BACHELOR OF SCIENCE IN
COMPUTER SCIENCE AND ENGINEERING

Inspiring Excellence

Implementation of an IoT Based Home Automation System Using Real Time Sensors

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We would like to dedicate this thesis to our loving parents who always kept faith in us and supported us in any circumstances ...

Declaration

It is hereby declared that this thesis is based on results we have found ourselves and this report or any part of it has not been submitted elsewhere for the award of any Degree or Diploma. Materials of work from researchers conducted by others are mentioned in references.

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Abstract

The research aims towards a full implementation of an IoT based home automation system through data processing so that the system can take suitable action based on the circumstances without human supervision. The goal of our research is to implement the prototype system so it can detect the presence of harmful gas as well as measure temperature and humidity. The research suggests that the system will require MQ-4, MQ-9, MQ-135 gas sensors, DHT11 temperature and humidity sensor, Arduino Uno, NodeMCU ESP8266 and Arduino Nano micro-controller. After the acquisition of the data from sensors, the system will go through several steps to determine the decision. This research proposes a two stage approach that includes the pre-processing stage and decision stage. The pre-processing stage involves acquiring and processing the data while the decision stage involves controlling the components of the home and operations of voice control using IFTTT. Moreover, for further research purpose, decision data of temperature and humidity are being stored on the cloud server.

Keywords:

Smart Home, Automated Fan, Gas Sensors, Voice controlled, PWM, Arduino, NodeMCU ESP8266.

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Chapter 1

Introduction

In our recent decades, with the advancement of technology the world is getting closer to everyone and the future of systems which are manually controlled are moving towards automated systems for larger interests. A smart home is a pattern of the advancement of technology and automation which refers that allow individuals to control electronic machinery's smarty as well as automatically from or outside of the particular home which will make life easier, smarter, comfortable and mostly automated. With the availability of internet these days, technology opened a new door named IoT (Internet of Things) which refers the networking of physical devices embedded with sensors, actuators, electronics, software, mobile apps and network connectivity which enables the system to collect, record and exchange data. As we can see in near future, the potential benefit of the IoT will be huge and our lives will be easier than ever. In the recent years smart phone technology has been remarkably advanced and since the android is an open source platform, it brought attention of many developers as it allows the easy access of hardware components by supplying many communication interfaces and real time sensors. The smart home system has applications in all parts of a particular building as well as each room and parts of that particular building which represents a great research opportunity in the field of engineering, computer science, electronics, robotics and many more. In this research paper, we are proposing an efficient and low cost smart home automation system that describes the fan, exhaust fan, window and light system which will work automatically on the basis of real time room temperature, presence of smokes and gases, given by different sensors. Additionally all applications of our proposed system can be remotely controlled by android smart phone via internet.

1.1 Background

The main keen homes were thoughts, not genuine structures. For quite a long time, sci-fi has investigated home robotization. Productive scholars, for example, Ray Bradbury, envisioned a future where homes were intuitive, and apparently ran themselves. In Bradbury's preventative short story, "There Will Come Soft Rains" he portrays a mechanized home that keeps on working even after people have ceased to exist. It's everything admirably and terrifying, until the point when you think about the real advantages of home robotization, and after that the thought turns out to be more ameliorating than chilling. Despite the fact that home mechanization has been around for quite a while, genuine keen homes have just existed a brief time. This course of events centers around equipment; which means genuine developments paving the way to the brilliant homes we know today and can anticipate from the not so distant future. Mid 2000s Smart homes, or home computerization, started to increment in prominence in the early-2000s[31]. In that capacity, diverse innovation started to rise. Shrewd homes abruptly turned into a more reasonable alternative, and in this manner a practical innovation for customers. Household innovations, home systems administration, and different devices started to show up on store racks. The present shrewd homes are more about security and living greener. Our brilliant homes are maintainable, and they help to guarantee that our homes aren't consuming superfluous vitality. They additionally push alarm us to interlopers (regardless of whether we're home or not). Current patterns in home computerization incorporate remote versatile control, robotized lights, and mechanized indoor regulator modification, planning apparatuses, portable/email/content notices, and remote video reconnaissance. "Network and intelligence are driving the manner in which families live and deal with their homes. So while we are relied upon to be in more places because of business travel, kids' school timetables and social exercises, these new savvy frameworks give bleeding edge network to your family, notwithstanding when you're far away. What's more, when the house is possessed, the abnormal state of computerization empowers more comfort, control and security from any piece of your property. Everything indicates less stresses and expanded delight throughout everyday life, which is something we would all welcome," composes ADT advances, who some say have bring down home security cost then different contenders. The Future of Home Automation will be CNN forecasts that the shrewd home of things to come will be somewhat similar to what we've found in the enlivened arrangement, "The Jetsons." Look forward to advanced cutting sheets (computerized everything, extremely), sub-atomic cooking gadgets, thus considerably more.

1.2 Report Organization

In chapter 2 we have discussed literature review. In chapter 3 there are working process. Where are 3 sections describing block diagram, flow charts and project view. In chapter 4 we discussed hardware and software. This chapter also have 3 sections describing choice of components, hardware mechanism and software. In chapter 5 we have done experimental studies. Hardware implementation, software data analysis and results and decision are the the section of chapter 5. In chapter 6 there are 3 section describing health and safety impact, lower energy consumption and cost analysis and economic impact and the name of the chapter is device impact. lastly there are future work and conclusion in chapter 7.

Chapter 2

Literature Review

Home is a place where people live and invest their most time. In this time they engage in leisure activities, individual decision making, well-being, reading, learning, and various other household work. As a result, everyone wants their home to be safe as well as smart and with the development of the information era and the improvement of living standard, different new key issues are posed to human attention every day [7]. Problems such as how to efficiently utilize and monitor the home appliances and home environmental parameters or how to control them with remote systems have caught the attention of many researchers and companies [33] [3] aimed to improve the standard and quality of our life. As a result, we got to see many exciting devices that deliver smart and safe home with interconnected sensors like smart bulb, fan, air conditioner, security camera and even smart lock. Furthermore there are devices that can control these smart devices automatically without any kind of users interference[10] [23]. Devices such as Google Home and Amazon Echo has revolutionized the smart home experience and the way we control and maintain home comfort as well as security[17] [13] [11] [32].

Now a days, most of the flagship smart-phones also support controlling of smart devices. With the help of this transforming technology Amazon, a online store can deliver product inside customers house even when the user is not at home. This was possible only because of certain smart security devices, such as smart lock, smart lock and amazon developed application[9] [2] . All of this resulted into more of a convenient and comfortable living condition for the users[27] [5].

The concept of "Smart Home Automation" was developed in 1984 by American Association of House Builders[31]. Although progress has been made to improve upon this idea over all these years, safety has been one of the greatest concern for the home automation system. According to the National Fire Protection Agency, U.S. fire departments respond

to over 3,200 gas-related residency fires per year and every 24 seconds, a fire department responds to a fire somewhere in the nation.

In Bangladesh, a survey by Titas gas transmission authority indicates that at least 3,819 gas leak-related accident occurred in 20013-14 and the number increased to 5,123 in 2014-15. So, ensuring safety has been a major concern to date but with the current generation of technologies, we can surely produce something that can eliminate these hazardous situations. In the past, some devices were used for this kind of situations but they were only used by big factories or large corporations, not in a household as they were very expensive at that time. Nowadays this devices are really cheap and easy to manufacture. Also they can be found as modular devices, so they can work independently and we can use them in various ways to fit our purpose. As a result, IoT is everywhere these days and it is getting bigger and bigger every single day and still has a lot to uncover[30] [16].

Unfortunately it is surprising to see that gas leak detection and protection smart devices are not available in the market as they should be. There are smart home device but they are more focused on comfort and less on small security threat that could be deadly if remain unchecked. So far there is no mainstream solution to the problem that focuses on gas leak detection and protection. As a result even if someone wants to secure their home, it is not possible to do so because of the choice constrain they have. Also many people rent house and it is certainly not feasible to carry a security device unless it is modular which our proposed device solves.

Previous studies focused on cabled communication such as CAN-Bus communication[14] used to connect smart home devices that can detect gas leakage and fire to provide protection. The system was useful at that time when wireless network like Bluetooth and wifi was not as widespread as now and although the technology has improved, we will emphasize more on autonomous system and wireless communication so that the devices can connect to each other and detect anomaly as well as prevent any sort of damage. Giving focus to wires communication will increase the operational area and this way our proposed device can be free from cable constrains and will be expandable and can be moved around the house or out of the house without affecting much of other connected devices. It gives greater flexibility to the work flow which can come real handy when creating or maintaining a larger network of devices. Also it solves the problem when people have to move from house to house and can still carry their smart devices that installed in their previous house.

In the past devices used various sensors for gas leakage and fire detection and indicated if there were such occurrence of instances or not but it was not enabled to take decision based on pre-programmed actions, like start exhaust fan and stop the main gas line if there is a gas leak or call the fire department for assistance if there is an occurrence of fire. Also, previous

studies enabled the user to remotely control their smart home devices such as turning on/off light and fan or doing surveillance over the internet[21]. This way user can maintain their home appliances according to his/her need and an application is used for this remote access of devices. Although it gives greater level of control over the user of these smart device but the users had a lot to do and sometimes it is not possible to give this much attention to the system or keeping track of everything that has been going on.

On the other hand, the system can be isolated easily if there is any sort of network failure in the system, rendering the device useless without any kind of supervision. Unfortunate if that ever happens the device will have no use and even if it can detect and do it's job but it could not be able o prevent it without user instruction. Considering these factors, the concept of automation can be largely helpful in those situations. Automation is the technology by which a process or procedure is performed with minimum human assistance.[1] That means that completing tasks without or with less help from human then what a manual labour need. Our vision also align with with automation stands for. We want things to be simple and easy to use so that anyone can use our device with ease. People can just install their device in the home and let it handle all the work and only notify the user if there is any problem that needs attention. They do not need to know about all the small details that happens around in their house, most of the people do not have time to analyze or care for those kind of data. But these data hold significant value for the whole system to operate. As an example, gas sensor can detect the amount of LPG gas on the air and understand if it exceed the normal level. If it does then the main gas source will be turned off, exhaust fan will start and the user will be notified that there has been a gas leak and if he wants to call concerned authority. If there is no gas leak then the system just keep the data for future analysis. Same goes for accidental fire problem. This way smart devices will not have to wait for the user to make decision every single time as well as the user do not have to care for analyzing complex data set to look for anomalies in his home system. For convenience, it can also easily turn off the fan and light after the user has left the apartment or turn them back on when he/she comes back, it can also warn the user that there is a intruder in the house and he/she should call the police unless the intruder is a known person[6] [25] [15]. The device will also be able to utilize the full potential of the internet and the service provided by the modern operating systems like Android, iOS, and windows as they provide great API to facilitate the IoT devices.

Google provide smart home action that lets user control smart home devices using Google Assistant, Apple's home kit also gives the same functionality but with their own personal assistant, Siri, and finally Amazon's Alexa skill kit also provides the same facilities which can be used via Amazon Echo. Smart devices can take advantage of these API and perform a broader range of tasks. If the user wants, his smart devices can simply connect it to the smart

phone and the devices can use the the service provided by the phone's operating system which was not possible in the past since, before handsets were not as capable as they are now[8] [24]. We can control and connect various smart devices The proposed device can use users smart phone in time of need or it can be directly connected using wifi or cellular network. This way the best possible use case can be ensured. Finally, smart home automation system has great potential for implementation in 21st Century[31]. We just have to unlock the potential and make sure that it has been implemented properly so that it serves it's purpose and keep pushing the boundary of technology.

Chapter 3

Working Process

In this chapter we have discussed the whole working process of our device. Here we have not only showed the project's physical view but also we have discussed all the working principles, a block diagram of the system and two flowcharts of the whole process. The working principles of the total system is shown on the flow chart and overview of the system is shown on the block diagram below.

3.1 Block Diagram

Block Diagram is a visual portrayal of a framework that utilizes straight forward, marked hinders that speak to single or different things, substances or ideas, associated by lines to demonstrate connections between them. A substance relationship chart (ERD), one case of a square outline, speaks to a data framework by demonstrating the connections between individuals, objects, spots, ideas or occasions inside that framework.

Block Diagrams are a summed up portrayal of an idea and are not proposed to show finish data concerning plan or produce. In contrast to schematics, outlines and design charts, square graphs don't depict the essential detail for physical development.

In this section we draw a diagram of our whole system using blocks. Where an Arduino Uno is connected with 3 sensors, a LCD screen, buzzer, exhaust fan and window of the room . On the other hand our second micro controller NodeMCU is connected with IFFFT sever which is connect with our Google assistant. The MCU is also connected with a DST11 Sensor, 4 Channel Relay and an Arduino Nano which is connected with the Fan of the room. The diagram is given below.

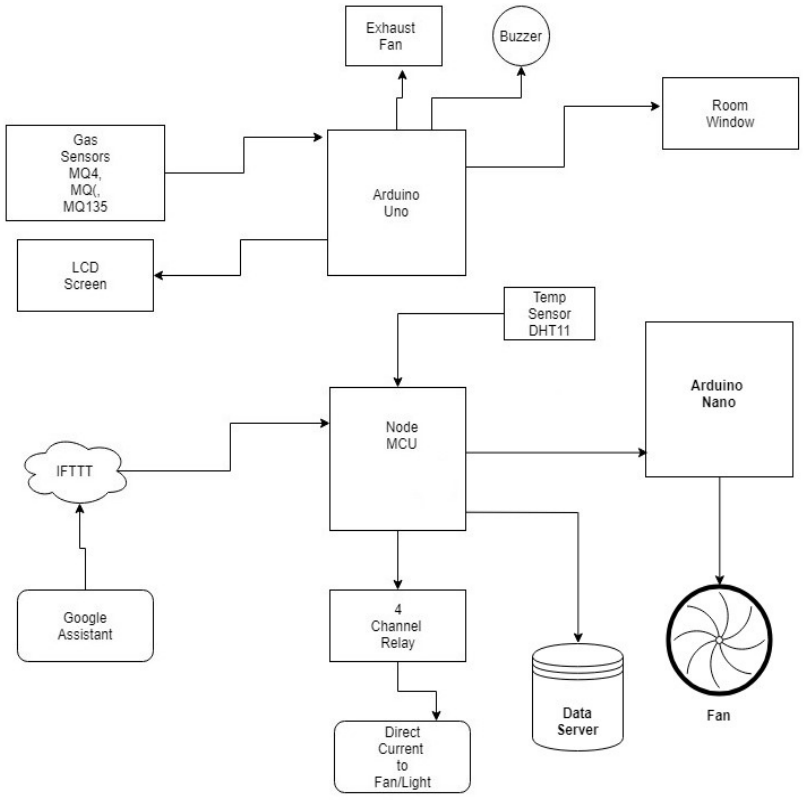

Fig. 3.1 Block diagram of IOT based home automation system using real time sensors

3.2 Flow Chart

A flowchart is a formalized realistic portrayal of a rationale succession, work or assembling process, association outline, or comparable formalized structure. The motivation behind a stream outline is to furnish individuals with a typical dialect or reference moment that managing a venture or process.

Flowcharts utilize straightforward geometric images and bolts to characterize connections. In programming, for example, the start or end of a program is spoken to by an oval. A procedure is spoken to by a square shape, a choice is spoken to by a precious stone and an I/O process is spoken to by a parallelogram. The Internet is spoken to by a cloud.

Flowcharts are utilized in planning and archiving straightforward procedures or projects. Like different sorts of graphs, they help picture what is happening and in this way help comprehend a procedure, and maybe likewise find more subtle highlights inside the procedure, similar to defects and bottlenecks. There are diverse kinds of flowcharts: each sort has its

very own arrangement of boxes and documentations. The Flow Charts of our system is given below.

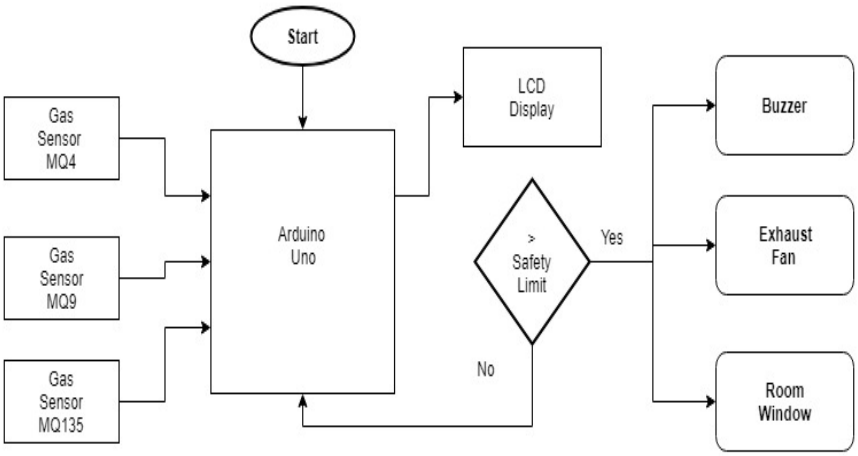

Fig. 3.2 Flow chart of the system with Arduino Uno

As in our system there are two processes working in parallel. That's why we have two flow charts the one which is shown in Figure 3.2 and that is process processed by micro controller Arduino Uno. The second processed by Node MCU and Arduino Nano . Which has a different flow chart and the second flow chart is given below.

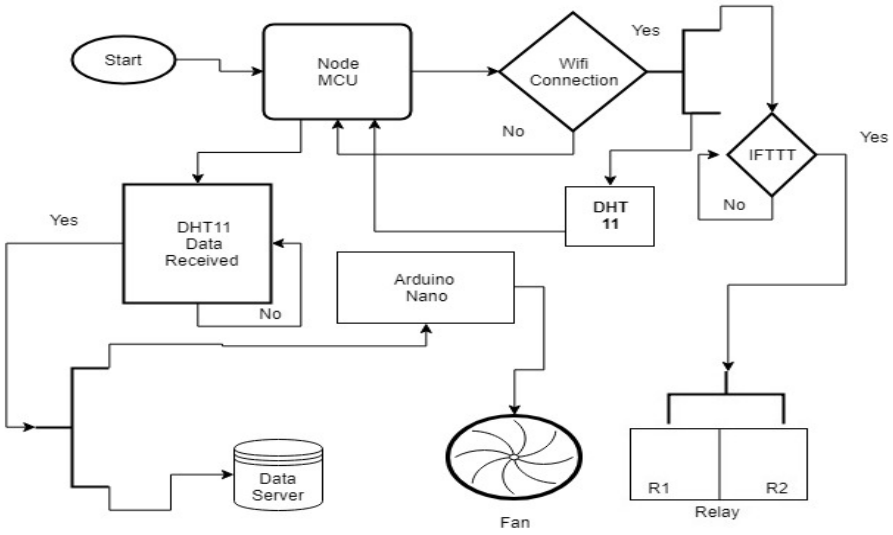

Fig. 3.3 Flow chart of the system with NodeMCU

3.3 Project View

Here, we can see the physical view of our prototype model in Fig. 3.4.

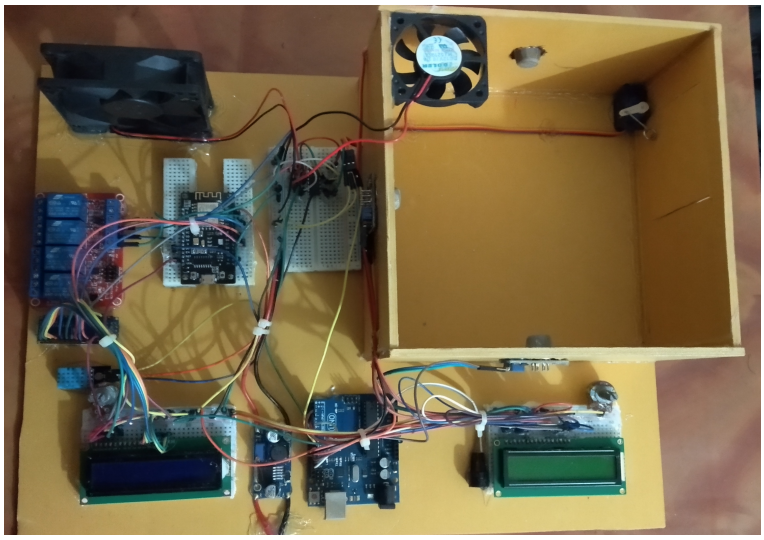

Fig. 3.4 IOT based smart home automation system based on real time sensors (Physical view)

Besides the physical view, we also have a schematic diagram of our device. Here in the Fig. 3.5 we can see the schematic diagram of our whole integrated system.

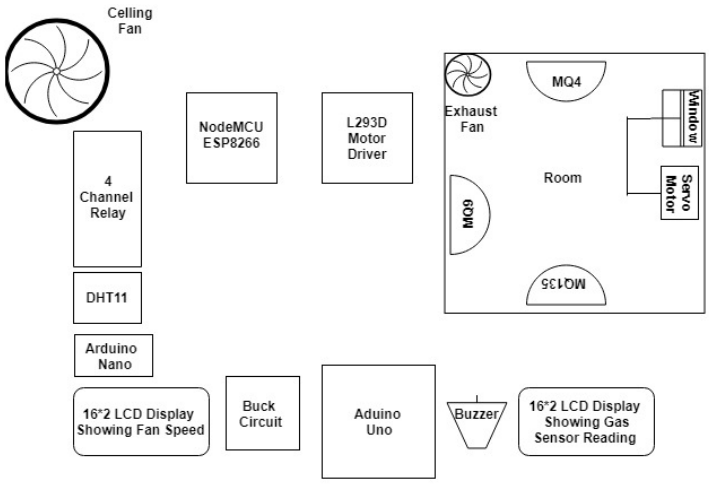

Fig. 3.5 IOT based smart home automation system based on real time sensors (Schematic diagram)

From the schematic diagram we can see that, there is a room in the top right corner of the board. Gas sensors are put in the three walls of that room. At the right side of the wall there is a window connected with the servo motor. At the top left corner of the board we placed the ceiling fan. Other components of our system for instance 4 channel relay, DHT11, Arduino Nano, 16x2 LCD display, Buck circuit, Arduino Uno, Buzzer, L293D motor driver, NodeMCU ESP8266 are placed accordingly on the board.

Chapter 4

Hardware and software

It is the heart of our model. We have used several components to fulfill the prototype model. In this section we are going to discuss about all those components as well as software we used to build the system.

4.1 Choice of component

The main portion of a prototype model is its components which are going to be used to operate the whole system. In this case it is very necessary to choose those components very carefully. In addition, if we do not choose components carefully, there might be some problems. For instance, when we will integrate the whole circuit together, some of the components might not perform well, there can have certain voltage drop or elements might not get proper power supply. In this case the whole system can be failed whereas the whole circuit integration is correct. So, perfect choice of components is really a big issue while making prototype models. Besides, costing is a big issue here as in the market, everyone generally prefers a good output with a very less budget. That is why for making a good product we all should bear in mind the cost minimization. We have selected different components to make the device physically. We tried to use cheap and effective as well as market available components. To build this project we have used 16 different components. Table-4.1 shows the component list of our prototype model. We have tried to show almost all the characteristics and behavior of different component that are used as a hardware part in our model.

Table 4.1 Components list of the prototype model

Serial	Component	Quantity
1	Breadboard	1
2	Connecting Wires	2 sets
3	NodeMCU ESP8266	1
4	DHT11 Temperature and humidity sensor	1
5	Arduino Uno	1
6	Buzzer	1
7	16x2 LCD Display	2
8	Potentiometer	2
9	MQ-4 Gas Sensor	1
10	MQ-9 Gas Sensor	1
11	MQ-135 Gas Sensor	1
12	4x4 Relay Module	1
13	SG-90 Servo Motor	1
14	DC-DC Buck converter	1
15	L293D Motor Driver	1
16	Arduino Nano	1

4.1.1 Breadboard

A breadboard is a solder less device for temporary prototype with electronics and test circuit designs. Most electronic components in electronic circuits can be interconnected by inserting their leads or terminals into the holes and then making connections through wires where appropriate. The breadboard has strips of metal underneath the board and connect the holes on the top of the board. The metal strips are laid out as shown below. The top and bottom rows of holes are connected horizontally and split in the middle while the remaining holes are connected vertically.

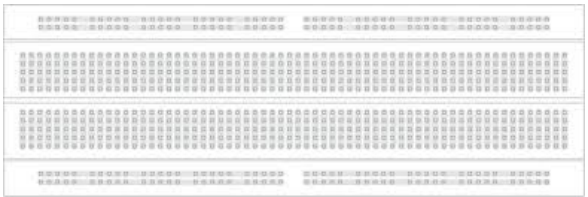

Fig. 4.1 Breadboard

4.1.2 Connecting Wires

Connecting wires allows an electrical current to travel from one point on a circuit to another because electricity needs a medium through which it can move. Most of the connecting wires are made up of copper or aluminum. Copper is cheap and good conductivity. Instead of the copper, silver can also be used which has high conductivity but it is too costly to use.

Fig. 4.2 Connecting Wires

4.1.3 NodeMCU ESP8266

NodeMCU is an open source IoT stage. It incorporates firmware which keeps running on the ESP8266 Wi-Fi SoC from Expressive Systems, and equipment which depends on the ESP-12 module. The term NodeMCU typically refers to the firmware, whereas the board is termed Devkit. NodeMCU Devkit 1.0 consists of associate ESP-12E on a board that facilitates its use. It additionally contains a transformer, a USB interface. The expression "NodeMCU" of course alludes to the firmware as opposed to the improvement units. The firmware utilizes the Lua scripting dialect.

Specification:

- Open-source
- Interactive

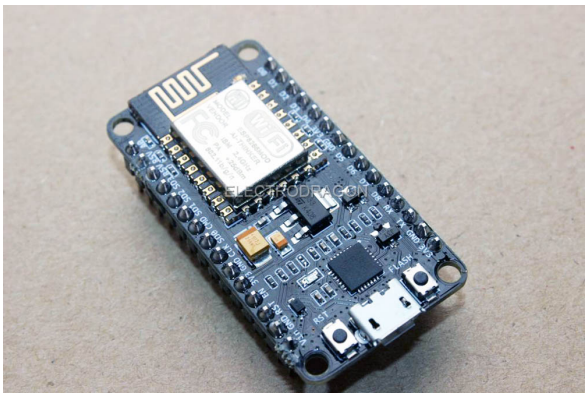

Fig. 4.3 NodeMCU

- Programmable
- Low cost
- Simple
- Smart
- WI-FI enabled
- USB-TTL included
- Plug and Play

4.1.4 DHT 11

DHT11 Temperature Humidity Sensor features a temperature humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high performance 8-bit micro controller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness.

Specification:

- Operating Voltage: 3.5V to 5.5V
- Operating current: 0.3mA (measuring) 60uA (standby)

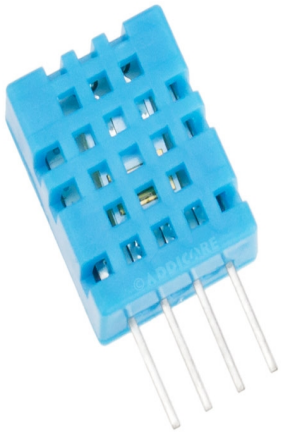

Fig. 4.4 DHT 11

- Output: Serial data
- Temperature Range: 0°C to 50°C
- Humidity Range: 20
- Resolution: Temperature and Humidity both are 16-bit
- Accuracy: ±1°C and ±1

4.1.5 Arduino Uno

The Arduino UNO is an open-source micro controller board based on the Microchip ATmega328P micro controller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts.

Specification:

- Microcontroller: ATmega328
- Operating Voltage: 5V
- Input Voltage (recommended): 7-12V

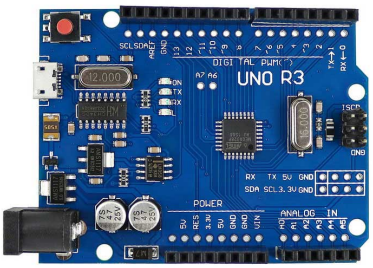

Fig. 4.5 Arduino Uno

- Input Voltage (limits): 6-20V
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 40 mA
- DC Current for 3.3V Pin: 50 mA

4.1.6 Buzzer

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke.

Fig. 4.6 Buzzer

Specification:

- Operating voltage 3.3V-5V
- PCB Dimensions: 28.2 (length) x 13.1 (W) x 11.5 mm (H)
- Wire length: 20.5cm
- Weight: 7 gm

4.1.7 16x2 LCD Display

An 16x2 LCD is an electronic display module which uses liquid crystal to produce a visible image. The display is a very basic module commonly used in DIYs and circuits. The 16×2 translates to a display 16 characters per line in 2 such lines.

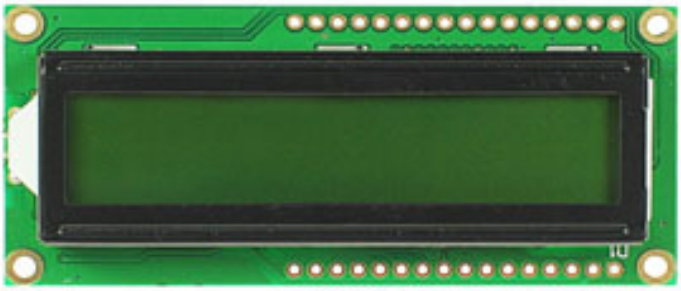

Fig. 4.7 16x2 LCD Display

Specification:

- Operating Voltage is 4.7V to 5.3V
- Current consumption is 1mA without backlight
- Alphanumeric LCD display module, meaning can display alphabets and numbers
- Consists of two rows and each row can print 16 characters
- Each character is build by a 5×8 pixel box
- Can work on both 8-bit and 4-bit mode
- It can also display any custom generated characters
- Available in Green and Blue Backlight

4.1.8 Potentiometer

A potentiometer is a simple knob that provides a variable resistance, which can be read into the Arduino board as an analog value. It has a range of resistance. They can be attuned from zero ohms to whatever maximum resistance that is specific to it. For example, a potentiometer of 10 k can be adjusted from 0 to its maximum of 10 k.

Fig. 4.8 Potentiometer

Specification:

- Input potentiometer resistance any value from 1 kilohm to 50 kilohms
- Span adjustment 50% to 100% of pot rotation
- Input impedance >10 megohms
- Excitation 1.2 V
- Output range 4/20 mA
- Max load resistance Rmax= [(Vsupply - 12V)/.020 mA] kilohms
- Response time 100 ms typical
- Common mode rejection 120 dB, DC to 60 Hz
- Operating temperature -13°F to 176°F/-25°C to 80°C

4.1.9 MQ-4 Gas sensor

MQ-4 gas sensor has high sensitivity to Methane, also to Propane and Butane. The sensor could be used to detect different combustible gas, especially Methane, it is with low cost and suitable for different application. Sensitive material of MQ-4 gas sensor is SnO2, which with lower conductivity in clean air. When the target combustible gas exist, The sensor's conductivity is more higher along with the gas concentration Rising.

Fig. 4.9 MQ-4 Gas sensor

Specification:

- Sensor Type Semiconductor
- Power requirements: VCC - 5V±0.1
- DO output: TTL digital 0 and 1 (0.1 and 5V)
- AO output: 0.1-0 .3 V (relative to pollution), the maximum concentration of a voltage of about 4V
- Detection Gas: Natural gas/Methane
- Detection Concentration: 200-10000ppm (Natural gas / Methane)
- Interface: 1 TTL compatible input (HSW), 1 TTL compatible output (ALR)
- Heater consumption: less than 750mw
- Operating temperature: 14 to 122 °F (-10 to 50°C)
- RH Related humidity less than 95% Rh

- O2 Oxygen concentration is 21% (standard condition) - Oxygen concentration can affect sensitivity
- Load resistance: 20KΩ
- Sensing Resistance Rs: 10KΩ- 60KΩ(1000ppm CH4)
- Preheat time:Over 24 hour
- Standard Encapsulation Bakelite, Metal cap

4.1.10 MQ-9 Gas sensor

This gas Sensor module is useful for gas leakage detecting. It can detect LPG, i-butane, methane, alcohol, Hydrogen, smoke and so on. Measurements can be taken as soon as possible based on its fast response time. Also the sensitivity can be adjusted by the potentiometer.

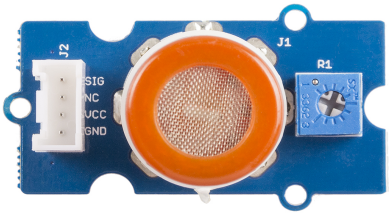

Fig. 4.10 MQ-9 Gas sensor

Specification:

- Good sensitivity to CO/Combustible gas
- High sensitivity to Methane, Propane and CO
- Long life and low cost
- Simple drive circuit
- Input voltage: DC 5±0.2V
- Power: 150mA

- DO output: TTL digital 0 and 1 (0.1 and 5V)
- AO output: 0.1-0.3V (relatively clean), the highest concentration voltage is about 4V.

4.1.11 MQ-135 Gas sensor

MQ135 gas sensor has high sensitivity to Ammonia, Sulfide and Benze steam, also sensitive to smoke and other harmful gases. It is with low cost and suitable for different application.Used for family,surrounding environment noxious gas detection device, Can be used for ammonia, aromatics, sulfur, benzene vapor, and other harmful gases/smoke, gas detection and it's tested concentration range is 10 to 1000ppm.

Fig. 4.11 MQ-135 Gas sensor

Specification:

- Wide detecting scope
- Fast response and High sensitivity
- Stable and long life
- Operating Voltage is +5V
- Detect/Measure NH3, NOx, alcohol, Benzene, smoke, CO2, etc
- Analog output voltage: 0V to 5V
- Digital output voltage: 0V or 5V (TTL Logic)

- Preheat duration 20 seconds
- Can be used as a Digital or analog sensor
- The Sensitivity of Digital pin can be varied using the potentiometer

4.1.12 DC-DC Buck Converter

We have used LM2596 DC-DC buck converter step-down power module with high-precision potentiometer, capable of driving a load up to 3A with high efficiency..

Fig. 4.12 DC-DC Buck Converter

Specification:

- Very light weight 15 g
- Our model- IM130731002
- Its max output current is 3A

4.1.13 Relay Module 4x4

This relay module allows to combine the processing power of Arduino to devices that use higher current and voltage. It does so by providing four relays that are rated for 7A at either 28VDC or 10A at 125VAC. Each relay has a Normally Open (NO) and a Normally Closed (NC) contact.

Fig. 4.13 Relay Module 4x4

Specification:

- 4-Channel Relay interface board, and each one needs 15-20mA Driver Current
- Both controlled by 12V and 5V input Voltage
- Equipped with high-current relay, AC250V 10A ; DC30V 10A
- Standard interface that can be controlled directly by microcontroller (Arduino , 8051, AVR, PIC, DSP, ARM, ARM, MSP430, TTL logic active low)
- Opto-isolated inputs
- Indication LED's for Relay output status

4.1.14 SG-90 Servo motor

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration.[1] It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

Fig. 4.14 SG-90 Servo motor

Specification:

- Operating Voltage is +5V typically
- Torque: 2.5kg/cm
- Operating speed is 0.1s/60°
- Gear Type: Plastic
- Rotation : 0°-180°

4.1.15 L293D motor driver

The L293D is a quadruple half H-bridge bidirectional motor driver IC that can drive current of up to 600mA with voltage range of 4.5 to 36 volts. It is suitable to drive small DC-Geared motors, bipolar stepper motor etc.

Specification:

- Supply Voltage Range 4.5V to 36V
- 600-mA Output current capability per driver
- Separate Input-logic supply
- It can drive small DC-geared motors, bipolar stepper motor.
- Pulsed Current 1.2-A Per Driver
- Thermal Shutdown

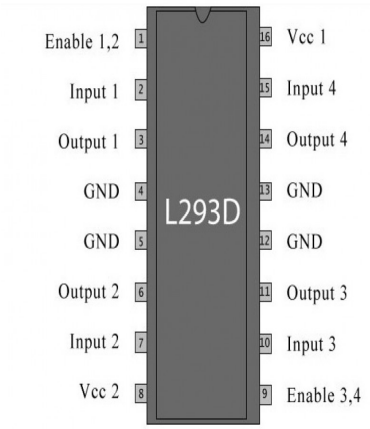

Fig. 4.15 L293D motor driver

- Internal ESD Protection
- High-Noise-Immunity Inputs

4.2 Hardware Mechanism

Hardware mechanism is the most important part of this project. In this section we have discussed how hardware part will work.

4.2.1 Gas sensing room

Here our prototype model is prepared for rooms. In this case, there will be three gas sensors MQ4, MQ9 and MQ135 which are used mainly for sensing smoke, CO (Carbon Mono-oxide) and CO2 (Carbon di Oxide) accordingly. This is the main purpose of our gas sensors to detect if there is any harmful gas present in our room. Besides these three, our sensors also detect methane, CNG, NH3, NOx, alcohol, Benzene and other flammable gases as well. These three sensors are connected to our micro controller Arduino Uno R3. When our prototype model is connected with the power, it will continuously show sensor reading to a 16x2 display.

4.2.2 Exhaust fan, fire alarm and window mechanism

Exhaust fan, fire alarm and window will work based on the sensor readings of MQ4, MQ9 and MQ135 gas sensors. We have set a parameter for smoke, CO (Carbon Mono-oxide) and

CO2 (Carbon di Oxide) which are the last limit for the safely level of human body. If the reading of sensors exceeds that limit, it will be harmful for human body. Even there can be occurrence of accidents. So, when our system will detect any kind of gas presence which exceeds the parameter, our fire alarm system will be turned on and continuously buzzing until all the gases that can harm a human body is out of the room. Now, for taking those gases out of the room where our system is installed, there is an exhaust fan which will also be turned on automatically if any gas is found that exceeds our given parameter. Besides this, one window is also connected to our system with one SG-90 Servo motor which will also be turned on to open the window when exhaust fan is on. So, here we can say, if our system detects any kind of harmful gas presence in the room where our prototype model is installed, it will automatically turn on the fire alarm, an exhaust fan and the window to take those harmful gas out of the room. In the meantime our sensors will be keep measuring the dimension of those gases and show continuously on the LCD display. As our exhaust fan is on and window is open, the rate of the gas will be gradually decreasing inside the room. When it will be at a tolerant level, our exhaust fan and window will be automatically shut down.

4.2.3 Smart fan based on temperature mechanism and data saving method in online server

Besides those gas detection as well as exhaust fan, fire alarm and window mechanism of our prototype model has another temperature sensor which is named DHT11. This temperature sensor is connected with NodeMCU. Our main goal was to utilize the temperature value for running a fan automatically. For this we are using PWM technique where our fan will turn on and off just based on temperature. Not only turning on or off but also the speed of the fan is also controlled based on the temperature values. For running the fan with PWM technique, we are using another micro controller named Arduino nano. Here in our model only fan is connected with the Arduino Nano. Besides, Arduino Nano is connected with NodeMCU for taking the temperature value from DHT11. Display is connected with Arduino Nano where it is only showing the speed of the fan. Initially when there is a high temperature, the fan will rotate with its full speed. If temperature is decreased by one degree Celsius, speed of the fan will also be decreased in a certain amount of percentage. Then, if temperature is decreased again, speed of the fan will be reducing again. By doing this in a continuous process, when the temperature value will be at its lowest level, the fan will be turned off. Here, we are setting the parameter of the temperature based on our sub continental environment and climate . Thus we are controlling the speed of a fan automatically. Besides controlling the fan based

on temperature value, we are also saving the daily temperature data across time on an online server so that we or other researcher can use real time data of months or years in further researches. For this connectivity to online server we are using NodeMCU Wi-Fi module instead of Arduino Un[[29][12].

Workflow of PWM technique

Digital signals have two positions: on or off, understood in shorthand as one or zero. Analog signals, on the opposite hand, can be on, off, half-way, common fraction the way to on, and an infinite variety of positions between zero and one either approaching one or descendant all the way down to zero. Analog and digital signals are handled very differently in electronics but sometimes this two has to work together. In this case, PWM is a way to control the analog devices with a digital output. It's one in all the first means that by that MCUs drive analog devices like variable-speed motors, dim able lights, actuators, and speakers. Actually PWM is not a true analog output, however it fakes an analog result by applying power in pulses. Here we use duty cycle and frequency to describe PWM. The duty cycle can change to affect the average voltage and the frequency of the cycles can be increased.

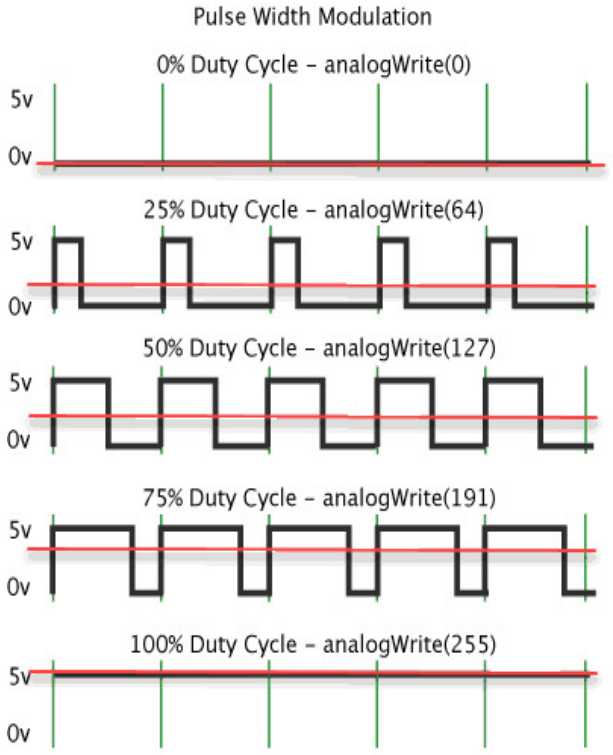

Fig. 4.16 An example of a PWM signal shown at several duty cycles and a high voltage level of 5 volts.

The pulse can also be increased in length but here the only thing will not be changed is high voltage level because in digital output on means always high. In the above figure we can see how PWM signal works at several duty cycles and high voltage level[[26] [4] [34] [35]].

4.2.4 Voice controlled home

This is our final feature of our model where we will be controlling any electronic device which is connected to our system by voice through google assistant. Google assistant is a very powerful AI build by google. We have added this feature to our prototype model so that our system will be a lot of machine-controlled and smart as well. We are using NodeMCU Wi-Fi module for this purpose where it is connected through home Wi-Fi network of user. In this case, user just need to say on his phone "Ok google" to turn google assistant on and then voice control feature of our model will be activated. When any instruction is given to google assistant by saying "Ok google" it sends request to IFTTT. IFTTT is a free web-based service to create chains of simple conditional statements, called applets. Here user of our prototype model can save their personal instruction through applets and when any instruction is given to the google assistant it starts matching the existing applets created by user. IFTTT is connected through user's google account and when google assistant finds the match, it passes the instruction to NodeMCU. A relay is connected with the NodeMCU Wi-Fi module. After getting the instruction from IFTTT, NodeMCU starts executing the instruction through the relay. Besides the voice command, user can also control the operations through an android application which is named Blynk app. It is an internet of things platform with a drag and drop mobile application builder that allows to utilize sensor data and control electronics remotely. In order to make a home automation system we are also using this app for more options and flexibility.

4.3 Software

In our prototype model we are using the Arduino IDE software to program the Arduino Uno R3 and NodeMCU ESP8266 micro controllers and Blynk app to configure the android control system.

4.3.1 Arduino IDE

Here, the open-source Arduino software (IDE) makes it easy to write code and upload it to the board. It runs on windows, mac os x, and linux. Figure- shows the Arduino IDE software editing window.

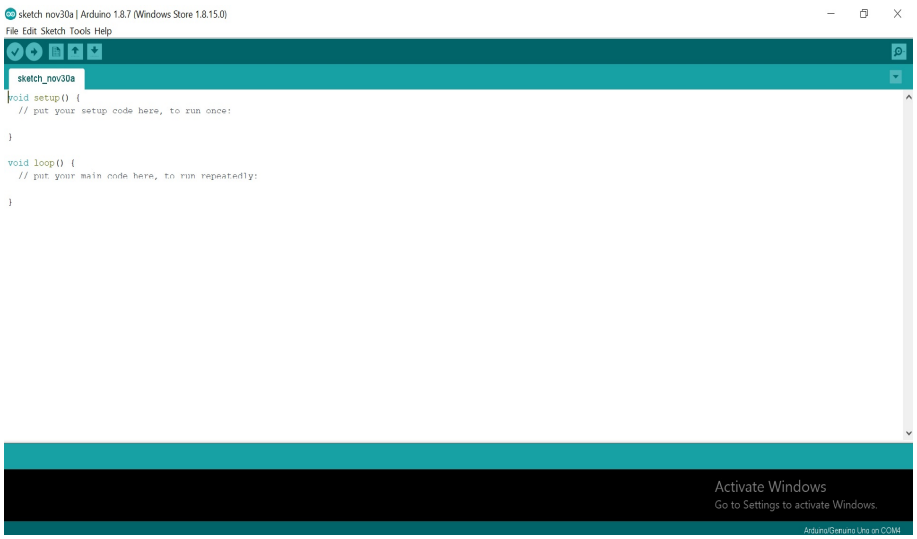

Fig. 4.17 Arduino IDE

4.3.2 Blynk app

It is an internet of things platform with a drag and drop mobile application builder that allows to utilize sensor data and control electronics remotely. Fig. 4.18 shows the control panel of home automation system in Blynk app.

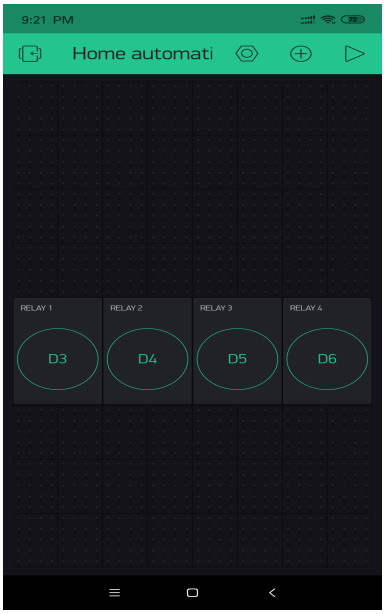

Fig. 4.18 Control panel of home automation system in Blynk app

As Blynk app is a drag and drop mobile application builder, Fig. 4.19 shows us the manual page of home automation system in Blynk app.

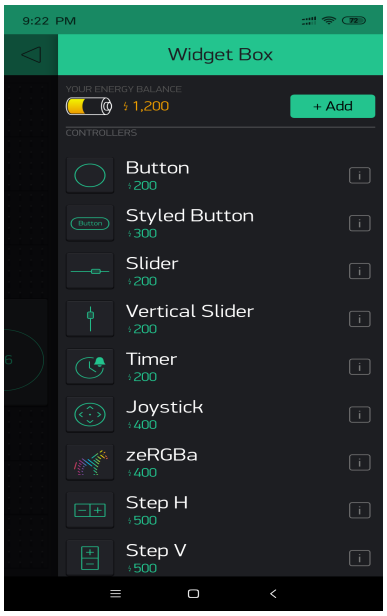

Fig. 4.19 Manual page of home automation system in Blynk app

Fig. 4.20 illustrates the settings page of Blynk app.

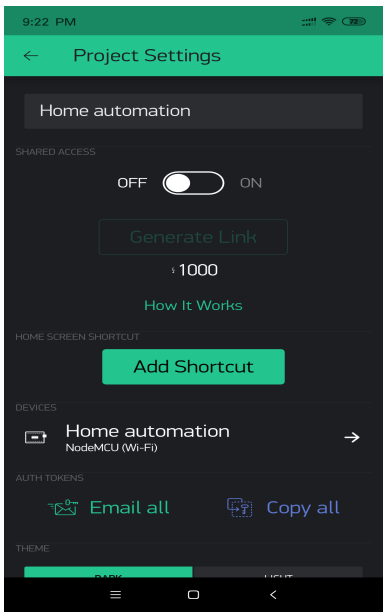

Fig. 4.20 Settings of Blynk app

Chapter 5

Experimental Studies

We have done some measurements and analysis with the components of the device. These topics are mentioned below.

5.1 Hardware Implementation

First of all our three gas sensors are connected with the Arduino Uno micro-controller. Here arduino provides the power supply to the sensors to start sensing gas presence from the environment. Here ground and 5V pins of Arduino Uno are connected with the GND and VCC pins of MQ-4 gas sensors. Remaining digital pin D0 of MQ-4 is connected with the digital pin 10 of Arduino Uno which is actually sending data to the arduino. Our another two gas sensors, MQ-9 and MQ135 are connected with the Arduino Uno with the same process as MQ-4 is connected with the Arduino.Here digital pin D0 of MQ-9 and digital pin D0 of MQ-135 are connected with digital pin 11 and 12 of Arduino Uno accordingly. Based on the results of gas sensors; exhaust fan, fire alarm and servo motor of our prototype model will turn on or off automatically. The VCC pin of exhaust fan, buzzer and servo motor are connected with the digital pin 8,13 and 9 of Arduino Uno accordingly. Remaining three pins of exhaust fan, buzzer and servo motor are connected with the ground of Arduino Uno. Next, our another sensor, DHT11 temperature and humidity sensor is connected with NodeMCU ESP8266. GND and VCC pin of DHT11 is connected with GND pin of L293D motor driver and 3V of NodeMCU. Remaining digital pin D0 of DHT11 is connected with the digital pin D2 of NodeMCU. DHT11 is sending sensor data to NodeMCU through this digital pin. Again, three digital pins of another micro controller Arduino Nano, D2, D3 and D4 is connected with the three digital pins D5,D6 and D7 of NodeMCU accordingly. Positive pin of a 12V fan is connected with the digital pin,D5 of Arduino Nano. Finally, IN1 and IN2 pins of 4x4 relay are connected with the digital pin D3 and D4 of NodeMCU.

5.2 Data analysis, Result and Decision

The MQ series of gas sensors have a heater installed inside with an electrochemical sensor. They are sensitive to a certain range of gas presence. The outputs can be read with an analog input of the arduino and out put is also an analog signal. When MQ-5, MQ-9 and MQ-135 three gas sensors are connected with the Arduino Uno, serial port of load sensors show the value. We can monitor these sensor values in both serial monitor of arduino uno and a LCD display. We have used 16x2 display, so we will be showing our output results in 16x2 LCD display. We configured the sensitivity controller of each gas sensor at a level that if any sensor detect any harmful gas like Carbon dioxide, Carbon monoxide or Smoke or any harmful gas the system will go on. Here in the Fig. 5.1 shows the outputs of MQ-4 and MQ-9 sensors data in LCD dissplay.

Fig. 5.1 Output value of MQ-4 and MQ-9 gas sensor in LCD display

Our target is not only to measure the sensor values but also to use those sensor values for taking the decision. In a simple way we can say that, our system will decide when to on the exhaust fan, fire alarm and window. This decision can be taken by simple if and else condition as micro controller do not understand any algorithm or process any data. So, when our gas sensors will find any gas presence in the particular room, it will just trigger on the exhaust fan, window and fire alarm. There is a potentiometer on the back of each gas sensor. We can set our value by just rotating the potentiometer. We triggered the potentiometer such a way, if it finds any presence of gas; exhaust fan, window and fire alarm will be turned on. That is how our exhaust fan, fire alarm and window is working based on the sensor values.

Table 5.1 Gas sensor results when gas is found

Sensor	Condition	Exhaust Fan	Window	Fire Alarm
MQ-4	If any gas triggered	ON	ON	ON
MQ-9	If any gas triggered	ON	ON	ON
MQ-135	If any gas triggered	ON	ON	ON

Temperature sensors are designed to use in almost any application as well as the prototype models and industry. The temperature is estimated with the assistance of a NTC thermistor or negative temperature coefficient thermistor.This sensor features a calibrated digital signal output with the temperature and humidity sensor capability. It is integrated with a high-performance 8-bit micro controller. This DHT11 temperature and humidity sensor is connected with the NodeMCU ESP8266. When our system is on, temperature and humidity sensor(DHT11) will start measuring the temperature and humidity values automatically from the surrounding environment. Serial port of load sensors show the sensor value. Here in the Fig.5.2 shows the outputs of sensor data in serial monitor.

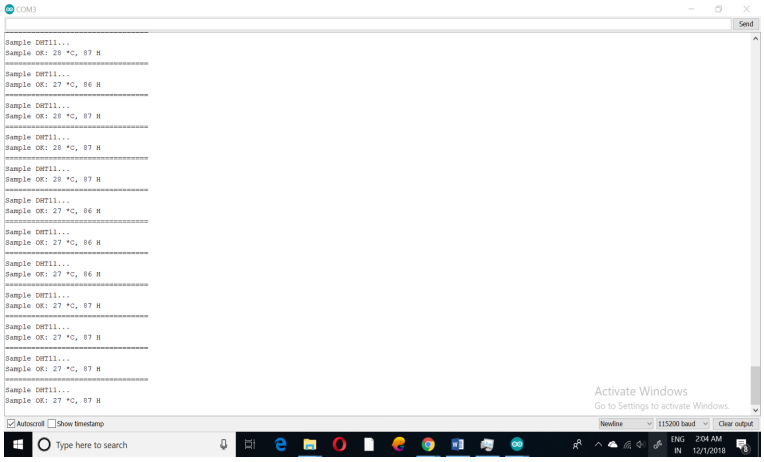

Fig. 5.2 Output value of DHT11 temperature and humidity sensor

In Fig. 5.2 we can see that the values of temperature and humidity sensor(DHT11). Here the temperature is fluctuating between 26 degree Celsius and 28 degree Celsius then stabilizes at 27 degree Celsius.

Here Table 5.2 shows the decision taken by the Arduino Nano of increasing or decreasing the percentage for the ceiling fan.

We are controlling the ceiling fan automatically in our prototype model based on the temperature we found in the surrounding environment using PWM (Pulse Width Modulation) technique. Digital control is utilized to make a square wave so that the speed of the fan can automatically rise or fall. Table 5.2 states the fan speed control based on temperature measured by DHT11 temperature and humidity sensor.

In the table we showed the parameters, based on what we set the fan controlling speed. Like if the temperature sensor detects the room temperature below 26 the fan will remain off of turned off. If the sensor detects the temperature 27 degree it will run the fan in 20 percent speed. If the temperature is 26 degree the fan will run at 40 percent. As the temperature

is rising or falling the speed of the fan will automatically increase or decrease and if the temperature is above 30 degree the fan will spin at 100 percent capacity.

Table 5.2 Fan speed control based on DHT11 temperature sensor data

Temperature	Fan speed
<26	Fan off
26	Fan speed 20%
27	Fan speed 40%
28	Fan speed 60%
29	Fan speed 80%
30 or above	Fan speed 100%

We have voice control automation system included in our system which works through a web server named IFTTT. It is connected with the Google account by which user can create applet. In Fig. 5.3 we can see a example of applet which was created while developing our system.

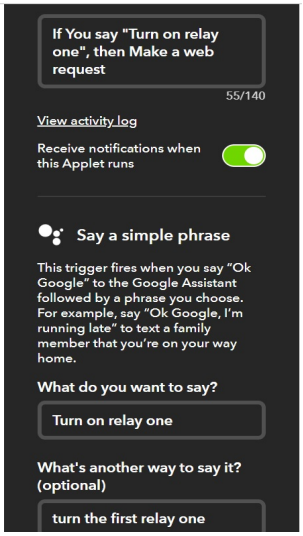

Fig. 5.3 applet 1

In the applet we can see how we can teach Google assistant a instruction in a different way of speaking. We used this applet for turning on relay which is connected with NodeMCU.

In Fig. 5.4 we can see how we teach Google assistant answer of any particular question. It is the second part of applet 1.

After this, when any kind of instruction is sent to NodeMCU via Google assistant, it will turn on automatically relay IN1 pin. Besides this in the applet 2 we can see a URL given where at the last of that URL, there is a digital pin D0 given which indicates the arduino

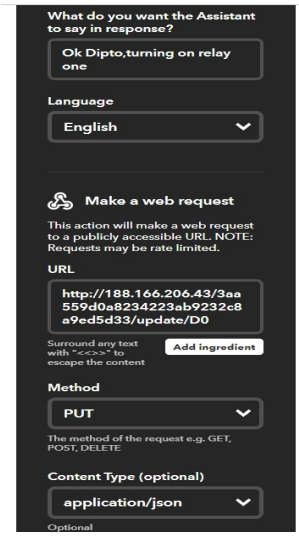

Fig. 5.4 applet 2

conversion of NodeMCU pin D3. In the hardware implementation part we have discussed that D3 and D4 pin of NodeMCU is connected with IN1 and IN2 pin of relay. That is how our voice command is reached to NodeMCU and executed by relay module. By the same process we teach Google assistant how to turn off that single relay as well as all instructions of voice command.

Chapter 6

Device Impact

In this chapter we have discussed different impact of the device in different aspect like . Besides this we have also discussed cost analysis and economic impact of this device.

6.1 Health and Safety Impact

Our prototype model is designed in a way, so that it can be helpful to people in safety issues. In recent days, in our society gas leakage is a common incident now a days. Many people loses their valuable lives because of this. For this reason we have designed a prototype model of home automation system where our system will automatically detect harmful gas presence in our rooms. After detecting, our system will remove this dangerous gases from the room with the help of an exhaust fan and window which will also be automatically turned on. Besides, by the fire alarm system the user can also be aware of the situation that there are harmful gases in the room. So we can see, for health and safety issues our system can bring a very powerful impact on society[22].

6.2 Lower energy consumption

Another major problem of our society is wastage of energy and in recent days this problem is becoming more acute[18][20]. As a fastest developing country many factories and mega malls are being established, in a result we are facing the energy problem. To reduce this kinds of problem, many agendas and project works are developing but still this problem has not been solved properly. So we all should come forward in order to solve excess energy consumption, otherwise in near future we will face more energy issues. Here, in our prototype model we are proposing temperature controlled smart fan which is able to control its speed

based on temperature value. As it is designed for rooms, so it can be installed in home, office, schools, colleges and many more places easily. As a result huge amount of energy and electricity can be saved.

6.3 Cost Analysis and economic impact

There are many system related to home automation available in the market but most of them high highly priced and not affordable for every person[28][19]. But our system is an integrated system which has many important features and its easily affordable for any person. Because it only costed 2700 BDT. Most importantly our system can be installed in many places, like room of homes, office rooms, schools, colleges or university class room. So it is really an additional plus point for our prototype model that it can perform multiple important operations at a time as well as it costs very less than the existing home automation system available in market. In table 6.1 there are details pricing for every components we used in our system.

Table 6.1 Price list of the components

Serial	Component	Quantity	Price
1	Breadboard	2	120TK
2	Connecting Wires	2 sets	120TK
3	NodeMCU ESP8266	1	450TK
4	DHT11 Temperature and humidity sensor	1	150TK
5	Arduino Uno	1	400TK
6	Buzzer	1	10TK
7	16x2 LCD Display	2	240TK
8	Potentiometer	2	20TK
9	MQ-4 Gas Sensor	1	100TK
10	MQ-9 Gas Sensor	1	100TK
11	MQ-135 Gas Sensor	1	100TK
12	4x4 Relay Module	1	400TK
13	SG-90 Servo Motor	1	120TK
14	DC-DC Buck converter	1	60TK
15	L293D Motor Driver	1	70TK
16	Arduino Nano	1	240TK
	Total		2700TK

When our prototype model will be sent for mass production, we believe that it will be

cheaper than expectation of the users. Besides they will also be satisfied using this system because of its simplicity and automation.

Chapter 7

Future Work & Conclusion

7.1 Future work

We live during a time where inventive innovation could easily compare to ever previously. Numerous individuals feel like they can't work except if they have a type of innovative contraption set up, and this stretches out to the home, which is the reason we are contemplating here what's on the horizon for home robotization. In any case, you need to trust that the savvy innovation utilized inside home computerization programming will keep on expanding its pervasiveness among individuals around the nation. Ten years prior, the idea of a cell phone with a touch-screen, a music player, a completely working web program and more alternatives appeared as though a curiosity held just for the most favored individuals. Five years prior, the possibility of such items as Amazon's Alexa menial helper appeared to be really unusual. However, in 2018, these are only a portion of the numerous innovative instruments that a substantial level of the populace depend upon every day. As innovation keeps on being created and new strategies for administration preparing are trialed, this will undoubtedly proceed such a movement.

With respect to home automation specifically, security will turn into a significantly bigger need than it as of now is. As we hear increasingly about any semblance of digital assaults and dangers from abroad, this will have individuals on alarm consistently, and it reaches out to the home, where a house that brags all these magnificently valuable things will turn into a more prominent focus for criminals, particularly amid occasion times. Right now, old-school mortgage holders are adhering to the more customary, less propelled methods for protecting their homes, yet this is turned out to be a dangerous and even useless exercise. As security dangers on all dimensions keep on expanding, this can just impact mortgage holders to surrender strategies for the past and head towards the future by utilizing home mechanization to take care of their belonging and themselves. Finally, home mechanization

is as of now to a great degree progressed, with the capacity to control locks, temperature, vitality, power and the sky is the limit from there, alongside littler yet similarly significant procedures, for example, exchanging over TV stations and noting your telephone. That is the condition of play in 2018, and we have just overcome much, however would you be able to envision the advancements that could be made in the years to come? We at times joke about the assignments that youngsters decline to do physically on the grounds that they have shrewd innovation to do it for them, yet this is just going to increment. Anyway we have a few gets ready for our exploration too. The fundamental issue we confronted was that there were no data set accessible on temperature of a solitary room or numerous room. So we couldn't examination that information to anticipate something. Be that as it may, our framework not just screens the temperature of the room it likewise stores it in an online database. So after a period we can investigation that information to improve our framework. We previously thought of utilizing that information to anticipate the most agreeable temperature for a client as for time. So that in the wake of running for a couple of days our framework can consequently control the fan, window and fumes fan to keep the appropriate temperature for the client without being directed or taking manual order from the client. To do this work we will require some additional equipment segment like Raspberry Pi, Ethernet Shield and so forth. At that point we can offer both the forms to a purchaser that on the off chance that he/she is intrigued to control the framework with some manual settings or he/she jumps at the chance to have a framework that consequently comprehends his/her solace without his/her direction.

7.2 Conclusion

The IoT enables items to be detected or controlled remotely crosswise over existing system foundation, making open doors for more straightforward incorporation of the physical world into PC based frameworks, and bringing about enhanced productivity, exactness and financial advantage. The development of a thorough brilliant home framework is a noteworthy advance in the improvement of this kind of savvy frameworks, which require a steady advancement to stay informed concerning the tremendous advancement of advances. This people group based structure (IOT SHS) is actualized because of its significance of serving diverse parts of the general public. This structure secured the requirements of ordinary, elderly and exceptional needs individuals. By applying this plan, we are uniting the innovation with the general public in favorable position to accomplish the welfare of the general public. In this research paper, we actualized a productive and minimal effort keen home automation framework that depicts the fan as in it has a temperature sensor which is named DHT11. This temperature

sensor is associated with NodeMCU. Temperature sensor will ceaselessly take temperature perusing from nature and it will demonstrate the outcome in a 16x2 LCD show. Our primary objective was to use the temperature esteem for running the fan consequently. For this we utilized PWM procedure where our fan will turn on and off simply dependent on temperature. Exhaust fan, fire alarm and window will work dependent on the sensor readings of MQ4, MQ9 and MQ135 gas sensors. We have set a parameter for smoke, CO (Carbon Mono-oxide) and CO2 (Carbon di Oxide) which are as far as possible for the securely dimension of human body. On the off chance that the perusing of sensors surpasses that limit, it will be hurtful for human body. Indeed, even there can be event of mishaps. Thus, when our framework will identify any sort of gas nearness which surpasses the parameter, our fire caution framework will be turned on and ceaselessly humming until every one of the gases that can hurt a human body is out of the room. Additionally all applications of our proposed system can be remotely controlled by android smart phone via internet. Another feature of our model where we will be controlling any electronic device which is connected to our system by voice through google assistant. We thought of a point when we can offer both the forms to a purchaser the upgraded one and the existing system that on the off chance that he/she is intrigued to control the framework with some manual settings or he/she jumps at the chance to have a framework that consequently comprehends his/her solace without his/her direction.

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