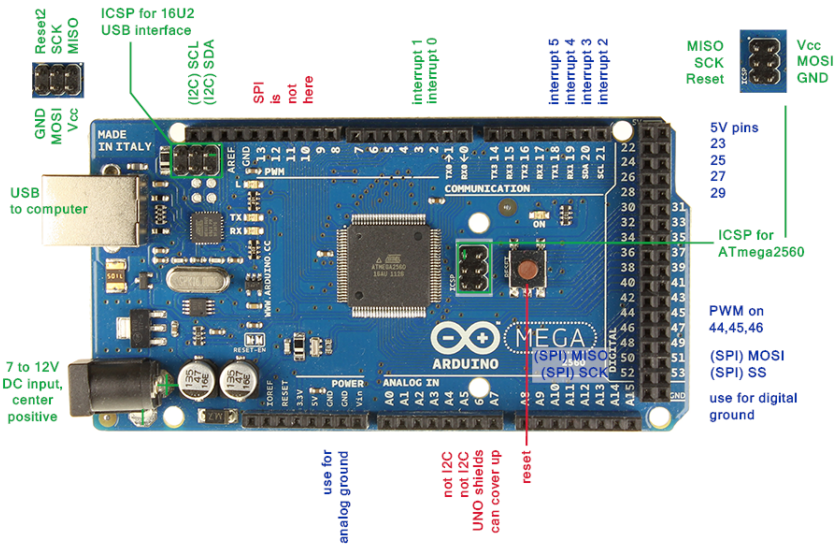

Figure 3.1: Arduino ATmega 2560[10]

3.3.5 Dimensions

The Arduino Mega 2560 board measurements primarily include the length and widths such as 101.6 mm or 4 inches X 53.34 mm or 2.1 inches. It is comparatively superior to other panel forms that are available on the marketplace. But from the specified dimensions, the power jack and USB port are somewhat extended.

3.3.6 Programming

Using an IDE (Arduino Software), the programming of an Arduino Mega 2560 can be performed and it supports C-programming language. Here the sketch is the code in the software that is burned in the software and then moved via a USB cable to the Arduino board. An Arduino super board contains a boot loader that removes the use of an external burner to burn in the Arduino board the program code. A STK500 protocol can be used to contact the bootloader here. When compiling and burning the Arduino code, we will remove the USB cable from the Arduino board to disable the power supply. If you decide to use the Arduino board for your design, a power jack will supply the power supply, otherwise the board's Vin button.

Another feature of this is multitasking wherever there is a handy Arduino mega board. Nonetheless, Arduino IDE Software does not allow multi-tasking, but for this purpose one can use additional operating systems to write C-program namely RTX FreeRTOS. This is easy to use with an ISP connector in your own custom build software.

3.3.7 Reasons for selecting Arduino

Ease of use: It is very easy to interact with Arduino, with just a few lines of code, analog sensors, motors and other electronic and electrical components. While there is a lot of overhead to read these sensors in Raspberry pi, we need to install some libraries and software to interconnect these sensors and components. And also Arduino's coding is simpler while Linux and its commands are necessary to use the Raspberry pi.

Robustness: Raspberry Pi runs on an operating system so it has to be shut down correctly before switching off the power, otherwise OS software may get infected and Pi may be harmed.On the other hand Arduino is just a tool that can be switched ON and OFF at any time, without any

risk of damage. Once the energy is restored, it will begin running the software again.

Energy consumption: Pi is a powerful hardware, it needs a continuous 5v power supply, and it's hard to run it on batteries, whereas Arduino needs less power with a battery pack, so it can be easily powered.

Price: Obviously Arduino is cheaper than Raspberry Pi, Arduino costs around Rs.700-1000 depending on the version, while price of Raspberry is around Rs.4500-7500.

CHAPTER 4

METHODOLOGY AND APPLICATION DESCRIPTION

4.1 Proposed Circuit and Hardware Connections

Here, we use Arduino 2560 as a micro-controller or the central hub that connects the app in the user's smartphone with the peripheral devices/sensors/actuators via Bluetooth module and/or NodeMCU.

4.1.1 Connection of NodeMCU with Arduino Mega

The NodeMCU ESP8266 Lua Amica WiFi Module is an open source firmware that comes with the development kit of ESP8266, which is also known as NodeMCU Development board.Their open source nature enables user to easily modify/edit/build the hardware design. ESP8266 chip has GPIO pins, serial communication protocol and many more features on it. However, Arduino functions on 5v level whereas the NOdeMCU is 3v level. This is solved by using few resistors for voltage division in the bread board. The GND of the NodeMCU and GND of the Arduino are connected. Arduino TX1/pin 18 and RX1/pin 19 are connected to RX and TX pins of the

NodeMCU Development Board respectively after dividing the voltage.

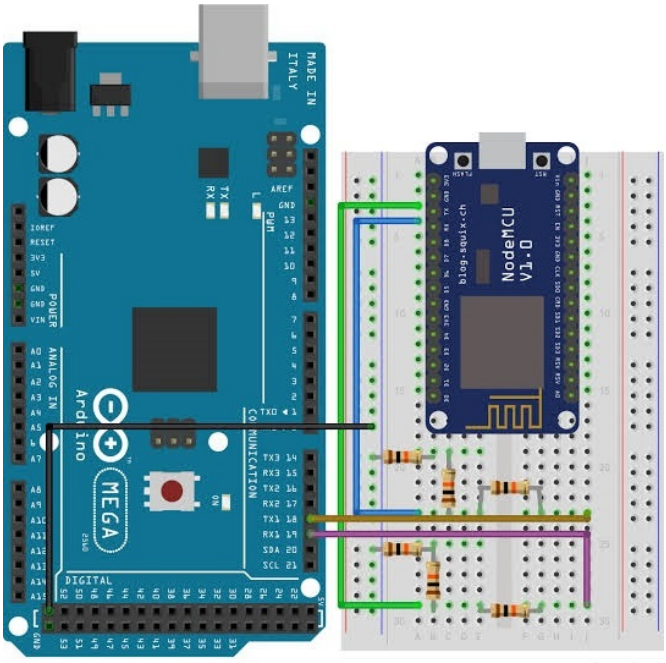

Figure 4.1: Connection of Arduino with NodeMCU ESP8266 WiFi Module

4.1.2 Connection of Camera OV7670 with Arduino Mega

The Camera Module comes with various handshaking signals like Vertical Sync Output, Horizontal Reference, Pixel clock Output, Reset Signal, etc. OV7670 is clocked from a 24MHz oscillator which gives the Pixel Clock an output of 24MHz. The connection diagram below defines the connection between the Arduino and Camera OV7670.

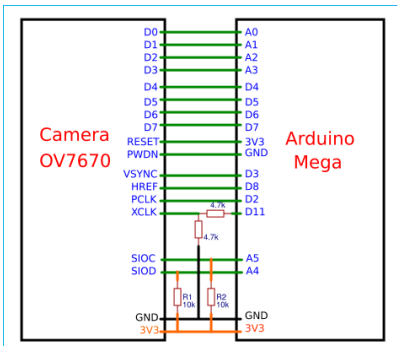

Figure 4.2: Connection of Arduino with Camera OV7670 Module

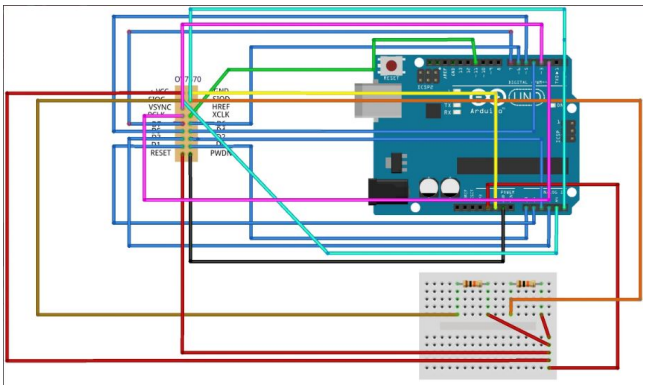

Figure 4.3: Connection of Arduino with OV7670

4.1.3 Connection of Dust Sensor with Arduino Mega

The 3.3V/5V pin of the Arduino is connected to the VCC pin of the Dust Sensor Module. After connecting the V-LED of the Sensor to the 100 Resistor, the LED-GND and S-GND pins are connected to Ground pin of the Arduino. Further, the Arduino's digital pin 12 should be connected to the LED pin of the sensor(output pin). Finally, the V0 pin (Analog pin) of the sensor is connected to the Arduino's analog pin A0.

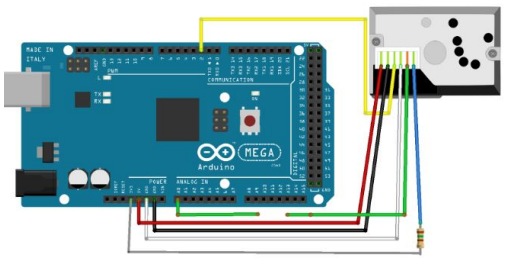

Figure 4.4: Connection of Arduino with Dust Sensor Module

4.1.4 Connection of Bluetooth Module with Arduino Mega

The HC-05 zs-040 modules have a voltage regular on then vcc in line. This means that they can tolerate a voltage of 3.6 to 6v and can be output from the Arduinos 5V. The data pins however, are not 5v, they are only 3.3v. This means that the 5v of the Arduino TX pin must be reduced to 3.3v. A simple method is to use a voltage divider made from a few resistors. We are using a 1K ohm resistor. The Arduino reads 3.3v as HIGH, so we don't have to convert the BT TX to Arduino RX. We can make a direct connection. Arduino 5V out to HC-05 VCC, Arduino GND

to HC-05 GND, Arduino TX1/Pin18 to voltage divider and then to HC-05 RX and Arduino RX1/Pin 19 to HC-05 TX.

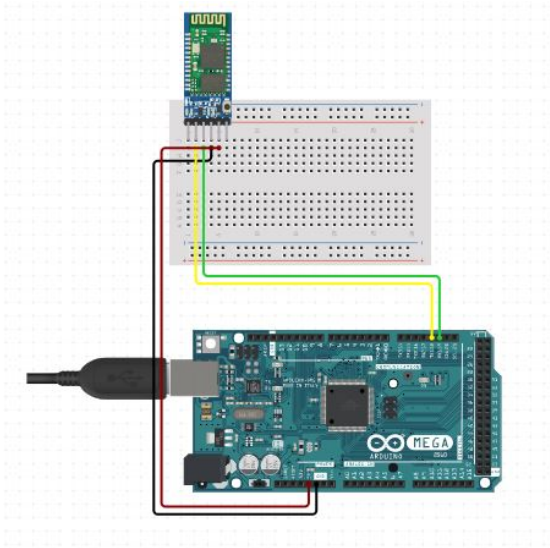

Figure 4.5: Connection of Arduino with a Bluetooth Module

4.1.5 Connection of PIR Sensor with Arduino Mega

Wiring the PIR motion sensor to an Arduino is pretty straightforward – the sensor has only 3 pins.

GND – connect to ground OUT – connect to an Arduino digital pin VCC – connect to 5V

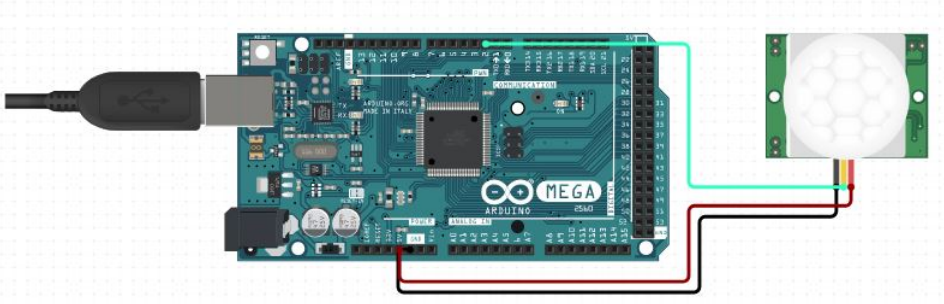

Figure 4.6: Connection of Arduino Mega with PIR Sensor

4.1.6 Connection of Vibration Sensor with Arduino Mega

DO – connect to Arduino digital pin GND – connect to ground VCC – connect to 5V

This looks similar to the Arduino connected to a PIR Sensor.

4.2 Application Description

4.2.1 Overview

The android OS provides the flexibility of using the open source. The inbuilt sensors can be accessed easily. We have built an application with following features:

1. The App provides dual mode of connectivity with the Arduino.
    - **Via Bluetooth:** Android Phone acts as a client and data are sent via Bluetooth.
    - **Via Internet :** Here, the Arduino communicates serially with NodeMCU which is connected with a local router. It in turn sends data to a Firebase server.
2. **Switch Mode:** Switch mode uses the radio buttons that are used to control the home appliances. The radio button sends the status of the switch.
3. **Voice Mode:** Voice Mode is used to control the home appliances using voice command. Using the inbuilt microphone of Smartphone, the application creates an intent that fetches the speech data to the Google server which responds with a string data. The string data are further analyzed and then processed.
4. **Integration:** This app provides special features to connect with other home automation systems like Google Assistant via their API.

4.2.2 Application Flowchart

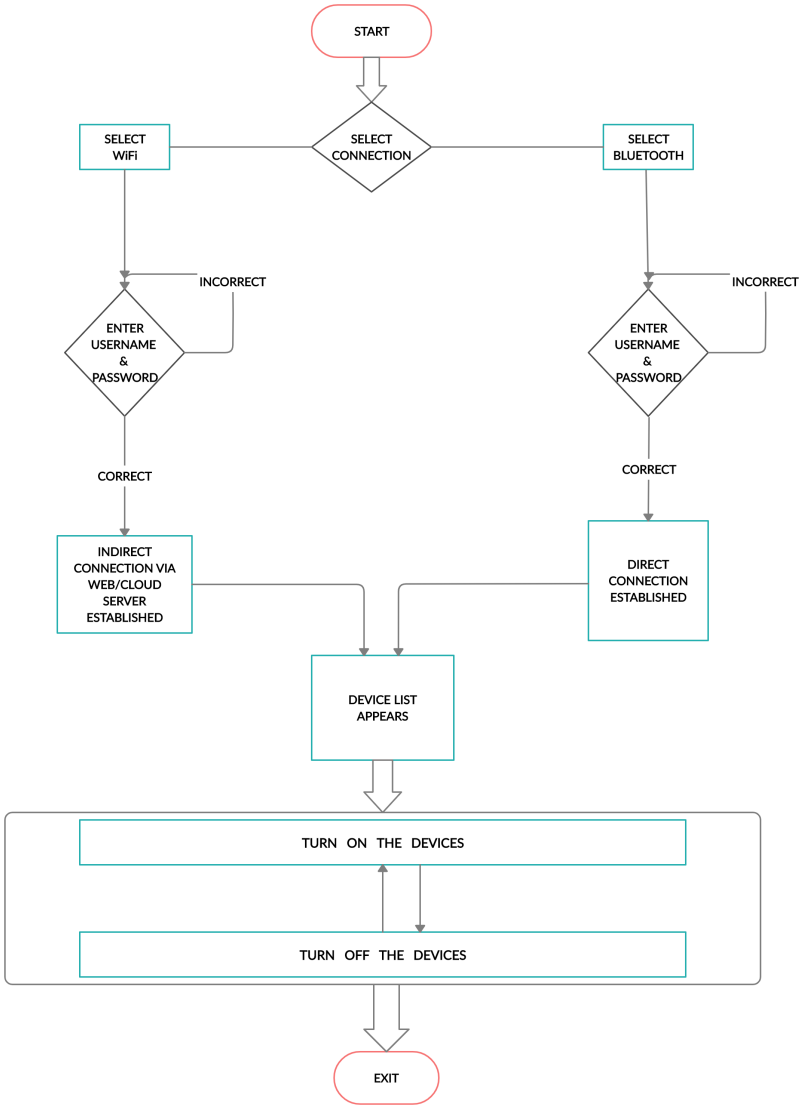

Figure 4.7: Application Flowchart

4.2.3 Features

- A Bluetooth device is connected to the Arduino.
- The application can manage the system.
- After providing the correct password, the application starts to work.
- If any of the connected sensors detect any infra-red motion, it will notify the application.

4.2.4 Advantages

- Easy to use and manage.
- Internet connection is not mandatory.
- The system provides secure connection with the devices.

4.2.5 Limitation

- If connected only with the Bluetooth, it can't operate beyond limited range(15-20 meter), but this limitation is solved with the use of WiFi Module.
- The App should be always running in the background.

4.3 Arduino Code

The arduino code[9] and the nodeMCU code was written in Arduino IDE and uploaded by USB cable. It is written as a modular code which helps in understandability and debugging. There is code written to drive each of the modules used in our system. These are the HC-05 (which serially communicates with Tx and Rx pins of Arduino), nodeMCU (which serially communicates with two digital pins of Arduino), OV7670, dust sensor module, PIR sensor and vibration sensor. The code can be separated into three parts :-

- **The initial definitions :-** It includes the library inclusions, passwords, register values, ssid, port address and helper functions.
- **The setup :-** It includes the pinmode definitions connected to every modules, baudrate, the bootup of initial values and start of connection.
- **The loop :-** This is the code that runs continuously when the Arduino is active. It checks for the mode of communication, retrieves values as codes and send the necessary values depending upon the codes.

4.4 Circuit Overview

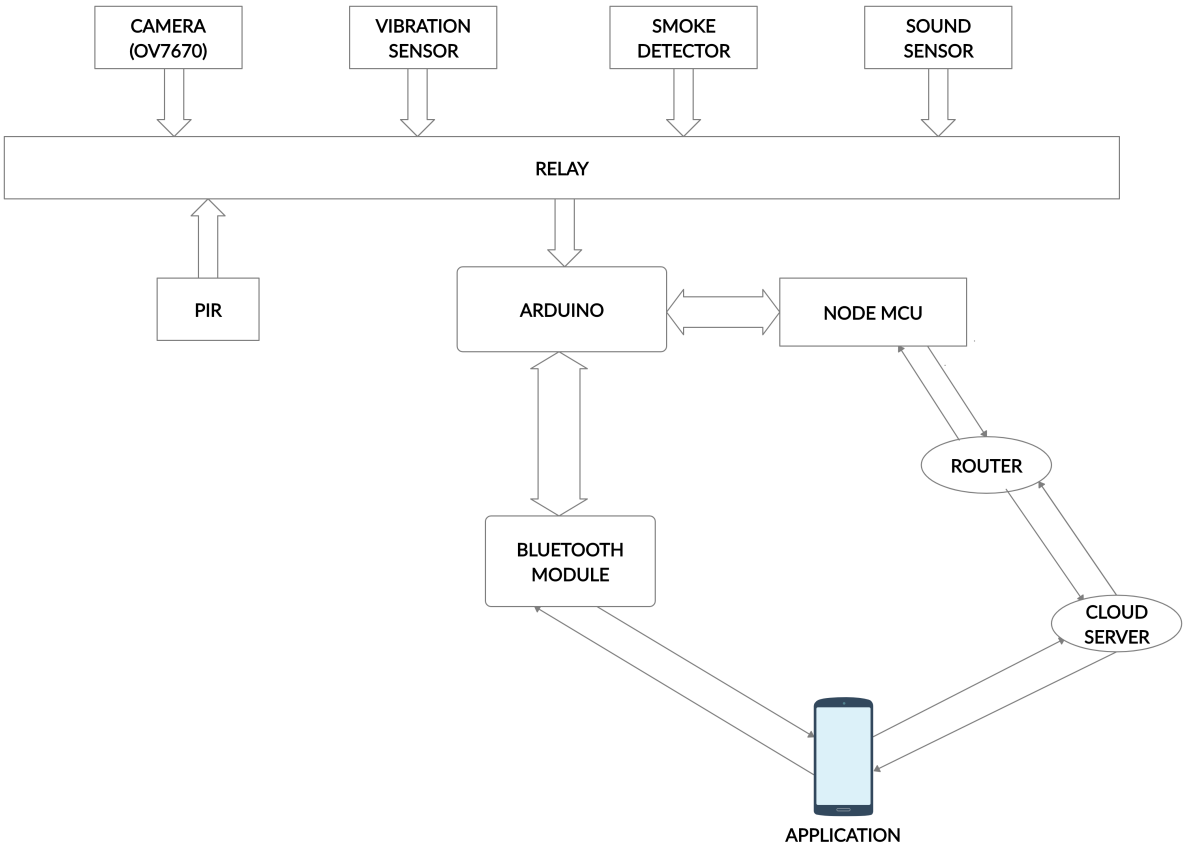

Figure 4.8: Overall Circuit Overview

4.5 Android Interface

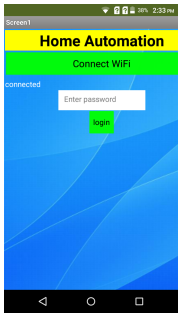

Figure 4.9: User Interface(1)

Figure 4.10: User Interface(2)

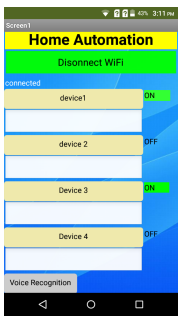

Figure 4.11: User Interface(3)

4.6 Implementation & Analysis

In this project, our aim is to make an affordable Home Automation System complete with security system sensors like PIR Sensor for motion detection, Smoke Detector, Camera Module for object detection, etc. We connected the Serial Bluetooth HC05 Module to Arduino Mega which acts as the connecting device between the user and the Arduino. We also connected the NodeMCU Development Kit with the Arduino for enabling WiFi and Internet connectivity. Further, we can connect this Arduino to various home appliances like fan, light, etc. with the help of a Relay. Moreover, we can also connect the Arduino with various other sensors like PIR Motion Detection sensor, Vibration sensors etc. as well. We will explain the working of the APP with PIR sensor in mind. Once the Arduino is powered ON, we can connect the Bluetooth module with the APP. Afterwards, we have to send a secret passkey through the App. We can proceed further only if the correct password is entered. This provides effective security for the system. Then, a list of available and controllable devices is displayed. For normal home appliances, we can turn them ON/OFF with a button. For PIR sensor, we can switch ON the device and on detection of any motion, a message of "DETECTED" will be displayed on the screen, otherwise a "SAFE" message will be displayed. Finally, we can turn OFF all the devices and disconnect the Bluetooth client and exit. Similarly, we can connect with the Arduino with Internet via the NodeMCU. The other main sensor used in our project is the OV7670 Camera Module. Once we turn ON this device, it will send a picture in every 10 seconds. Other than that, we also used sensors like Vibration sensor and Smoke detection sensor which facilitates the system with more features. To ensure portability and scalability of the system, we provided features for our system enabling to connect with Google Home Assistant for seamless integration.

CHAPTER 5

Hardware & Software Specifications

5.1 Hardware Specifications

5.1.1 Node MCU ESP8266 Lua Amica WiFi Module

Figure 5.1: NodeMCU WiFi Module

- ESP8266 includes USB-TTL.
- Microcontroller: Tensilica 32-bit RISC CPU Xtensa LX106.
- Operating Voltage: 3.3V.

- Input Voltage: 7-12V.
- Digital I/O Pins (DIO): 16.
- Analog Input Pins (ADC): 1.
- Module has 10 GPIO and Every GPIO can be PWM.
- Contains PCB Antenna.
- 12C,1-Wire & Play.

5.1.2 Camera OV7670 Module

Figure 5.2: Camera OV7670 Module

- Resolution 640x480 VGA
- Standard 0.1inch (2.54mm) pin pitch header connector
- Mounted with high quality F1.8 / 6mm lens
- Output support for Raw RGB, RGB (GRB 4:2:2, RGB565/555/444), YUV (4:2:2) and YCbCr (4:2:2) formats
- Onboard regulator present.
- Only single 3.3V supply is needed
- High sensitivity for low-light operation
- Low operating voltage for embedded portable apps
- Standard SCCB interface compatible with I2C interface

5.1.3 Optical Dust/Smoke Particle Sensor GP2Y1010AU0F

- It is a dust sensor embedded with an optical sensor system.
- A phototransistor along with an IRED are diagonally arranged and the system as a whole detects the reflected light of dust in air.
- Compact, thin package (46.0 x 30.0 x 17.6 mm)
- Low consumption current (Icc: MAX. 20 mA)
- Effective in detecting very fine particle like cigarette/tobacco smoke.
- Lead-free and RoHS directive compliant.

Figure 5.3: GP2Y1010AU0F OPtical Dust Sensor Module

5.1.4 Bluetooth Transceiver Module with TTL Outputs HC05

Figure 5.4: Bluetooth Transceiver Module

- HC-05 is a Bluetooth SPP (Serial Port Protocol) mod.
- Easy to use.
- Bluetooth Version 2.0 and EDR (Enhanced Data Rate).
- 3Mbps Total 2.4GHz network transceiver and baseband modulation.

5.1.5 REES52 Serial Wi-Fi Wireless Transceiver Module ESP8266

Features of the module are as follows:

- Wi-Fi direct (P2P), soft-AP.
- Integrated TCP or IP protocol stack.
- Power down leakage current of ¡10uA.
- +19.5dBm output power in 802.11b mode.

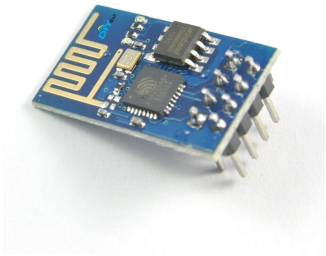

Figure 5.5: ESP8266

5.1.6 Sound Sensor Module

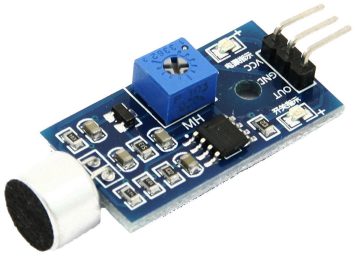

Figure 5.6: Sound Sensor Module

- Sound Sensor Module Main Chip: Lm393, Electret Microphone.

- Working Voltage: Dc 4 6v Has The Signal Output Instructions Single Signal Output.
- Effective Signal Output For Low Level.
- Output Low Level And Signal Light Will On When There Has Voice.

5.1.7 PIR Sensor Pyroelectric Infrared Module

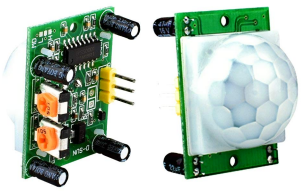

Figure 5.7: PIR Sensor Module

Features of the module are as follows:

- Level Output: High 3.3 V or low 0V.
- Operating Voltage Range: DC 4.5-20V.
- Quiescent Current: ¡50uA.

5.1.8 REES52 Optocoupler 4 Channel 5V Relay Module Relay Control

Features of the module are as follows:

- 4-channel relay output module, relay output contact is maximum 250A 10A
- Input s are IN1, IN2, IN3, IN4. These signal lines can be active low or active high.
- 5V 4-Microcontroller-controlled relay board (Arduino, 8051, AVR, PIC, DSP, ARM, ARM, MSP430, TTL logic) requires 50-60mA driver current.
- High-current, AC250V 10A, DC30V 10A.

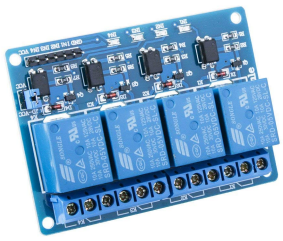

Figure 5.8: Relay Module

5.2 Software Specification

We have used two different programming languages for our project. For the development of the application on android, we have used Java Platform. MIT Kit App Inventor where Java programming is performed.

5.2.1 Java

Java is used in a diverse range of computer platforms varying from low-end embedded systems and mobile phones to high-end corporation data centres and supercomputers.

5.2.2 Python

Python incorporates impressive power with syntax that is very clear. It has many system calls and libraries interfaces, as well as numerous window systems, and can be expanded to either C or C++.

CHAPTER 6

Conclusion & Future Direction of Work

6.1 Conclusion

The project raised the concept of Smart Homes that could support multiple Home Automation Systems. It basically explored the built modules such as circuits for sensors, android-controlled application and communication. Home Automation or Smart Homes can be characterized as the integration and implementation of home or work environment technology to provide its occupants with convenience, comfort, security, safety and energy efficiency. The model built in the project will help us accomplish our home automation goal, which is mainly controlling devices effectively efficiently using either the Android Application or via the Smartphone's voice command.

As proposed, a series of experiments were performed. These experiments demonstrate how smoke or particle dust present in the air can be detected, how an intruder can smartly be detected with sensor, how the home can be monitored via a camera module and how house-owner is notified regarding the activities in the home during his absence. The proposed system can also be used with Voice commands to control the home actions like controlling home appliances.

Further, no undesirable traffic can access the application or the system because application is protected with a password set by the user himself, thus, ensuring the maximum security. Beside this, the application we developed is easy to use and user-friendly. Automation feature like Google Home-Assistant is also added for better utilization. A proper Internet connection can make the application available anywhere in the world to track user's house's current status. Hence, we were able to meet our goals. We had our limitations in time and expenses but we hope that it will serve as basis of other latest systems as that of other existing systems. While maintaining the blueprint of this project intact, we did considered about the device's cost-effective property, being user-friendly and using less space as possible without compromising the functionality.

After completing a group project such as the HAS, it becomes apparent that a strong emphasis on hierarchy and modularity early in the design process results in a clear specification. This specification allows the implementer of the system to keep a clear idea of what tasks need to be accomplished and never get confused by the complexity of the task at hand. If, while constructing the system, any part failed to be realized, it was possible to work around the problem and still manage to implement a system that was working towards the final goal. The lesson learned is that more time spent designing results in less time wondering what went wrong with the implementation.

6.2 Future Direction of work

We have done all of a typical smart home's basic necessities. The activities we've performed are not the only tasks that can be accomplished by the components. For that kind of project, there are several other scopes. With a robust relay unit, more appliances can be connected to this network. Automatic door system for garage can be added for additional safety. There are a number of additions to this system that could be designed to achieve sensing and detection with better accuracy. The way automatic alerts are carried out can be improved using the GSM module to make the system more effective. We could also add some other sensors (like Vibration module, temperature module, Fire sensor etc). We can design algorithm to ensure concurrency control among valid users. This system can also be made extra cheap and durable by the solar power system. Then, the solar power will run the system.

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CHAPTER 7

Biographical Sketch

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