AUTOMATED HOME USING IOT AND AI

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ABSTRACT

In this project, A home automation system for a home is to be implemented and built a control interface. “Thingspeak” IOT platform will be used as an IOT could platform to control data from sensors and visualized the information and it will be sent reaction into the system according to data. Temperature measuring sensors, Gas protection sensors, face recognition systems, power-consuming sensors, and home instrument control system is to be used for this project. MATLAB and SIMULINK software will be used for analyzing the process of data. Moreover, the face recognition system would be implemented by using a neural network method that can be obtained accurate results. A software has been developed to control the entire home according to a pre-trained neural network. Using these methods users can be controlled home without staying at home instead they will be able to control home using the internet. This is known as IoT technology (Internet of Things). IOT is widely used in a lot of methods such as medicine, hospitals, hotels, and home control systems. To be collected all data from sensors, thingspeak IOT platform is to be used as data-based. PIC microcontrollers and nodeMCU would be used to control sensors and to connect sensors with WIFI and Arduino IDE and MATLAB would be used to program the smart home system. Moreover, GSM Modules, Twitter and Email have been used to provide necessary information for the user.

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1 INTRODUCTION

In modern days, IOT is being used to IOT of projects, Research, Industries to connect things and devices via the internet. The Internet of things is mainly based on the technology of wireless communication. IOT makes people convenience of their works in daily life. By using IOT, data can be monitored via smart devices wherever the user is staying. In this project, an automated home system which includes security systems based on camera, a Power control system using appropriate sensors, control system and parameter measuring systems using appropriate sensors. “Thingspeak” IOT could net and MATLAB software have been used to analyze data which obtain from sensors and NodeMCU development board. Moreover, PIC microcontrollers have been used to control all the sensors. A neural network on the security system and Sensor controlling system has been built as a research part of this project using MATLAB.in MEng B protect, NodeMCU and PIC microcontrollers are to be used for data transition by connecting via serial communication. Moreover, GSM technology is to be utilized to connect phones with users. This smart home project initiated with my idea which was made by myself. The research projects that have been done by other universities were influenced to success Smart home Concept. Specially, the project supervisor helped me develop this concept according to research. Therefore, A smart home has been created using the above-mentioned technologies and methods.

Mainly, Automated home has two mode of controlling methods which are normal mode and AI mode. In normal mode, controlling of devices would be done according to program code that has been created using Arduino and mikroc. While, controls of devices would be controlled by the neural network that has been trained in AI mode. Therefore, the user can either use normal mode or AI mode that has been built as a research development in this project.

A lot of sensor based controlling systems have been included in this project for user to monitor the details of home. One of the most important aspect of a home is security. Therefore, Face recognition security system has been developed using neural networks to identify the face of Owner. In addition to that, Relay module has been used to control home devices using mobile phone via nodeMCU (Wi-Fi). GSM module has been also added to the system to obtain sensor values to the phone through a message. Heart rate can be measured and analyzed. Moreover, Gas level, water leveL, weather condition such as wind speed, temperature, humidity and raining status and power consumption of home can obtained in this system, LCD display has been used to display above mentioned parameters using appropriate sensors.

Automated System has a control panel that consists of main circuits and GSM modules.PIC microcontroller circuit, nodemcu circuit and power circuit are the main three circuits in this project. All the sensors and components are connected to the control panel. This control panel consists of switches panel to obtain wind speed and heart beat rate. There is another switch to obtain a SMS message of sensor readings via GSM module whenever the user wants to obtain details as well.

Eventually, sensor details are corrected to "Thingspeak" IOT platform. If the sensor values are above or below the limits, user is informed via email and twitter messages. In addition to that, safety measurements would be implemented according to the program. For example, if the water level of the tank is low than pre-set level, water filling system can be activated automatically. If gas and temperature level is above the pre-set limit, fire protection system would be activated. Therefore, protection systems can be added and activated according to sensor values. Above mentioned measures would continue either user selects normal mode or AI mode.

Process of entire project can be used as follow,

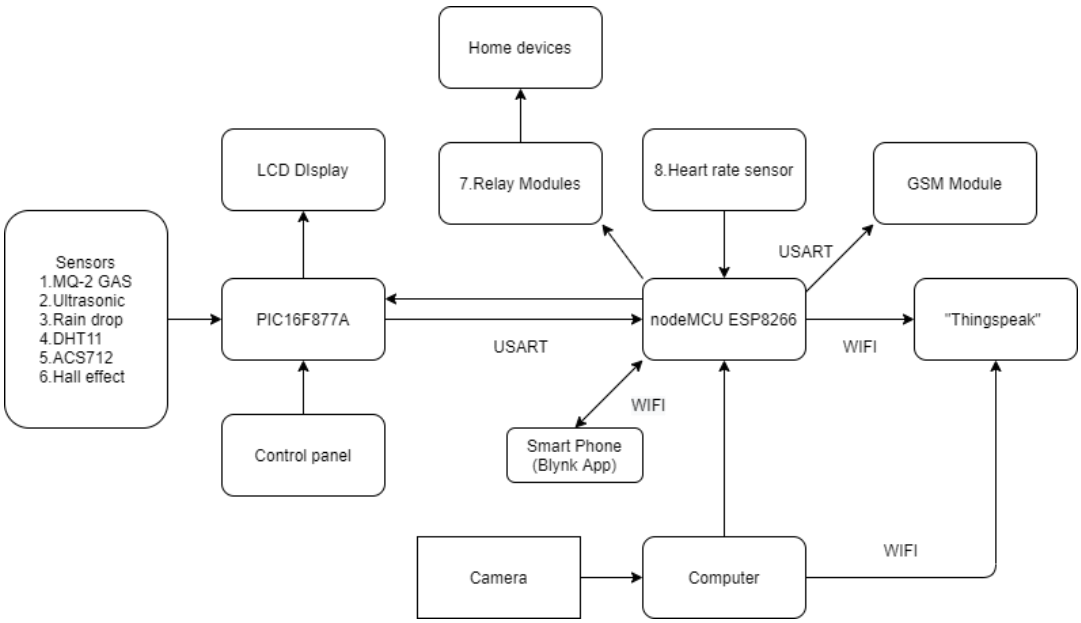


Figure 1:Process of the Automated Home

2 AIMS AND OBJECTIVES

2.1 AIMS

Aim is to build Automated Home System which obtains data from sensors, to connect Data to MATLAB software and “Thingspeak” IOT platform using internet., to send Desired reactions to microcontroller (Arduino/nodeMCU/PIC microcontrollers) in order to control the system After analyzing data, to create an AI software using MATLAB neural network to control devices automatically and also to inform the user by email or twitter message using “Thingspeak” React app and by messages using GSM modules.

2.2 OBJECTIVES

In this Project, Automated Home System is to be created by studying about IOT Technologies, GSM Technology, Use of AI and Industrial Productions in Modern Society. The most important fact is creating and developing a product that is able to fulfil the human requirements in day-to-day life. Objectives of this project can be shown as follows,

- Creating security system using Web camera
- Creating temperature and humidity control system
- Creating smart device control system
- Creating water control system
- Creating power consumption control system
- Creating rain detection system
- Measuring wind speed with anemometer
- Measuring heart rate and indicating to user
- Creating Gas detecting system
- Connecting nodeMCU and PIC microcontrollers using serial communication
- Creating message alert system using GSM800L
- Creating mobile app to control devices
- Connecting MATLAB with nodeMCU
- Connecting nodeMCU with thingspeak IOT platform
- Creating a software using neural network
- Maintaining Thingspeak channel to obtain data, analyze data and react using Thingspeak iot platform.

3 SCOPE

In order to success and develop this project, it is necessary to study about technologies in a wide range. Scope of the project can be shown as follows,

- Implementing a module of home to execute the project objective.
- Home device control system
- Security system
- Water control system
- Researching about image processing and picture recognition
- Researching about IOT technology
- Researching about microcontroller and programming methods.
- Studying about WIFI connection technology.
- Studying about neural networks and AI (Artificial Intelligence).
- Studying about data analyzing.
- Developing a home automation system product which can be affordable for customers.
- Studying about PIC microcontrollers.
- Studying about cost analyzing.
- Studying about MATLAB and SIMULINK.

4 LIMITATIONS

The Sensor values that are obtained from the sensor are not accurate 100%. Therefore, there can be Small fluctuations in Sensor Values due to the Temperature and Other environment facts. For an Example, Facial recognition can be malfunctioned due to the high Intensity of Light and Heart beat measuring sensor's readings can be changed due to displacement of finger pulses.

5 BACKGROUND RESEARCH

5.1 IMPORTANCE OF IOT

Internet of things is a technology that is connected things in several place via internet. This technology is used in enterprise such as smart environment systems, home automation system, marketing, medical and health care centers and transportation. Moreover, this concept was invented in 1994 with idea of sending small package of data to large number of nodes as a Device-to-Device communication system(D2D). Wifi connectivity is latest technology of IOT to connect things via wireless media. Scalable, accuracy, speed, efficient are very compatible compared with other data-based system and less power consumption, ability to connect devices directly and precisely and intermittent connectivity are main feature in IOT technology.

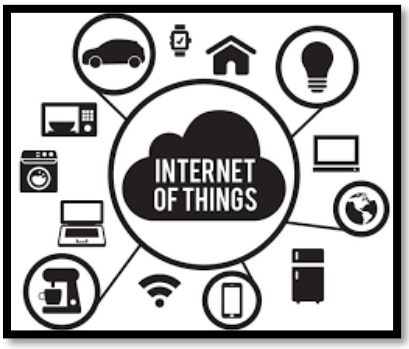


Figure 2:IOT protocol

5.2 IMPORTANCE OF SMART HOME

Security and protection of home cannot be controlled when user stays away from the home, if there is a problem, owner has to involve physically to solve that problem. if user is working at home with one thing, User will not be able to find out other important things of home and will not be able to check devices at the same time. using IOT system, it is easy to find out issues and control devices without any delay. Problems that can be occurred in future will be able to identify earlier. Most of the time important factor of things also can be to identified by human without technological knowledge. These

problems will be able to cause to a huge accident or damages in home and to human in home as well. The project aim is to give and provide a solution to society for home to be controlled in very convenience way. And to be obtained data in meaningful way. And research about how to connect neural networks with IOT systems.

Figure 3:Smart Home

5.3 SENSORS USED IN SMART HOME

In Smart home concept, Temperature, Gas level, humidity of home atmosphere, water level of home and other devices controlling in home like fans, switches, TVs, etc. are to be controlled appropriate sensors. Sensors and devices that are used in this project are described in this section in proper way.

5.3.1 LM35 temperature measuring sensor

LM35 temperature sensor is a specially made sensor that consists of comparative electrical output in Celsius and due to better accuracy, LM35 sensor is used in lot of industries. This sensor gives output voltage according to temperature therefore it is not necessary to amplify output voltage using amplifier circuit like thermocouples. lm35 sensor has 0.01 voltage per Celsius of scale factor moreover 60 microamps is needed from power supply for this sensor be use of low self-heating capacity.

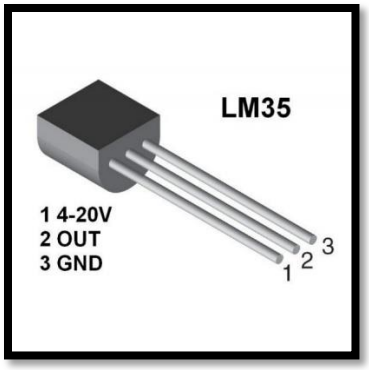


Figure 4:LM35 Sensor

LM35 sensor has three main pins. Vcc pin is used to be power pin and it is required to supply 5V dc voltage to function the sensor. Ground pin is used to ground the sensor circuit and output pin is used to obtain output voltage. This sensor has been designed to obtain measurement correctly by using linear characteristic between centigrade and output voltage. This sensor can be operated in 4V to 30V while measuring from - 55 Celsius to 150 Celsius temperature range. Sometimes sensor output is able to amplify using operational amplifiers.

LM35 sensor can be operated between 35V to -2V but optimum voltage is 5V. Compared to other temperature measuring sensors, it is low cost and it can be used for remote applications because this sensor is a very small sensor.

5.3.2 DHT11 temperature and humidity measuring sensor

DHT11 sensor is used to measure temperature and humidity in embedded circuits. This sensor is mostly used in weather stations and automation farming and it is used to make rain predictions. Compared to other sensor this sensor is low-cost component which is affordable to use projects. DHT11 sensor is capable of measuring temperature between 0 to 50 Celsius and capable of measuring humidity between 20% to 80% moisture with accuracy of 2%. Thermistor which consists of resistive and wet NTC has been used in this sensor to measure temperature. This sensor can be operated between 3.3V to 5V and it has fast response with time. Anti-interference is another feature of this sensor. OPT (One Time Programmable) memory has been used for this sensor to store calibration coefficients moreover, signals which consist of low power are detected by interval sensor. These signals are detected up to 20 meters.

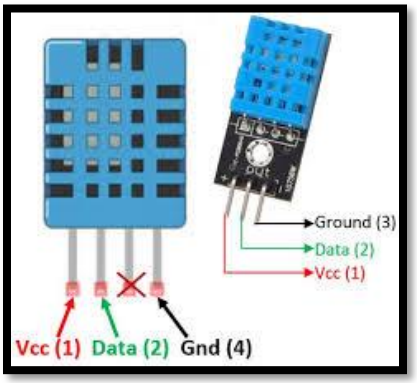


Figure 5:DHT11 sensor

Vcc pin is used to power up the sensor, data pin is used to obtain temperature and humidity values using serial transmission protocol, N/C pin is not connected and ground pin is connected to ground.

NTC or thermistor is used in order to measure the temperature of system. Thermistors consist of semiconductors like ceramic and polymers to detect large changes of resistance with small changes of temperature. This changes between temperature and resistance occurs according to an exponential way.

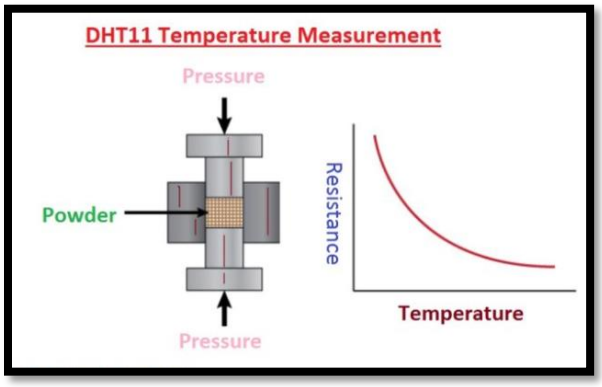


Figure 6: Graph of Temperature VS Resistance (Aosong,2017)

Two electrodes and holding substrate has been used to measure humidity in atmosphere. According to moisture amount, conductivity of substrate changes. Using that process humidity can be measured correctly.

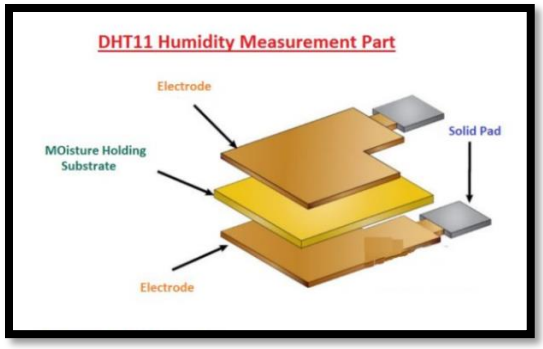


Figure 7:Humidity measuring part of DHT11(Aosong,2017)

5.3.3 ACS712 Current sensor

ACS712 sensor is used to measure dc or ac current of a circuit. It is able to be used to measure up to 30A. Proportional to input current, analog output is given by this sensor. Due to high accuracy of that sensor, it is used in motor control switching and load detection circuits. Also, this sensor has been used to protect from overcurrent faults of systems. It can be operated using 5V. Moreover, copper conduction path has been built with surface of die. Magnetic field is generated according to input current when current passes through copper conduction. Then hall IC is used to convert appropriate output voltage. Current amount can be measured using output voltage.

Positive slope occurs, when primary conduction path has increasing current. thickness of conduction is used to protect device. When current flows through conduction path, internal resistance is around 1.2 milli ohms.

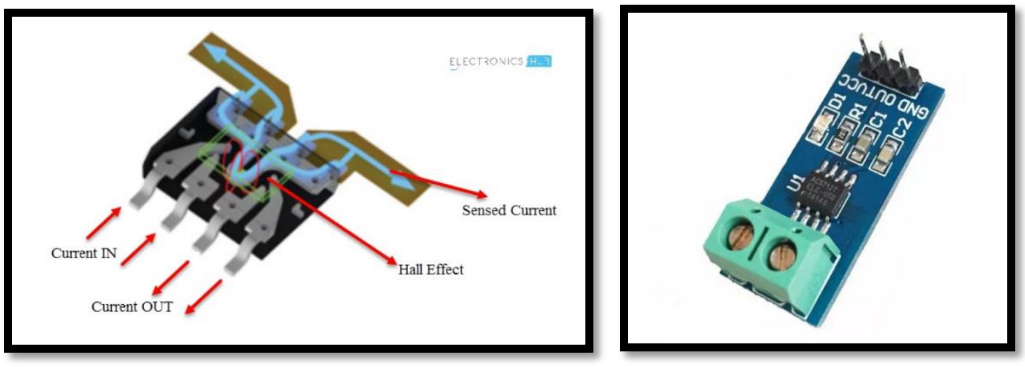


Figure 8:ACS712 Sensor(www.openimpulse.com)

Vcc pin is used to supply 5V, output pin is used to obtain output voltage to measure current, ground pin is connected to the ground. This sensor has 50khz bandwidth. Therefore, it can be used for high frequency current detection. Because of stable output offset voltage, it is easy to use this sponsor and total error is 1.5% when temperature is at 25C and 4% when temperature is at - 40C to 85C.sensivity of output is between 66 to 185 mV/A. Also, hysteresis of sensor is around zero.

5.3.4 Ultrasonic sensor

HC-SR04 is a device that is used to measure distance to an object. This sensor is mostly used in electronic projects and transducer has been made to receive and transmit data from sensor and to the sensor. Non-contact technology is used to measure the distance in this sensor. This sensor has measuring range between 2cm to 400cm. Receiver converts electrical signal into ultrasonic wave and transmitter converts ultrasonic waves into electrical signal for sensor to be measured distance to an object. This sensor has 3mm resolution, 30 degree measuring angle and 4Mhz operating frequency.

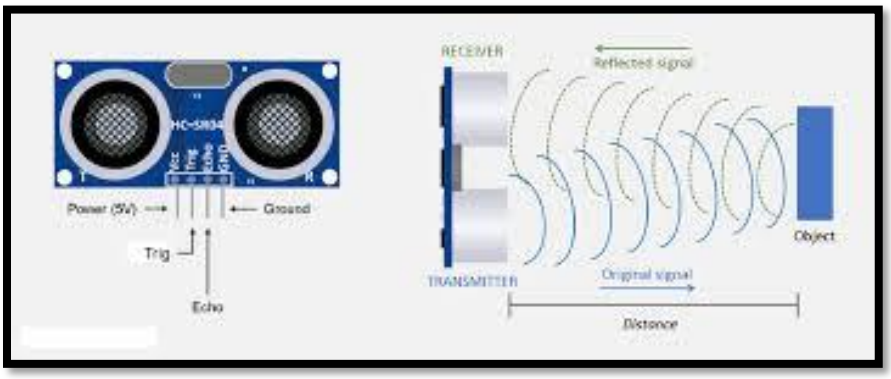


Figure 9:Ultrasonic Sensor(www.ia.omron.com)

Vcc pin is used to supply 5V for sensor to power up, trig pin is used to send ultrasonic wave and echo pin is used to collect bounce back ultrasonic wave at receiving end. Ground pin is connected to ground.

When 5v is given into sensor and trig pin is give high value to be 10us. Transmitter starts to send 8 cycles of ultrasonic pulses. After reflecting from the object, ultrasonic wave is detected using echo pin. Following equation can be used to calculate distance to an object

$$S = \frac{(V \times t)}{2}$$

Figure 10:Equation for measuring distance

Where S is distance, V is speed of sound and t is time. Measuring time has to be divided by 2 to measure the distance because calculated time is equal to reaching time to object and receiving time from object.

Ultrasonic sensor can be used in destructive testing, medical ultrasonography, wireless charging and speed delectation and direction observations.

5.3.5 Camera

Webcam is to be in this project for face recognition. Webcam is a device that counts of chip which is capable to catch moving images and convert images into binary numbers. Image sensor which is called electronic Eye is main part of a webcam. Image sensor consists of semiconductor chip which is made out of millions of light sensitive squares. When webcam is compared with digital camera, digital cameras has more megapixels than webcam.

Figure 11:Web cam

When light Rays go through the lens of the camera, image sensor starts to detect the color and sperate into small pixels. There two types of image sensors. CCD image sensor (charge couple device) chip is used to convert light into varying electrical signal and CMOS image senor (Complementary metal oxide semiconductor) is used for high performing color detection. Compared to CCD sense chip, CMOS sensor chip works fast and cost low. Then pixel pattern converts into number which is stored in memory chip in the camera. This binary numbers can be used to detect faces for a security system using neural

networks. Brightness and color of each pixel is store in memory and picture can be obtained using display or monitor. If webcam is connected to WIFI, binary number are transmitted via Internet.

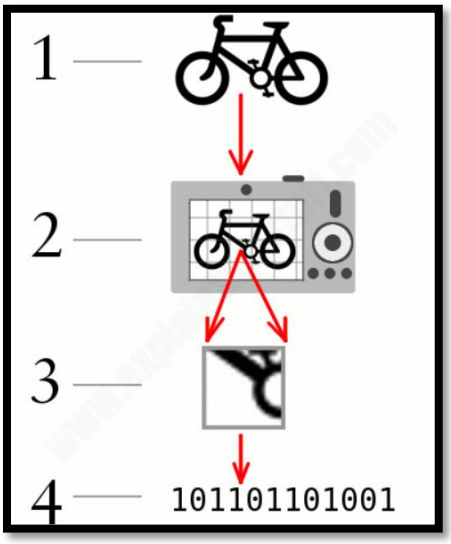


Figure 12:converting picture to binary (David Wagner,2016)

5.3.6 MQ2 Gas sensor

Gases are not sensitive to human nose because of that gas sensor are invented as a protection sensor. Gas sensor is a device that is used to detect the presence of gasses in the atmosphere. Corresponding voltage is provided according to gas presence therefore, output values can be determined using pre-estimated values. Metal oxide sensor, optical sensors, electrochemical sensors, acoustic sensors are main types of gas sensors that can be used for projects.

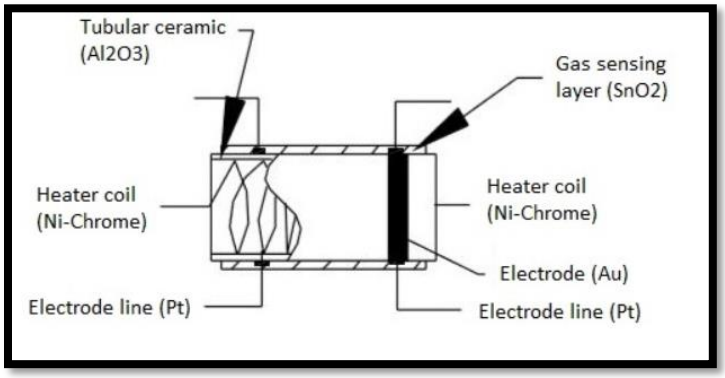


Figure 13:Inside of the Gas sensor(www.elprocus.com)

Gas sensing layer is the component that is used to sense the variations of concentration of gasses. It consists of chemiresistor which is able to change the resistance according to the concentration. Heater coil is component that is made out of nickel chromium which consists of high melting point therefore, accuracy and efficiency of sensor can be increased. Electrode line is used to provide small current. Electrode line is made of platinum wires. Electrode is used to connect sensor layer to electrode line. Tubular ceramic is a component that is made of aluminum oxide. This component can tolerate high temperature therefore it is useful for sensor to work more accurately and efficiently. Mesh over the sensing element is use to protect inside element of the sensor.

Figure 14:MQ-2 GAS sensor(www.elprocus.com)

Vcc pin is used to give power supply, GND pin is connected into ground, digital output pin is use to obtain high or low signal when any combustible gas is present. Analog output pin is used to obtain continuous output voltage which changes with concentration of gas. MQ-2 gas sensor is to be used in this project which is capable to measure methane, butane, LPG and smoke.

5.3.7 Pulse Sensor

Heart rate measuring sensor (pulse sensor) is a sensor that is used to detect the heart rate. this sensor consists of two surfaces. the first part consists of a light-emitting diode and an ambient light sensor. the second surface consists of the noise cancellation and amplification. these surfaces are connected to each other to obtain readings properly.

A LED has been connected to the top of the sensor to detect the heart rate when vain in the human body places on the LED. in here, the LED starts to emit a light ray that can detect blood flow within veins when the heart pumps blood. this process is utilized in this sensor to detect heart rate.

Specifications of pulse sensor can be shown as follows,

- Ability of detecting biometric pulse rate
- Diameter is 0.625cm
- Thickness is 0.125mm
- Sensor can be operated with +3.3V to +5V
- Current consumption is 4mA

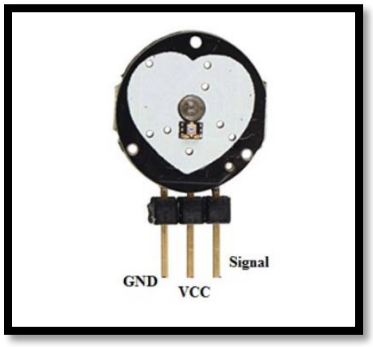


Figure 15:pulse Sensor

5.3.8 Hall effect sensor

Hall effect sensor has been created to detect magnetic fields base Hall effect law. built-in high gain amplifiers have been used in these sensors. because microvolts per Gauss can be obtained for small voltage.

hall effect sensors can be dived into two categories according to the output of the sensor, which is analog and digital. voltage regulator, a Hall Element, and an amplifier have been used in analog sensors, and the output of the sensor is proportional to the Hall Element output or the magnetic field strength. due to the continuous linear output, analog hall effect sensors are suitable for measuring proximity.

the digital output can be obtained using the digital hall effect sensors. the Schmitt Trigger has been used in these sensors to obtain hysteresis or different threshold levels which provides high or low outputs. Digital hall effect sensors can be used in 3D printers and CNC Machines and detection and

positioning in industrial automation systems. A1321 is one of digital hall effect sensor that can be used in a lot of applications.

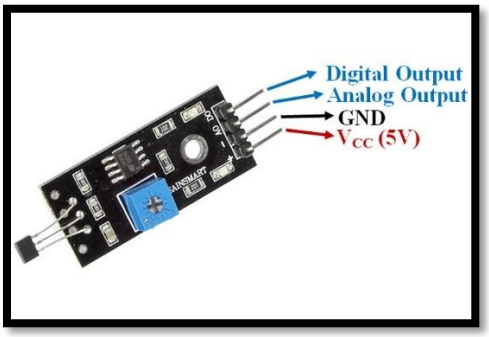


Figure 16:Hall effect Sensor

5.3.9 Rain drop sensor

Raindrop sensor is a sensor that can be used to detect water sensitivity. this module consists of a plate that is sensitive to water according to the resistance of the iron plate. when raindrops are placed on the iron plate, the digital signal would be produced by the sensor. specifications of the raindrop sensor can be shown as follows,

Raindrop sensor is a sensor that can be used to detect water sensitivity. this module consists of a plate that is sensitive to water according to the resistance of the iron plate. when raindrops are placed on the iron plate, the digital signal would be produced by the sensor. specifications of the raindrop sensor can be shown as follows,

- Anti-oxidation, anti-conductivity, with long use time
- Small board PCB size: 3.2cm x 1.4cm
- operating power is 5V

Figure 17:Rain Drop Sensor

5.3.10 LCD Display

LCD is an electronic display module is a module that consists of a crystal to create visible images. this module consists of the 16×2 LCD display that has been used in many circuits. A letter is translated into 16 characters per line in 2 such lines which are displayed character in 5 by 7-pixel matrix.

Specifications of 16 by 2 LCD module,

- Operating Voltage is 4.7V to 5V
- Current consumption is 1mA without backlight
- both 8-bit and 4-bit mode are available

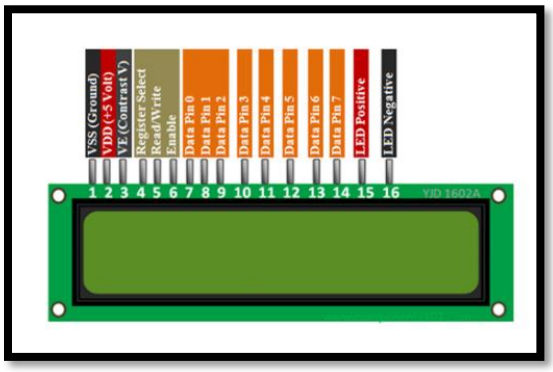


Figure 18:LCD Displays module

5.3.11 GSM Module 800L

SIM800L GSM cellular chip from SimCom is the main part of this GSM module which can be operated voltage of 34V to 44V.UART has been used for communication in this GSM module and the baud rate from 1200bps to 115200bps with Auto-Baud detection can be used to transmit data as well. These GSM modules consist of Helical Antenna and solders directly to the NET pin on PCB for the communication and UFL connector facility has been provided to keep the antenna away from the board. 2G micro-SIM card can be used in these modules.

Features of sim800L GSM module can be shown as follows,

- Supporting with Quad-band: GSM850, EGSM900, DCS1800 and PCS1900
- Serial-based AT Command Set
- Sending and receive GPRS data

Figure 19:SIM800L GSM Module

5.4 SERIAL COMMUNICATION

Serial communication is an asynchronous communication that consists of A 8-bit ASCII code representing a symbol and this symbol can be transmitted in an asynchronous manner. in this process, the asynchronous transmitting waveform of RS232 standard should be followed and initially, the least significant bit (LSB) is sent. after that, the most significant bit (MSB) is sent last. The data bits are sent between the start bit and stop bit. Transmission often occurs at a baud rate of 9600 bit per second. this process can be shown as follows,

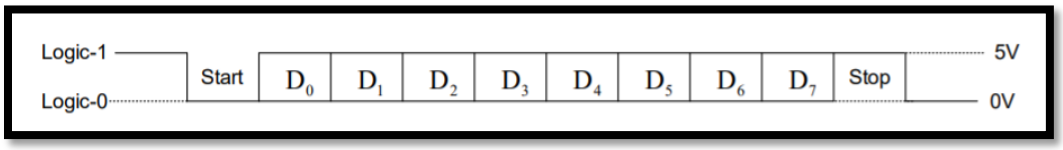


Figure 20:Process of serial Communication (OSISIOGU,2015)

5.5 RELAY MODULE

Relay module consists of relay that can be used as switch in electrical and mechanical circuits. Electromagnetism is used for relay to produce high voltages from small voltages. Normally close and normally open is two main states of a relay when input voltage is given into relay, initial state of relay becomes opposite state. Using this method, relays can be used switch devices and control devices. Home appliance, robotics and protection for electronic circuits are few of important usage of relays.

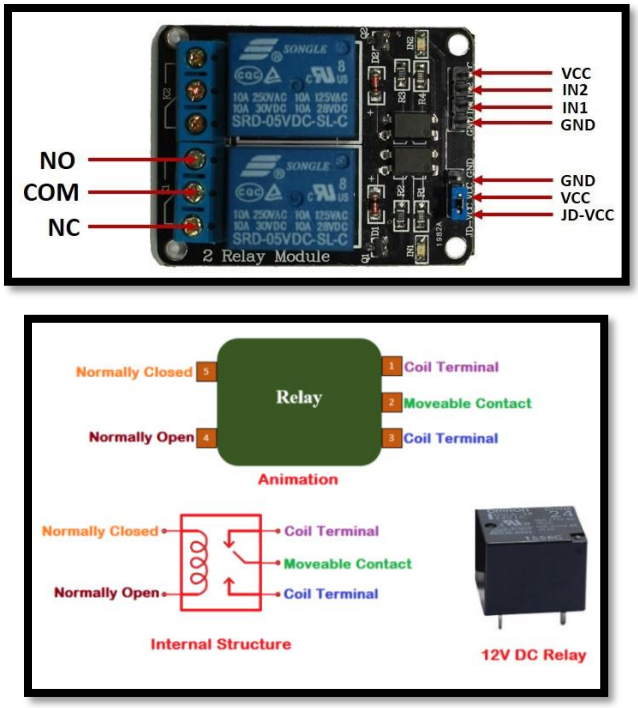


Figure 21:Relay module(randomnerdtutorials)

When power is not given to relay, NO pin is in Normally open condition and NC pin is in close condition. Therefore, when relay is energized, normally open condition becomes normally closed and normally closed condition becomes normally open. NO pin has to be used, when relay is connected with software. Magnetic field which generates due to current go through the coil of relay is used for switching in this device.

Mechanical, electrical and magnetic components are used in electromagnetic relays, solid state relay has solid components which consists of power gain to switch devices without any movement of switching component. Thermal relay is used to switch devices according to temperature of a point. Reed relays consists of two magnetic strips which switches according to the magnetic field.

5.6 nodeMCU

NodeMcu is a development kit that is used to create iot based projects. ESP8266 or Esp32 low cost WiFi module have been used in nodemcu and this development kit is manufactured by espressif systems in chain. Lua script lines are used in nodeMCU for user to be programed as opensource firmware. PWM method, 12C, SPI (Serial Peripheral Interface) and UART (Universal asynchronous receiver transmitter) serial communication can be connected using this development kit because GPIOs pins (analog and digital). USB, UART and microUSB ports have been included in this device. UART port is used to convert USB data into UART data which is used in serial communication. It is able to edit and modify firmware because of open source-based system.

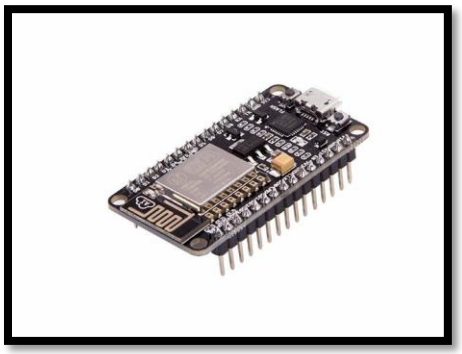


Figure 22:NodeMCU Board

NodeMcu can be powered up by using USB power from computers, by supplying 3.3V power through a regulated circuit and by using power Vin pin while giving between 7V to 12V dc voltage. Moreover, arduino IDE can be used to program nodemcu kit.

Becuase of internal WIFI module, it is easy for user to connect this device. Therefore, complexity of project and circuit is able to be reduced. Serial port monitoring, incubator controllers, IOT based projects, security alarms systems, etc... are the main usage of nodemcu device.

5.7 ESP8266 MODULE

ESP8266 WIFI module is component that can be used to connect device via Internet and TCP (transmission control protocol) /IP (Internet protocol) are used in this module to communicate. RF circuit is not needed because of self-calibrated RF which consists in this module. This is a system on chip (SoC) which consists of RF balun, power amplifier system, power managing units and low noise amplifiers. 32-bit microcontroller has been included in this device to process instructions. Also 32 KiB RAM,64 KiB boot ROM and 80 KiB user data RAM are included in module. External QSPI flash memory is used to access with SPI.

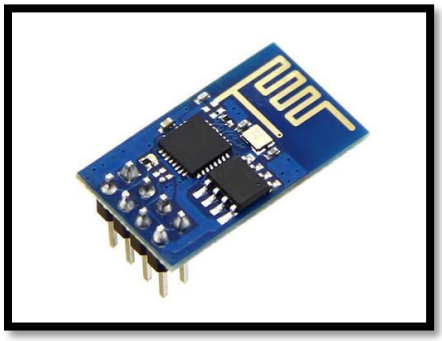


Figure 23:ESP8266 WIFI module

5.8 ESP32 MODULE

ESP32 is a WIFI module that consists of integrated WIFI and dual mode Bluetooth. This module has tensilica xtensa LX6 microprocessor and this chip consists of 520 KiB SRAM, wireless connectivity of 802.11 b/g/n/e/I, digital and analog ports, SPI ports, UART ports and PWM port to control devices. Also, this device has temperature sensor and touch sensor. Serial communication method is used in this module via Internet.therfore this module is used for iot projects. Processing speed of this microcontroller is very high compared to ESP8266 module and connectivity accuracy and efficiency is also very high.

Figure 24:ESP32 WIFI module

5.9 Thingspeak IOT PLATFORM

"Thingspeak" is an IOT platform that provides lot of features for user to be connected and controlled devices via Internet. This platform is capable of collecting data, analyzing data and visualizing data. Data can be collaborated with web services, social networks and API. "Thingspeak" channels can be created to store data from sensors and embedded systems. Eight data channels are able to be created and three location fields can be created to store latitude, longitude and elevation and one status field can be used for user to indicate devices information. To develop a channel, "hingspeak" web site provides facility to maintain information of devices.

Figure 25:Thingspeak IOT platform

Also, "Thingspeak" is IOT platform based on MATLAB to collect data from internet, analyze data and react according to data. There is visualizing meters which can display data in desired way. Channels can be made in this platform by existing a data base. MATLAB codes can be run in this platform itself. According to its developers,"Thingspeak" is an open-source. internet of things can be used for applications which consists of API to store and receive data from things via HTTP protocol. Twitter

massages can be sent using this platform reaction feature. When user programs to react according to sensor or devices data. For an example, if security system of a home indicates that home is in danger. “Thignspeak” will inform user by sending a twitter massage.

5.10 Arduino IDE

Arduino IDE is a software that is crated as open-source software. Arduino development board can be programed by using this software. It is easy to program and compile code compared to other software and languages. Inbuilt function and command are provided by manufacturers for user to program and collect data from sensors and embedded circuits. This software supports with windows, Linux, max OS and it can be connected with Arduino Uno, nano, mega and micro development boards which are provided by manufacturers. C language and c++ language can be used for programming.

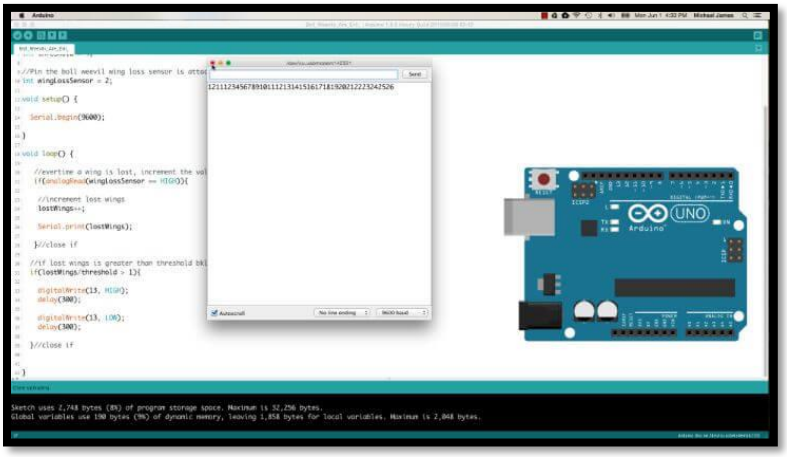


Figure 26:Arduino IDE

This development board is very inexpensive therefore it can be used for Iot robotics projects and IOT projects. Arduino IDE is very flexible to edit code. Libraries are able to be used directly without coding or making them separately.

5.11 MATLAB AND SIMULINK

MATLAB is a high-performance language which can be used for engineering aspects. MATLAB states that Matrix Laboratory. This software is developed by linear system packages and eigen system package projects. MATLAB provides user a user-friendly programming interface, visualization and computation environment to create their project. Worldwide universities are used MATLAB software because of high performance. Math and computation, modeling and simulation, data analysis, exploration and visualization, designing scientific graphs and charts and algorithm development like neural networks and logical algorithms are main features of MATLAB software. MATLAB is a very useful software which developed by MathWorks with multi-paradigm numerical computing environment and also MATLAB can be applied with proprietary programming languages. MATLAB SIMULINK application can be used to create SIMULINK block in order to get work done without coding.

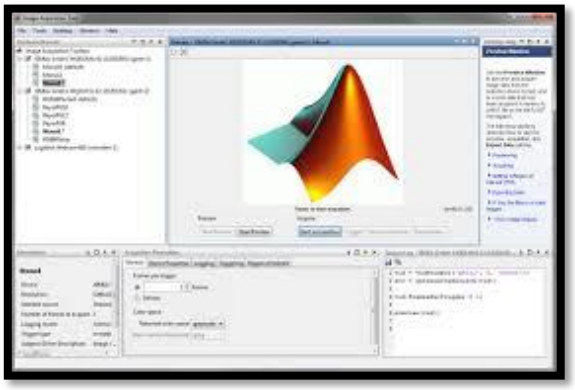


Figure 27:MATLAB Software

5.12 MIKROC PROGRAMMER SOFTWARE

The mikroc pro is an IDE for pic microcontrollers that can be used to program and this software consists of very powerful tool compile codes to develop applications for embedded systems. Mikroc PRO for pic consists of ANSI compliant compiler, a board set of hardware libraries, and comprehensive documents. Specification of mikroc can be shown as follows,

- Writing c source code using the built-in code editor.
- Pic libraries that can be used in different applications.
- Ability to get detailed graphs and reports.

Figure 28:MIkroc programmer

5.13 PIC16F877A MICROCONTROLLER

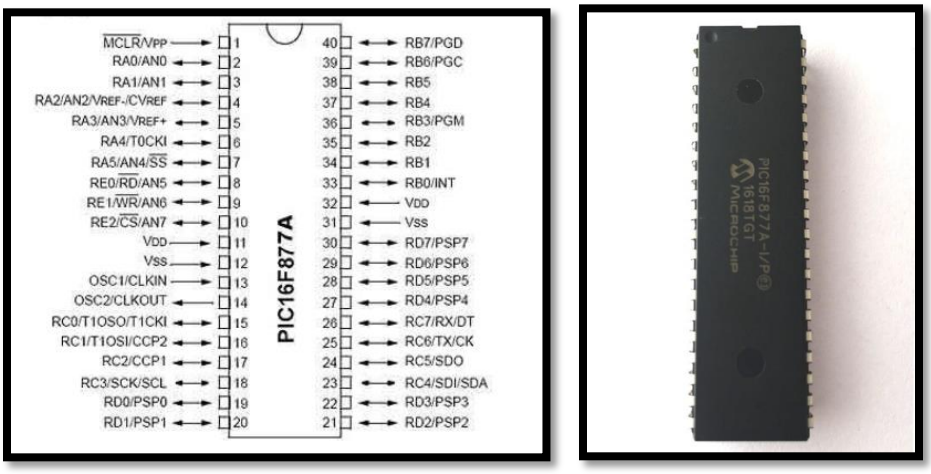


Figure 29:PIC16F877A Microcontroller

PIC16F877A is a microcontroller that is introduced by microchips. These Microcontrollers can be used in many of projects. Specification of PIC16F877A can be shown as follows,

CPU	8-bit PIC
Number of Pins	40
Operating Voltage(V)	2 to 5.5V
Number of I/O Pins	33
ADC Module	8ch,10-bit
Timer Module	8-bit (2),16-bit (1)
Comparators	2
DAC Module	Nil
Communication Peripherals	UART (1), SPI (1), I2C (1), MSSP(SPI/I2C)
External Oscillator	Up to 20Mhz
Internal Oscillator	Nil
Program Memory Type	Flash
Program Memory (KB)	14KB
CPU Speed (MIPS)	5MIPS
RAM Bytes	368
Data EEPROM	256 bytes

Figure 30:Specification of PIC16F877A

5.14 SOM (SELF ORGANIZED MAP) NEURAL NETWORK

Self-Organizing Map (SOM) is a neural network which is trained according to unsupervised learning to obtain low dimensional which is discrete into input space of the training samples. These samples are known as maps. This method can be used for reducing of dimensions. In this method, error correction method is not used. Instead of that, competitive learning method is used. SOM use neighborhood functions which has topological properties of input space. According to the data, weight vector is created with samples randomly. Then each vector creates its own neighboring weight. Maps are created growing from different shapes like squares, L shape, rectangular and hexagonal shapes.

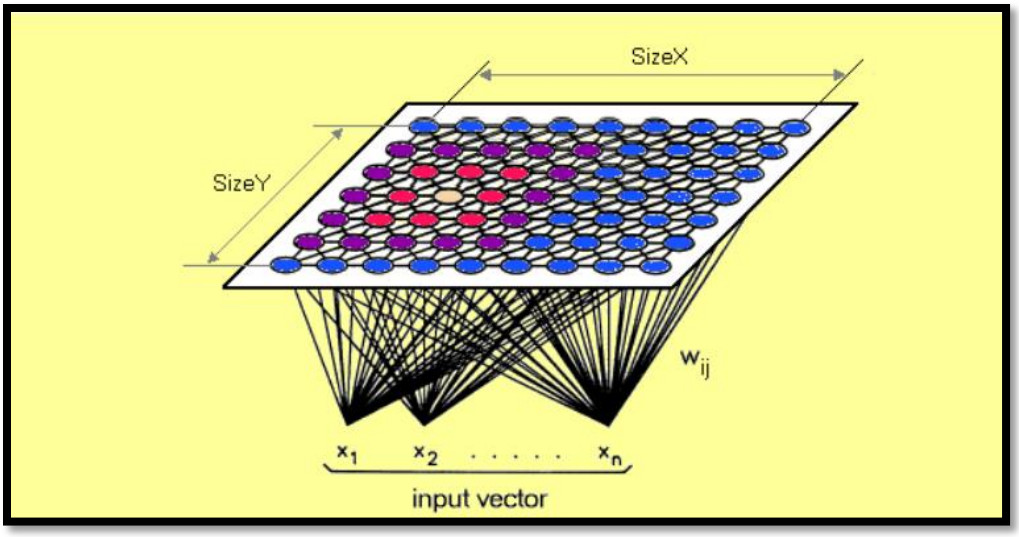


Figure 31:SOM Neural Network (Behbahani,2012)

Algorithm of SOM neural network consists of vector which is chosen from set of training data. Then Best Matching Unit (BMU) methods is used to examine which weights are almost equal to input vector. After that, neighborhood of BMU is identified using number of neighbors. Then winning weight is selected with more like sample vector. Then this procedure is applied to another N iteration. BMU method calculates distance from weight to sample vector and find the shortest distance sample to be winner. According to above mentioned method SOM neural network finds patterns and creates its own patter for training data with more accuracy.

5.15 NEURAL NETWORKS

Artificial Neural Network (ANN) is a paradigm that consists of information processing. ANN was inspired by biological nervous systems. moreover, a large number of highly interconnected processing elements called neurons have been utilized in a neural network to build a connection according to input data. pattern recognition and data classification are the main fields that are being used neural network technology to create artificial intelligent (AI) projects. ability to derive meaning from complicated, detecting trends, computer techniques Adaptive learning and operating real-time data are the main specifications of ANN. Inputs, transfer function, activation function and output are main part of a neural network. Diagram of neural network can be shown as follows,

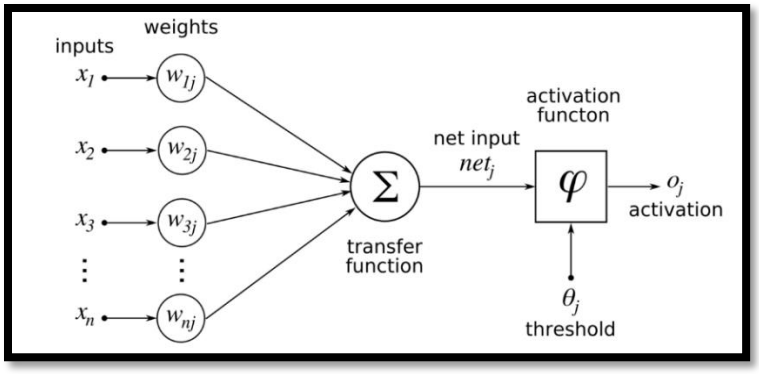


Figure 32:Process of Neural networks (Ali moti,2017)

5.15.1 Activation Function

Neural networks are used to solve non-linear networks mostly. Linear approach been used in solving since it only needs to be check whether the output is above the threshold of linear model or not. Difference between linear vs non-linear approaches can be shown as follows.

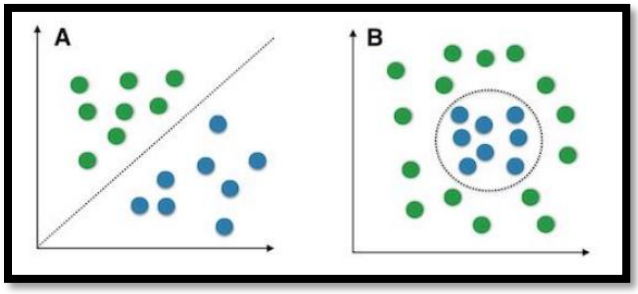


Figure 33: A: Linear Approach and B: Non-Linear Approach (Kang, 2017)

In above figure is an example for identifying blue color dots. The activation function makes the incoming non-linear data mapped to form the proper output. This activation function determines whether a particular neural function is present or not present.

5.15.2 Training a Neural Network

Artificial Neural networks can be created to perform properly by training a neural network properly. The three basic types of Training methods for ANN can be shown as follow,

1. Supervised training
2. Unsupervised training
3. Reinforcement training

In supervised learning, inputs, and outputs should be adequately supplied. adjusting weights techniques are used to minimize the output error. this procedure is called optimization. in Unsupervised learning, only inputs are provided to the neural network. the output of the system is identified recognizing the patterns correspond to the inputs. This training method is also called adaptive training.in reinforcement training, A machine learning environment is provided to the system. then A model is created by neural training itself by identifying Inputs and Outputs. A model that has been implemented with reinforcement training could be used in different environments to quickly adapt and overcome the situation in a shorter period of time rather than explicitly programming.

5.16 LM7805 VOLTAGE REGULATOR

The LM7805 regulator is used in a lot of electronic circuits as a power regulator. A constant output can be obtained for different input voltages. The name 7805 signifies two meanings, “78” means that it is a positive voltage regulator and “05” means that it provides 5V as output. in this project, LM7805 IC to reduce DC input voltage to 5V power supply of the main PCB.

Features of LM7805 Voltage IC can be show as follow,

- 5V Positive Voltage Regulator
- Maximum input Voltage is 25V
- Operating Current is 5mA
- Junction Temperature maximum – 125 degree Celsius

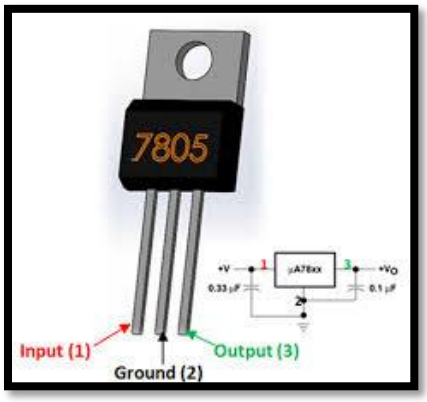


Figure 34:LM7805 Voltage Regulator

6 LITERATURE REVIEW

6.1 HOME CONTROLLING SYSTEMS USING IOT

In 20th century, it is very difficult to connect things to obtain information from devices for people to get work done with machineries. By that time people used to collect data by writing notes or keep data as a written ledger. Because of that data analyzing was very difficult process and it tooks more time. People wasted a lot time and labor hours. After internet was found in 1950's, the world has changed and developed in positive way. The scientists tried to observe the way to communicate thing using internet. As a result of that they were able to connect people and things together for an example, they were able to create websites for people to delivered information very quickly. Then scientists came up with a concept of connecting things using internet to purchase things, banking, medicine etc. previous communication process was being done by using wire connections. But present-days communication process is being done by wireless communication. Mostly used communication device is ESP8266 WIFI module. This WIFI module is able to connect device to internet. IOT technology is used for IOT industries. There are automation systems for homes, hospitals, agriculture etc. in this project, automated home system will be implemented using IOT technology. IOT helps people to collect data, analyze data, visualize data and make decision and prediction to success their day-to-day life.

There are a lot of researches base on automated home system using IOT and they contain with different technology ideas. Some industrial company also have commenced to develop Automation systems for their customers. According which different communication method and device control systems are used for these projects.

Research on an intelligent self-learning system for home automation using IOT was done by DR.sanjeev wagh in 2015. In this project, they used android device to control devices as GUI. ATmega-32 microcontroller has been used for this project. A circuit board has been developed including ADC (Analog to Digital convertor) circuit, Diver circuit, signal conditioner circuit. they have used light, temperature, level and humidity sensor for user to be obtained the information control.

Research on an IOT based home automation using Android application has been invented by department od CEE, kuppam engineering college in 2013. Arduino mage and HLK-RM04 WIFI module to control and connect thing with internet. Android application has been developed to control devices with

high security system. Also, digital display has been used for information to be shown. Fan speed controlling system, rain sensors, light controlling system have been include to this project. In this project WIFI module directly connect with phone without using IOT platform.

Voice controlled home automation system using natural language processing and IOT, research project has developed by department of Rajalakshmi institute of technology India in 2017. This project is based on voice recognition. AI (Artificial Intelligence) is used for making decisions. Smart phone is used to control devices and user authentication system has been used to secure the system. Appliances are controlled by Arduino board and mobile application is referred to control in user desired way.

In 2017, international conference on I-SMAC has published research paper on smart home project using IOT and light controlling, home appliances, computers are expected to be controlled via internet. This system allows user to monitor and to control using frugal Labs IOT platform (FLIP). FLIP board based on Arduino Nano, AC current relays and LDR sensor have been used as sensors and devices.

According to research paper on Automatic service request system for security in smart home using IOT by pranav kmar Madupu and B. Karthikeyan in 2018, smart home has been developed using raspberry pi IDE. PIR sensors, PI camera module, Raspberry Pi3 microcontroller, smoke sensor and vibration sensor have been used in this project to obtain data. Rabian OS, Python scripting Language, Thingspeak IOT platform and Eagle designing tool have been used.

In my Meng engineering research project, home automated system will be implemented using IOT technology. MATLAB and SIMULINK software will be used in this project as well. This project aim is to build automation system to obtain data from sensors, to connect data to MATLAB software and Thingspeak iot platform using internet After data analyzing, to send suitable reaction to microcontroller (NodeMCU and PIC microcontroller), In order to control the system and to inform the user by email or twitter or GSM massages to take necessary reactions using Thingspeak react app facility.

Gas sensor, temperature measuring sensors and security sensors will be used in this project obtain data. Smart devices (Lights,Fans,switches,etc) control system will be built. Security system will be created to control door using camera or IR sensors. Image processing system will be implemented using MATLAB neural network tool as a research and also AI neural network system to be controlled all systems will be implemented. A protocol of a smart home will be created for Meng B project as well.

By using this Automated Home system, user will be able to control home by themselves without staying at home via internet. MATLAB has been used to show every detail in pc, therefore, Using MATLAB,

Devices can be controlled and also using thingspeak. This system will save a lot of time and effort of people for better lifestyle. and Neural network system will be able to control things automatically in progressive manner.

6.2 IOT TRANSMISSION METHODS

According to research by IFIP symposium on integrated network and service management in 2019, Wireless sensor network (WSN) has been used to implement the connection for IOT systems because lot of inexpensive micro-sensor nodes have deployed in system which use widely in nowadays. To obtain better performance, a delay and load balancing based hierarchical route planning method has been used for sensing and monitoring in WSN. According to requirements, clustering strategy which is based on energy consumption performance and energy balancing and data forwarding method which is based on load balancing are used in this project.

Research published in IEEE international conference on smart internet of things by weifeng Sun and shumaio Yu in 2018 has suggest that the parallel transmission techniques can be improved for IOT based systems due to need of high-speed data transmission. SCTP and TCP simulation have been observed in this project by using different error rates to achieve better results. Dynamic multi-path switching method (MS-SCTP) which reflect data have chosen to be optimize way of internet transmission.

According to research on UHF RFID transmission with soft-input BCH decoding which is published in IEEE World forum on internet of things by information processing lab, Department of electrical engineering and information technology, TU Dortmund university in 2014. Radio Frequency identification (RFID) wireless communication method is used to improve the communication for IOT systems. While developing Forward Error Correction (FEC) system, this project has been developed to obtain better result by using Cyclic Redundancy Check (CRC) codes. BCH decoding method has been used for hard coding which consists of chase algorithm. This algorithm is capable of control sequence of data.

6.3 FACE RECOGNITION USING NEURAL NETWORK

According to research on joint convolution neural networks for face detection and attribute recognition which is published international symposium on computational intelligence and design (ISCID) in 2016, face detection and attribute recognition network (FDAR-NET) has been used for face recognition. Due to FDAT net, it is possible to obtain high speed performance using low level convolution layers.

Research on Profile face recognition using local binary patterns with artificial neural network which is published in international conference on artificial intelligence and data processing (IDAP) in 2018 has introduced Local binary pattern (LBP) for face recognition. In this process, face is dived to k2 sub regions and single feature vector is created to train neural network. This system has real time face detection techniques, rotation-invariant techniques, rotation face detection methods and head position detection which is used in biometrics methods.

Research on Face recognition using cloud Hopfield neural network which is published in international conference on wireless communication for processing and networking (WiSPNET) in 2016 has published a research on cloud Hopfield neural network (CHNN). Converting grey scale facial images into binary image with OTSU'S method, creating weight matrix of the network and distorting face with the help of CHNN retrieval algorithm are main three process of this process. This research has proved that CHNN is able to use for getting 82.8% accuracy than conventional HNN method which is able to use to obtain accuracy of 45%.

In my project, SOM neural network is to be used for face recognition using MATLAB. SOM system is capable to create neural network by itself considering training data and with help of cluster pattern.

7 METHODOLOGY

The concept of Smart home using IOT has been developed from the last decade to up to modern days but I have realized that there are some issues in this concept (unaffordable for users and technical issues). Therefore, I decided to implement a smart home for Meng project. In this project, MQ-2 gas sensor to detect gases, ACS712 sensor to measure current consumption, ultrasonic sensor to measure water level, rain drop sensor to detect the Rain, DHT11 sensor to detect temperature and humidity, hall effect sensor to detect wind speed, camera to recognize the face for user to improve the security of the home and heart rate sensor to detect the heartbeat have been used to build this project. Moreover, WIFI, GSM and serial communication technologies have been utilized in this project as well. In order to control devices, relay modules have been connected to the home devices which can be control using Blynk mobile app and all the sensor values are sent to IOT platform which is known as thingspeak to collect the data and analyze data. After that process data, necessary actions would be taken by thingspeak reaction features. Automated home system has two main controlling methods. Which Normal mode and AI mode.

7.1 NORMAL MODE OF THE SMART HOME

In this mode,Some sensors are connected to the PIC16F877A microcontroller and some components are connected to the nodemcu board. Above mentioned parameters are displayed in LCD display. If a value is above or lower the given limits, relays will be controlled to open the necessary control system. In order to control home devices," blynk" app can be used via WiFi. These parameters can be obtained to user using the control panel to send GSM messages for user to be aware. GSM system has been created to send message alerts as well. The door security system has been developed using SOM neural network with help of MATLAB software. Pic microcontrollers and nodemcu have been connected via serial communication to transmit data each other. NodeMCU sends all the information to iot platform. The following figure shows the entire process of MEng project.

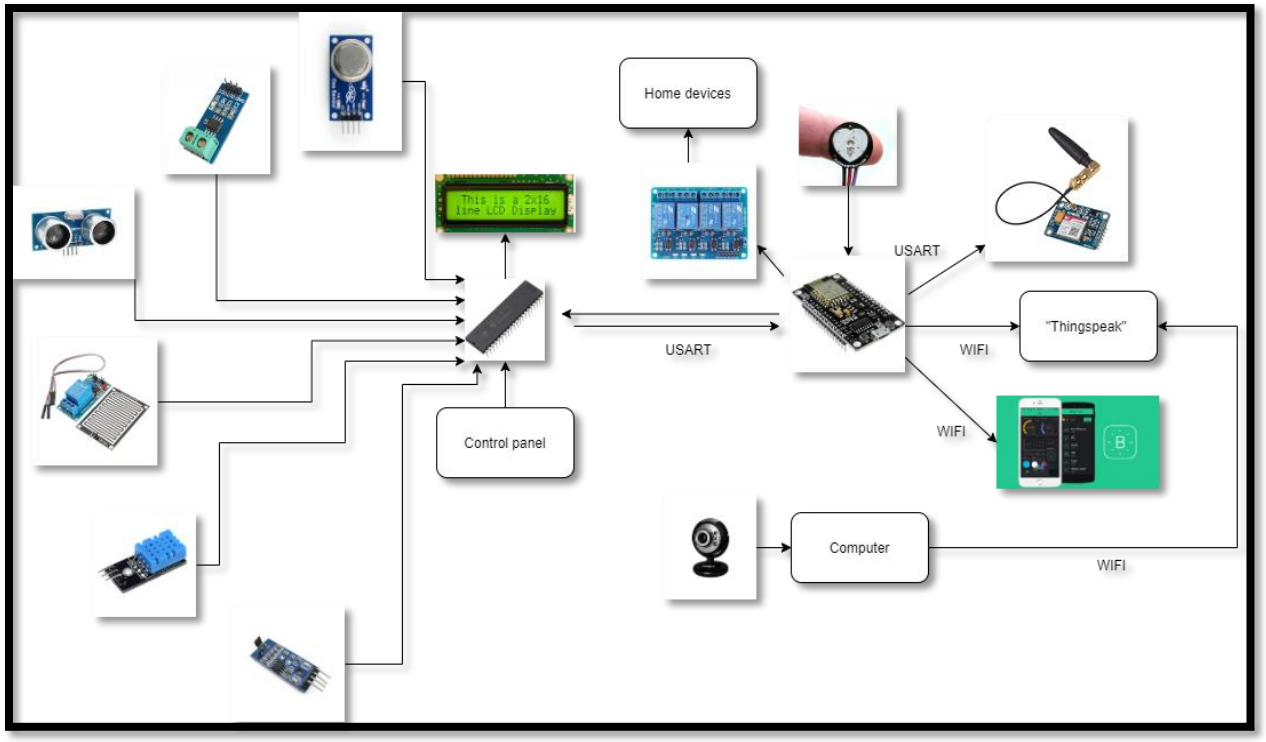


Figure 35:Process of Smart Home

7.2 AI MODE OF THE SMART HOME

AI mode has been introduced as an additional feature for the smart home. In this mode, the entire process is done by the neural network that has been pre-trained using MATLAB neural network toolbox. In order to switch to the AI mode, the user should use GUI that has been created using MATLAB as a software (GUI) in this system. nodeMCU and computer should be connected via USB. In this mode, Microcontrollers have been programed only to collect data. Necessary reactions are taken by the neural network according to trained data. When Sensor values are fed into MATLAB neural network using nodeMCU via USB. Reactions are sent to nodeMCU by the neural network to control relay modules and protection systems. Sensor detail (SMS) can be obtained via GSM module separately as in normal mode. Process of AI mode of smart home can be shown as follows,

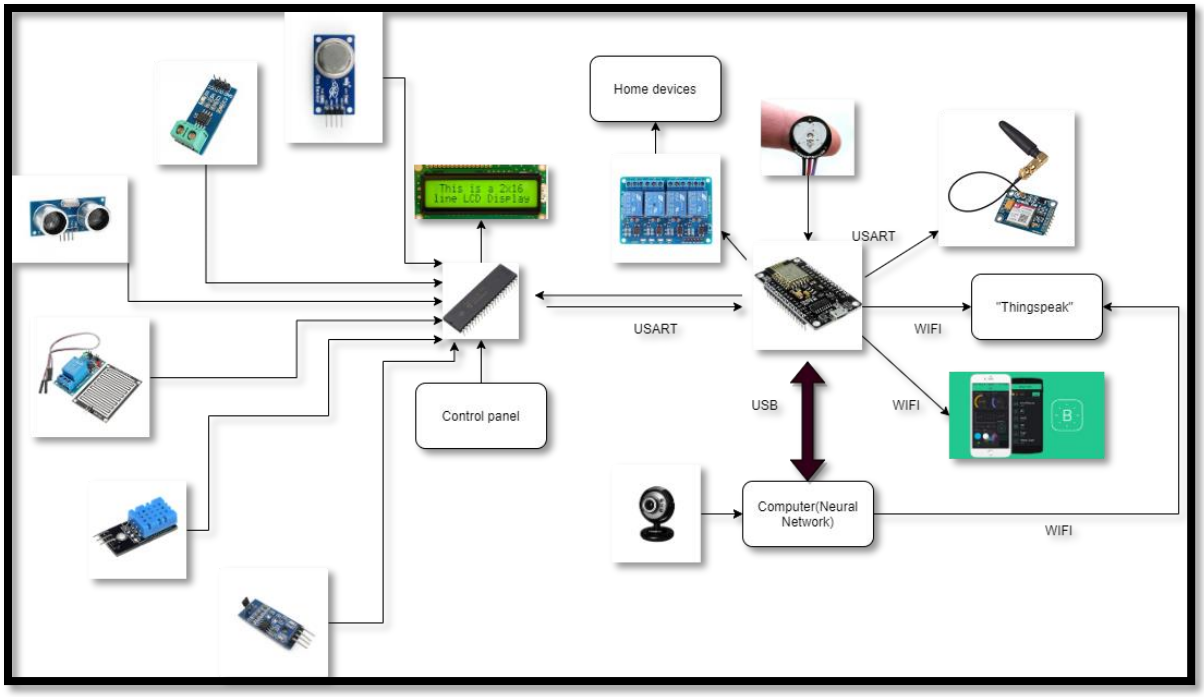


Figure 36:Process of Smart Home (AI mode)

8 DESIGN AND IMPLEMENTATION

Once the hardware was built according to the Simulation, criteria of testing should be done. This was done with aim of making sure that the components and instruments that have been selected and built previously are operating properly. In this project, implantation of concept can be divided into procedures which are mentioned in below.

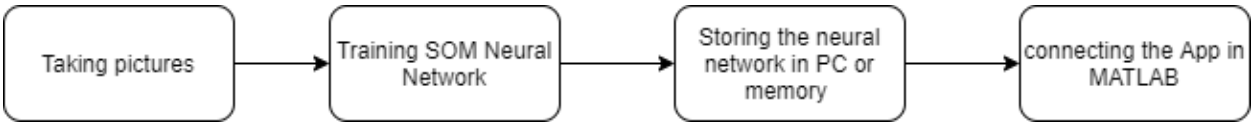
- Creating security system using Web camera
- Creating temperature and humidity control system
- Creating smart device control system
- Creating water control system
- Creating power consumption control system
- Creating rain detection system
- Measuring wind speed
- Measuring heart rate
- Creating Gas detecting system
- Connecting nodeMCU using serial communication
- Creating message alert system using GSM800L
- Creating mobile app to control devices
- Connecting MATLAB with nodeMCU
- Connecting nodeMCU with thingspeak IOT platform
- Creating a software using neural network

8.1 CREATING SECURITY SYSTEM USING WEB CAMERA

A face recognition system was created using SOM neural network in MEng A project but this system has improved by training the face recognition system with more pictures of user in MEng B project. In MEng A, only 5 pictures were used to develop the neural network. But more than 50 pictures of user were used to create SOM neural network developing the performance of the face recognition system for MEng B project. This face recognition system consists of two major parts which are,

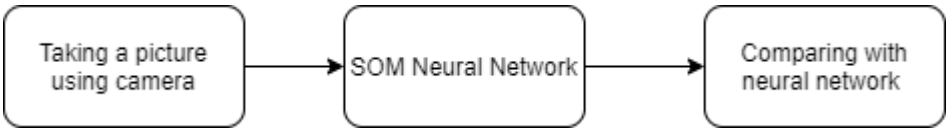
1. Training the SOM neural network using pictures of user
2. Creating the door control security system with help of trained SOM neural network

Process of Training the SOM neural network can be shown as follow,

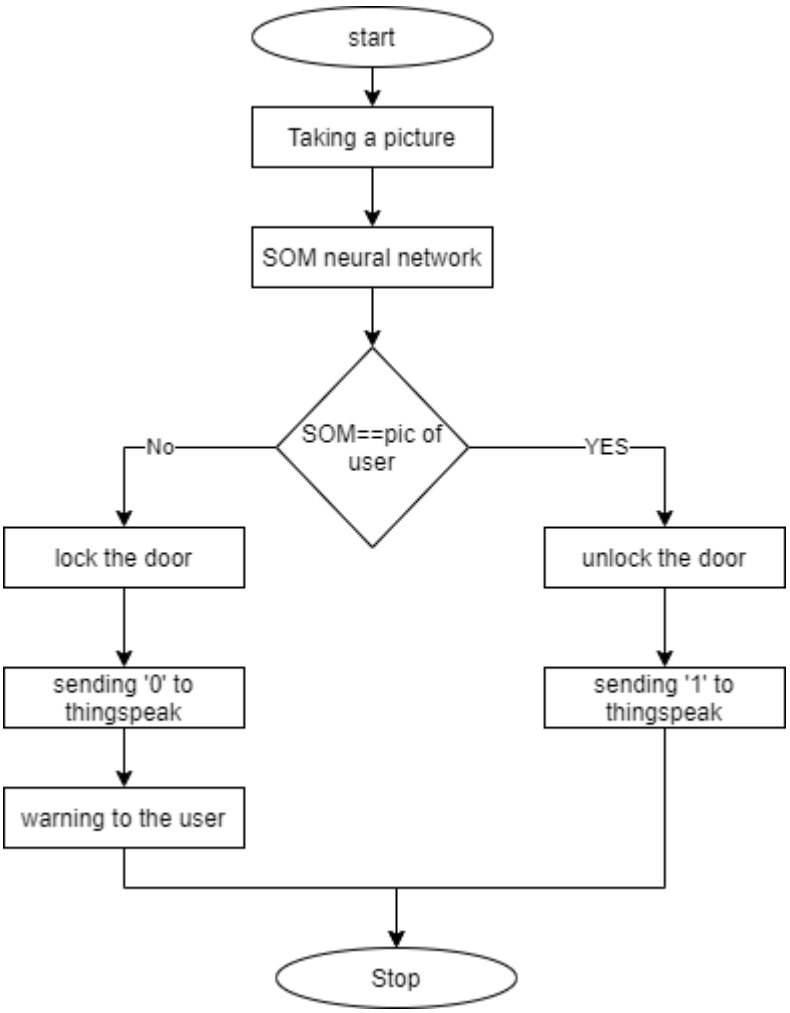


In this process, pictures are taken via camera and converted in to gray color. After that, each picture is converted into 256 by 256 matrix and fed into SOM neural network for neural network training with the help of MATLAB neural network tools and Codes. Then Trained neural network is stored in PC. Moreover, there is GUI (Graphic User Interface) which has been created for user to access to the security system as a software. So that, User is able to use face recognition system using neural Network in this project.

Process of the door control security system can be show as follow,



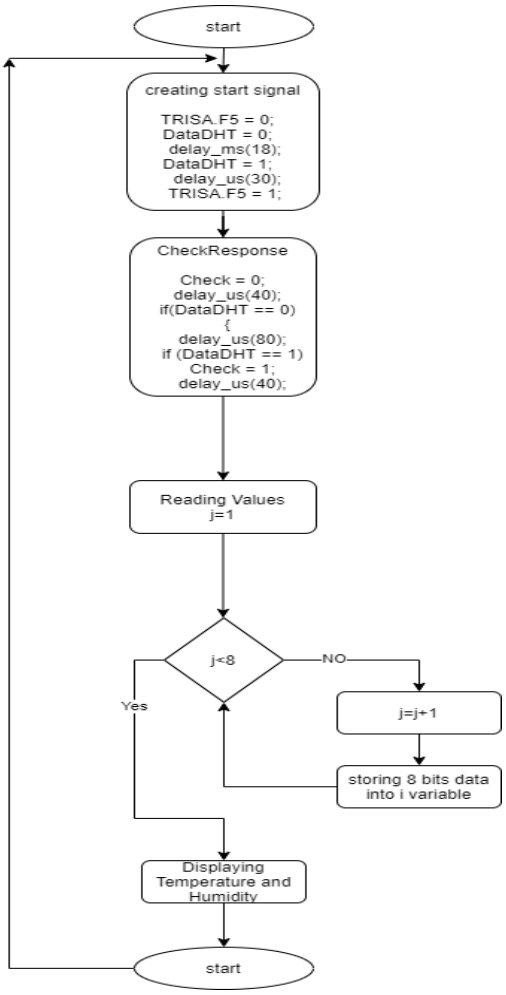
Flowchart of Door security system (MATLAB App) can be shown as follow,



In this system, Result of SOM neural network and input picture are compared with trained data. If the neural network result is equal to the input picture of user which has been trained earlier, the door would be open and if not, the door wouldn't be open and warning message would be sent for user to be taken necessary measures. Data are sent to the thingspeak IOT platform as well.

8.2 CREATING TEMPERATURE AND HUMIDITY CONTROL SYSTEM

LM35 sensor was used to measure the temperature of the home in MEng A project. But DHT11 sensor has been used to measure the temperature and humidity in MEng B project for user to obtain data in convenient manner. PIC16F877A microcontroller has been used to obtain data from sensor. Flowchart of data acquisition can be shown as follow,



In this process, start signal pulse which is 18ms is sent to DHT11 sensor then response of the sensor is obtained after 80ms after that data are store in temperature and humidity variables as 8 bits to display the sensor values in LCD display.

8.3 CREATING SMART DEVICE CONTROL SYSTEM

The main intention of this system is to control the devices according to the user command and whenever the sensor values are exceed above given limits. Cooling systems, water control systems and message alert systems should be opened automatically as per the program code. Blynk app has been used in this project using WIFI as well. Process of the devices controlling system can be show as follow,

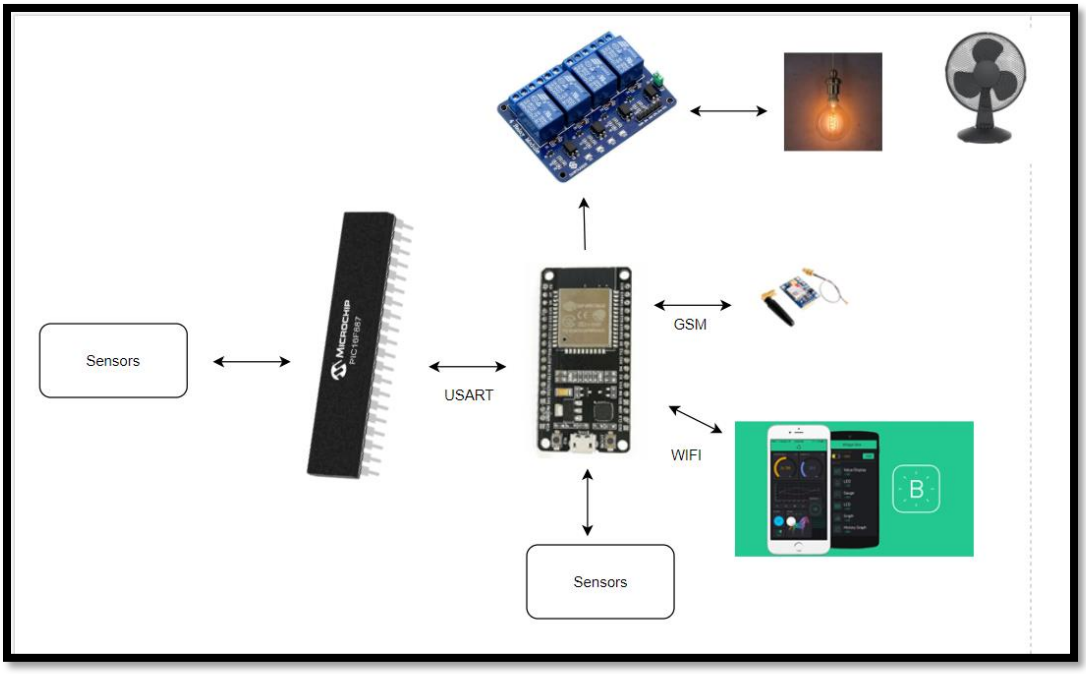


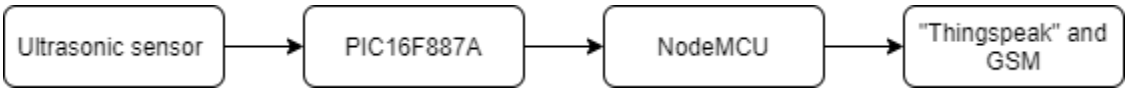
Figure 37:Device control system

Blynk app has been used to control the devices according to the user desire whenever user wants to switch on or off lights, fan, other devices. GSM module has been used in this project to obtain to the mobile phone when user wants to obtain data of sensors. It can be shown as an important part of the project that both GSM and WIFI technologies are available in the same system.

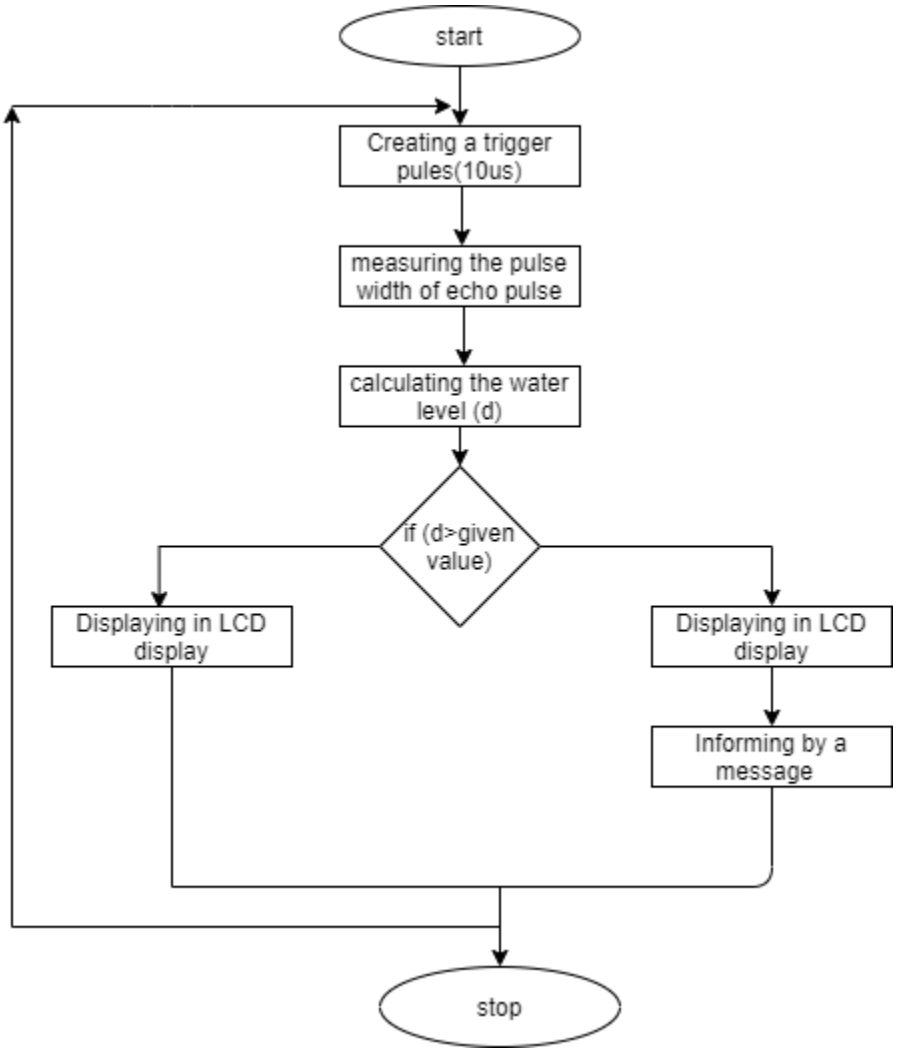
8.4 CREATING WATER CONTROL SYSTEM

Water control system has been designed to indicate water level of water tank of the home once it exceeds the limit given by the user, message alert system would be sent GSM and twitter messages for user to be aware that water level is not sufficient for the use of home. Ultrasonic sensor has been used to measure the water level and pic16F887A microcontroller has been used to control the sensor

moreover, these sensor values are given into NodeMCU using serial communication and nodeMCU would be sent data to IOT platform. The process of this system can be shown as follow,



Flowchart of the measuring process of ultrasonic sensor is able to be given as follow,



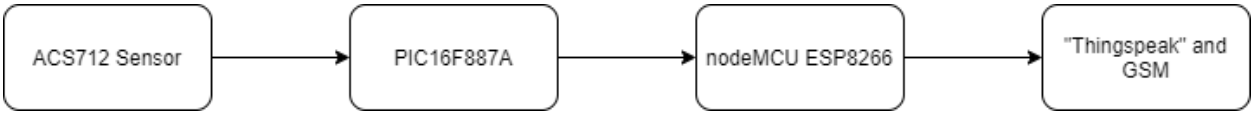
In this process, A trigger Pulse(10us) is created and transmitted. Once the obstacle (Water Surface) hits the transmitted signal, reflected signal is detected by the receiver End of Sensor as The Echo pulse. Pulse width (Time) of that signal is used to measure the distance. If The water level is low that limit, necessary action would be taken by system. Distance measuring Equation can be shown as follows,

$$S = \frac{(V \times t)}{2}$$

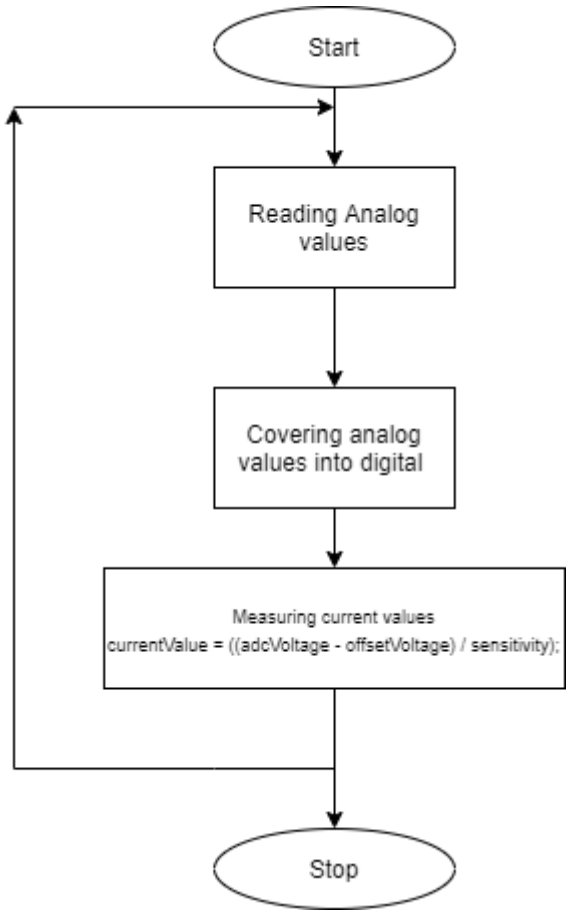
Where S is distance, V is speed of sound and t is time.

8.5 CREATING POWER CONSUMPTION CONTROL SYSTEM

Acs712 sensor has been used to measure the current amount consumed by the user. Then current sensor values are given into the pic microcontroller to send data to the nodemcu. When then thingspeak receives data, iot platform will inform the user to necessary actions according to the details. GSM message can be obtained using mobile phone as well.



Flowchart of the measuring process of ACS712 sensor is able to be given as follow,

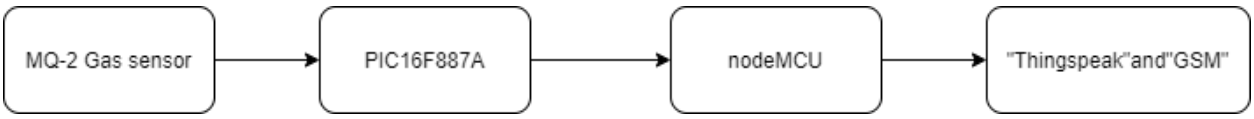


In this process, Analog Signal from sensor is obtained by the microcontroller. Then Analog Signal is converted into digital signal. Current consumption can be obtained using digital voltage as follow. Sensitivity($100mV^{-1}$) depends on the Sensor which is chosen by the user.

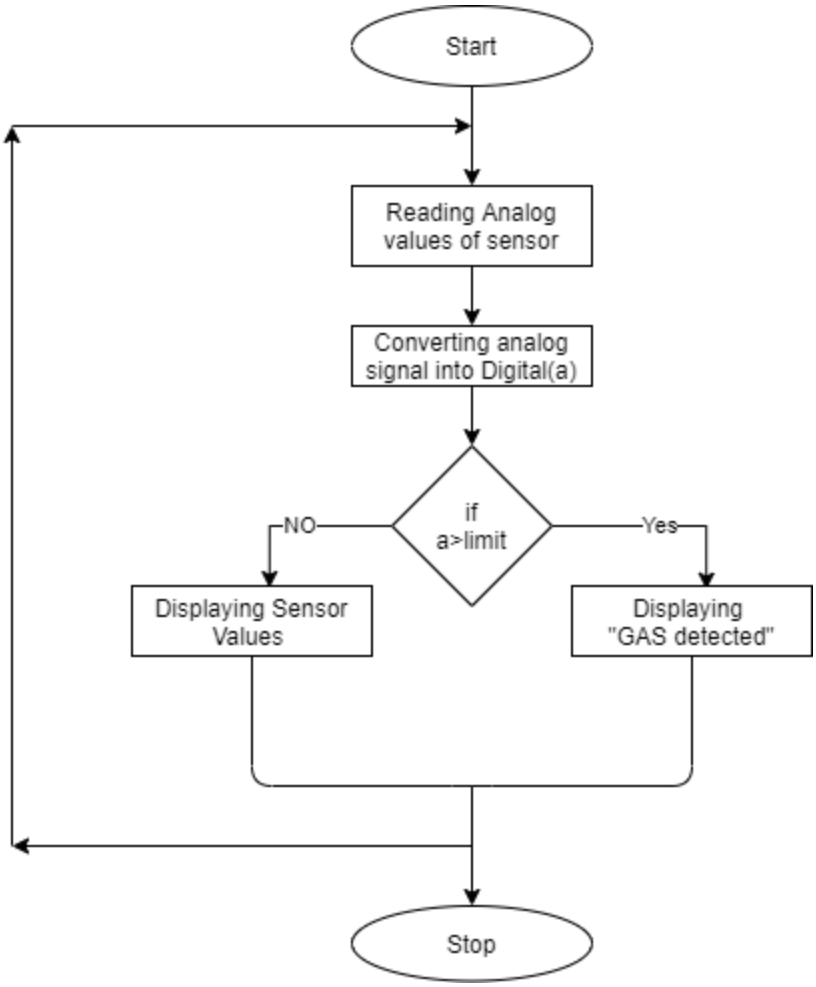
$$Current = \frac{Digital\,Voltage - offsetVoltage}{Sensitivity}$$

8.6 CREATING GAS DETECTING SYSTEM

MQ-2 gas sensor is connected to the pic16f877a microcontroller to measure the air quality in home. Data will be sent to the thingspeak via nodemcu. If a gas is detected by the system, user would be informed immediately and necessary actions would be taken to protect the home by activating fire protection system.



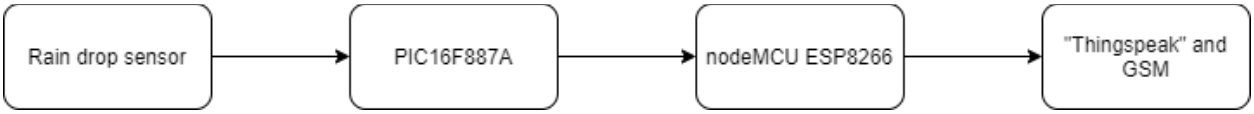
Flowchart of the measuring process of MQ-2 sensor is able to be given as follow,



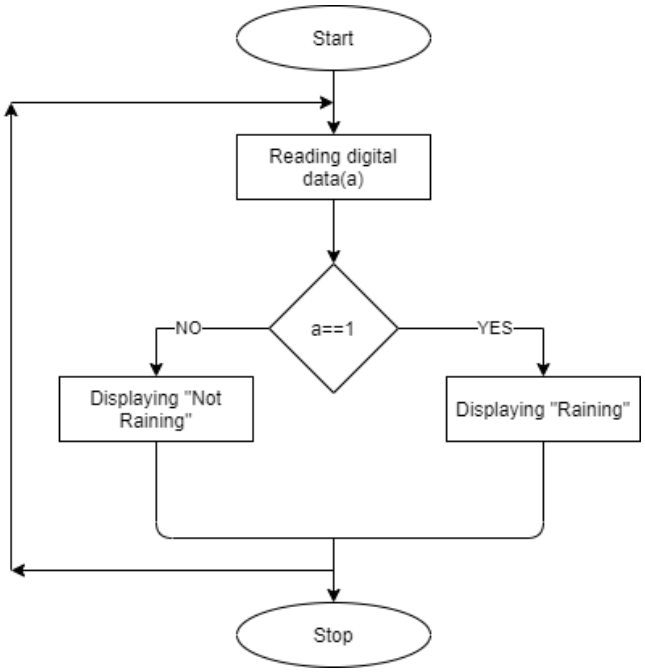
In this process, Analog Signal from sensor is obtained by the microcontroller. Then Analog Signal is converted into digital signal. if the digital value exceeds the appropriate value, Gas alter is sent to user and Fire protection system is activate automatically. “Thingspeak” also would take necessary action to inform the user as well.

8.7 CREATING RAIN DETECTION SYSTEM

Rain drop sensor is connected with the pic16f877a microcontroller. When the rain sensitive plate gets wet, digital signal is given to the microcontroller to detect if it is raining or not. Then data will be sent to NodeMCU via serial communication. These values are given to “thingspeak” and data analysis can be done according to requirements of user.



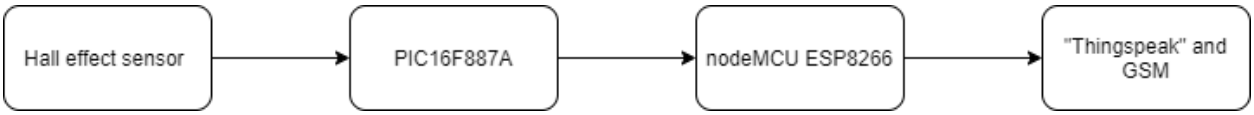
Flowchart of the measuring process of Rain drop sensor can be given as follow,



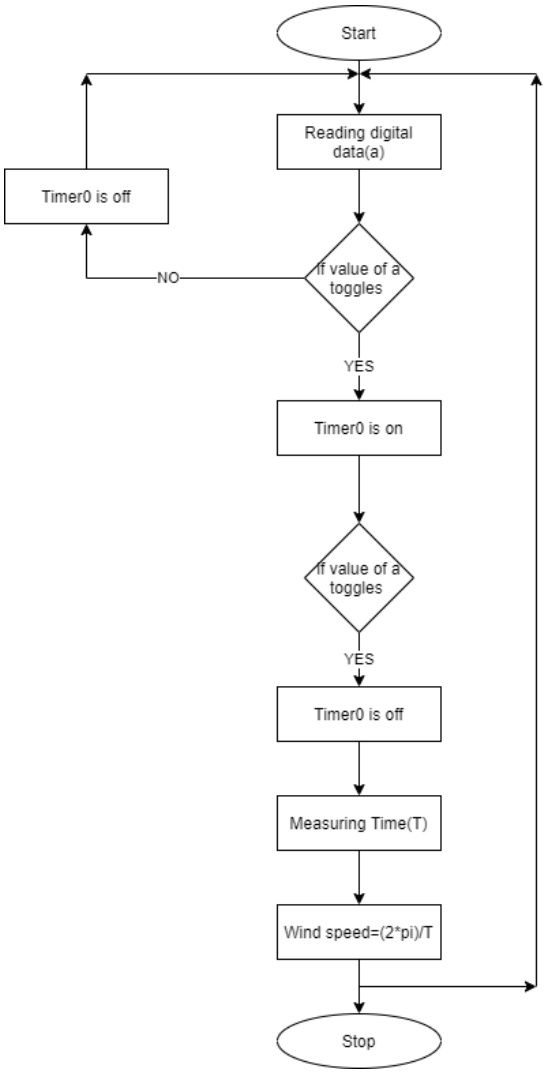
In this system, if input voltage of the microcontroller is high, the system indicates that “Raining”. If input voltage is low, the system indicates that “Not raining”.

8.8 MEASURING WIND SPEED

Hall effect sensor has been used to detect wind speed using Magnet that has been fixed in the core of the hardware part. When a magnetic field is detected, hall effect sensor produces a digital pulse. Wind speed can be detected using pulse width of the sensor. Then microcontroller send values to the nodemcu. According to the values that are given into the thingspeak, the reactions will be taken as per the programming code.



Flowchart of the measuring process of hall effect sensor can be given as follow,

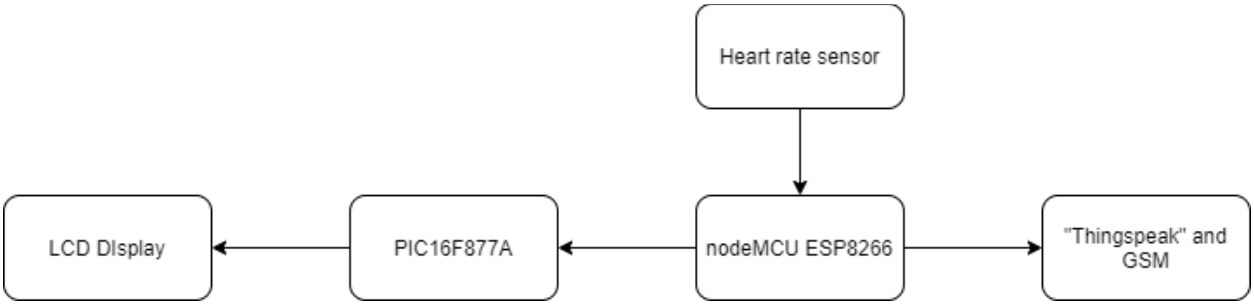


In this process, digital pulse from the hall effect sensor is fed into microcontroller. Then if this is a toggle in the edge of digital pulse (either Falling edge or Rising edge), Time0 register of PIC16f887A microcontroller starts counting. When edge of digital pulse toggles again. Time0 stops counting. Therefore, Pulse width (Time per Cycle) can be measured using Timer0 register. In order to measure the Wind Speed, following steps can be used.

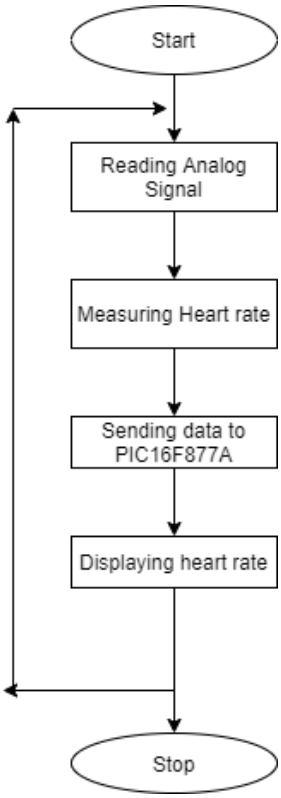
$$Wind\ Speed(\omega) = \frac{2 \times \pi}{Time(T)}$$

8.9 MEASURING HEART RATE

Heart rate sensor is connected to the nodemcu. Sensor values of heart rate are sent to the pic16f877A and to “thingspeak” IOT platform. NodeMCU and microcontroller have connected through the USART (Serial communication). This sensor can be used for user to be aware of health conditions to take precautions before take medicine.



Flowchart of the measuring process of heart rate sensor can be given as follow,



In this process, Analog signal is red by nodemcu. Then number of beats is calculated compared with threshold value. In order to measure BPM, it is necessary to calculate number of beats for 10 seconds using arduino programing. Then number of beats for 10 seconds should be multiplied by 6 to obtain the beat per Minutes (BPM).

$$BPM = Heart\ Beat\ for\ 10\ Seconds\ \times 6$$

Heart rate Values is sent to PIC microcontrollers via serial communication to display values in lcd display. Moreover, these values are sent to the “thingspeak” by nodemcu as well.

8.10 CONNECTING NODEMCU USING SERIAL COMMUNICATION

In this process, PIC16F877A microcontroller and nodeMCUESP8266 are connected using serial communication (Universal Synchronous/Asynchronous Receiver/Transmitter). USART transmits data between start bit and stop bit and data are sent as an ASCII code with 8 bits. Sensor values has been sent within two devices in this project, both devices should be connected to Ground (GND).

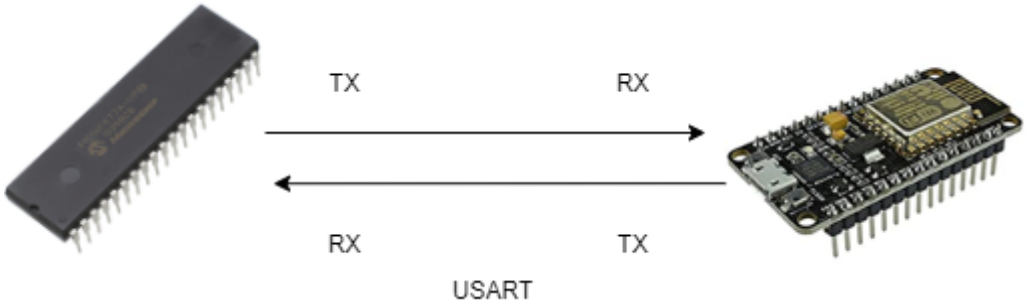


Figure 38:Serial Communication between PIC16F877A and nodeMCU

8.11 Creating message alert system using GSM800L

GSM module has been connected with the nodeMCU using serial communication. String data is utilized to data which can be identified by the GSM module in serial communication. Furthermore, GSM module has been connected to the mobile phone for user to obtain the data.

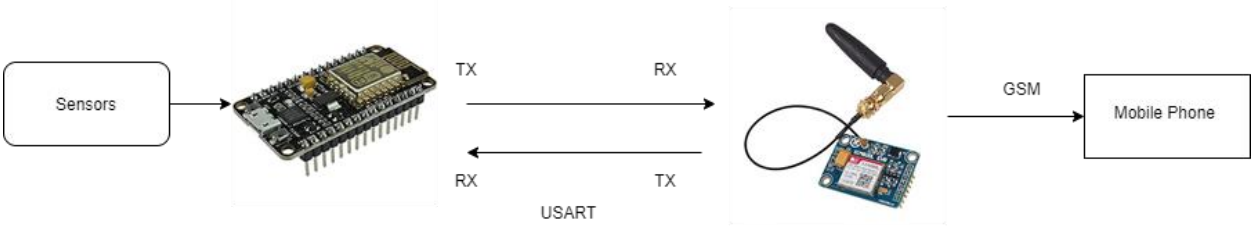


Figure 39:GSM system

8.12 CONNECTING MOBILE APP TO CONTROL DEVICES

Blynk app has been used to connect devices with nodeMCU via WIFI. Fan, lights, motors and etc can be control using this app with the help of IOT technology. Relay modules can be added to this system to be controlled more devices. Moreover, this system is able to be developed as data base in addition to the iot platform to present the parameters of the sensors.

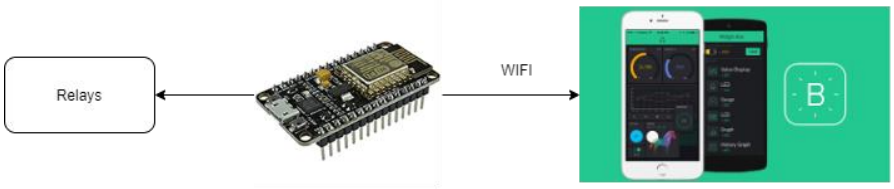


Figure 40:Process of Blynk App

8.13 CONNECTING MATLAB WITH NODEMCU

Nodemcu has been connected to the MATLAB using USB cable to read the serial communication data that is sent to serial monitor in arduino. In this process, simulink block has been created to obtain the data from nodemcu. Therefore, data analysis and visuailizing can be done using MATLAB simulink as well.

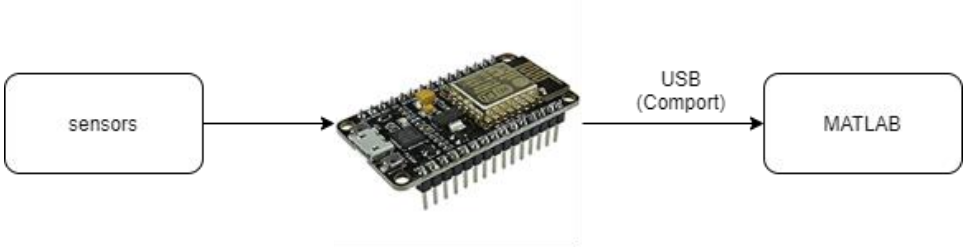


Figure 41:Connection between MATLAB and nodeMCU

8.14 CONNECTING NODEMCU WITH THINGSPEAK IOT PLATFORM

Thingspeak iot platform has been used to analyze and visualize data using MATLAB coding. According to preprogrammed value limits, the necessary actions will be taken automatically. Emails and twitter messages will be sent whenever the system detects an error for user to be aware so that, user will be able to control or take necessary actions.

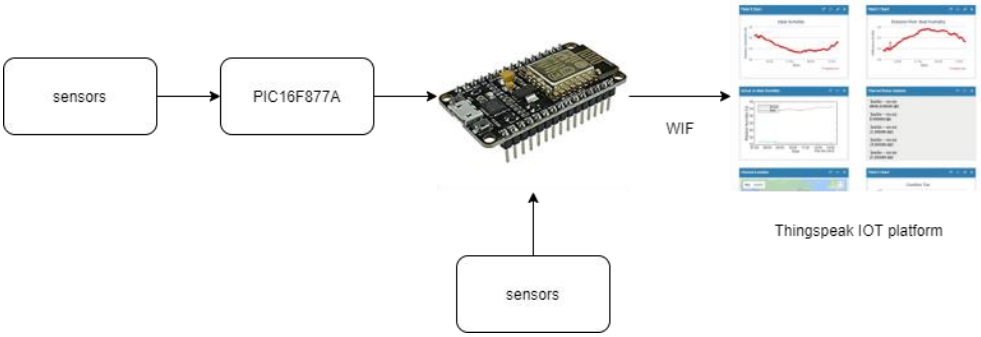


Figure 42:Connecting to IOT Platform

8.15 CREATING A SOFTWARE TO OBTAIN PREDICTIONS USING NEURAL NETWORK

Neural network which has been trained using sensor data is used to create the smart home Controller software. By using this software, the user will be able to predict or obtain an idea about the home to maintain or control home. When data is given to neural network, controlling procedure will be done according to pre-trained data in the neural network. Real time data from nodeMCU are connected to the GUI in this system. therefore, Controlling Status are provided to user what are the things that user should be considering and This software can be used to control entire home control systems (Above discussed) automatically using Neural networks. This software help user schedules the maintenance of the home as well.

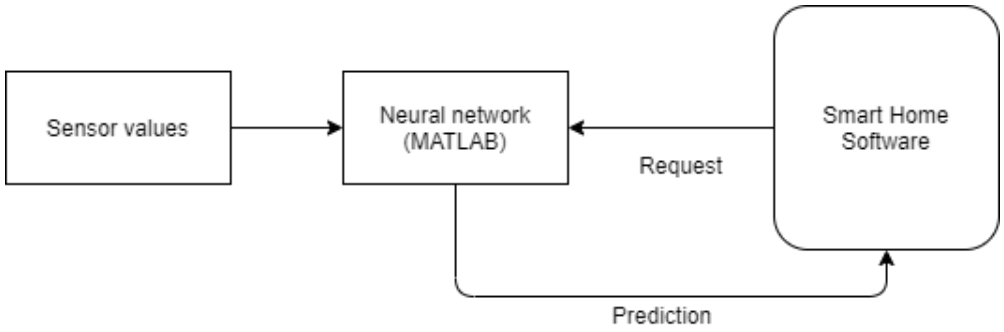
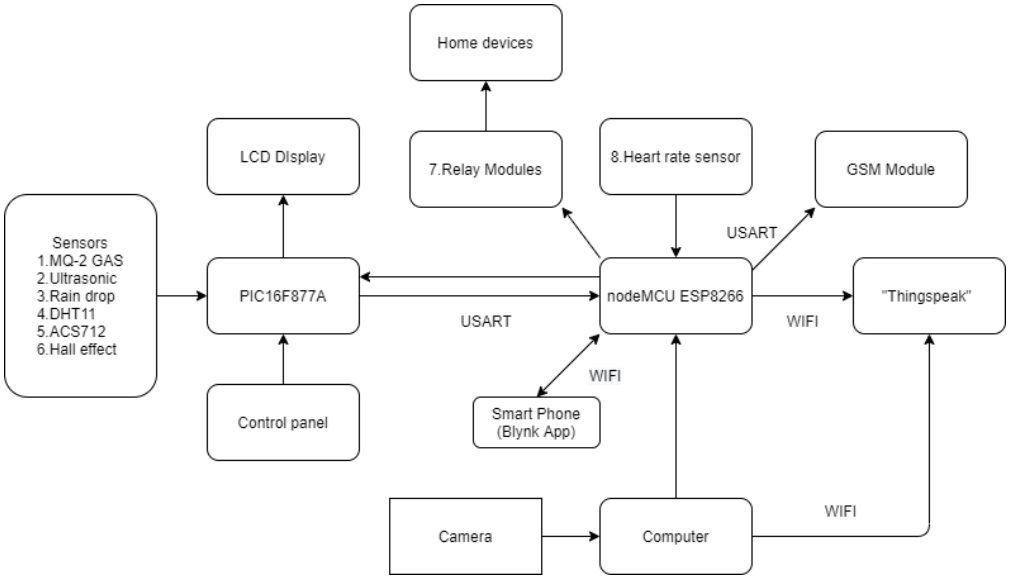


Figure 43:Process AI GUI

- Diagram of entire Smart home can be shown as follows,



9 RESULTS AND SIMULATIONS (DISCUSSION)

Each system that has been discussed in design and implementation section are to proofed using results and simulations in this section.

9.1 CREATING SECURITY SYSTEM USING WEB CAMERA

In this security system, face can be recognized precisely in appropriate with the lighting therefore, result cannot be obtained in dark environment and to detect face correctly, person have to stand in front of webcam directly.

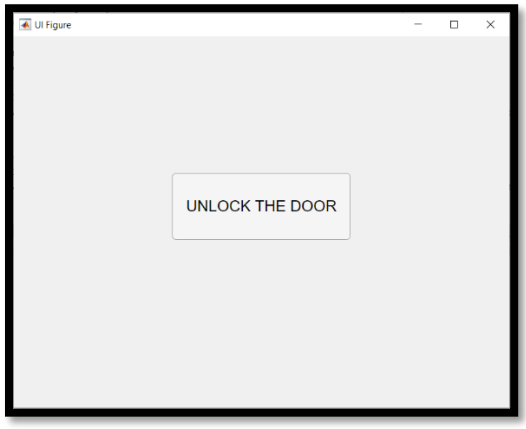


Figure 44:GUI for security system

Above picture shows GUI made using MATLAB to control the security system. When unlock door button click, face recognition process starts. If system identifies user's face, value 100 would send to thingspeak and if not, value 50 will be sent to thingspeak. Then user is informed that "Someone is trying to enter your home".

Following figure shows the process of face detecting in MATLAB,

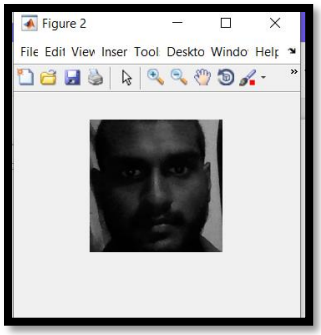


Figure 45:Detecting face

Neural network checking can be shown as follows,

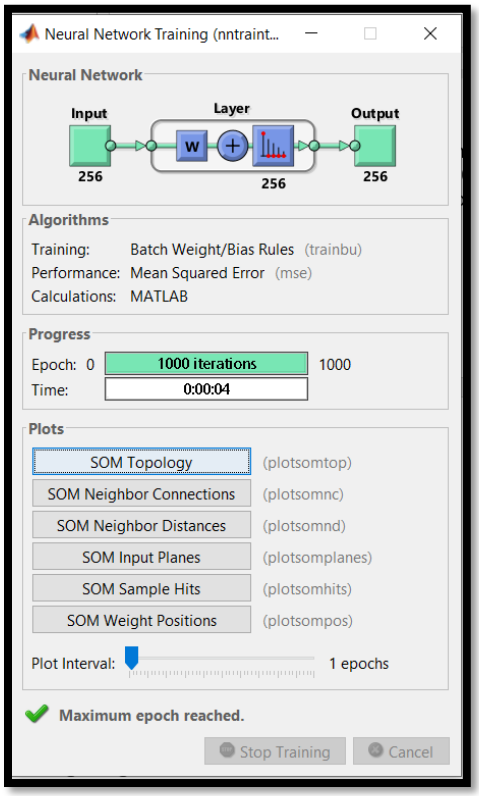


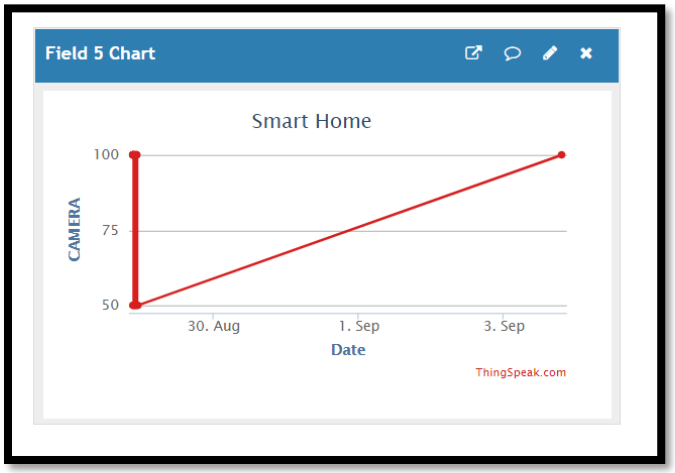
Figure 46:Neural network process

Result when system does not detect user correctly,

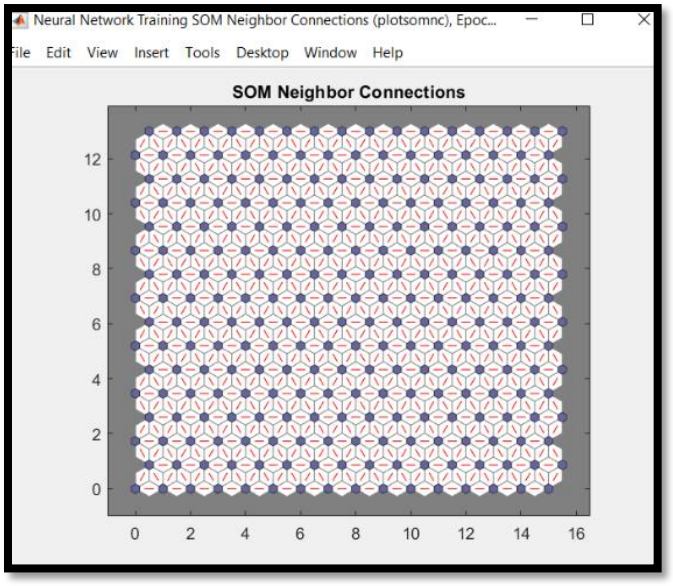
Figure 47:Twitter Reply

In here a twitter message will be sent for user to be aware. Therefore, necessary action can be taken to protect the home. This system has been developed to face of the user rather than MEng A project. In MEng B project. Face recognition was developed using more than 100 pictures. Although, SOM neural network gives current result with minimum five pictures. Therefore, accuracy of the system has been increased by 65%. Above picture shows twitter message when face has not detected by the system.

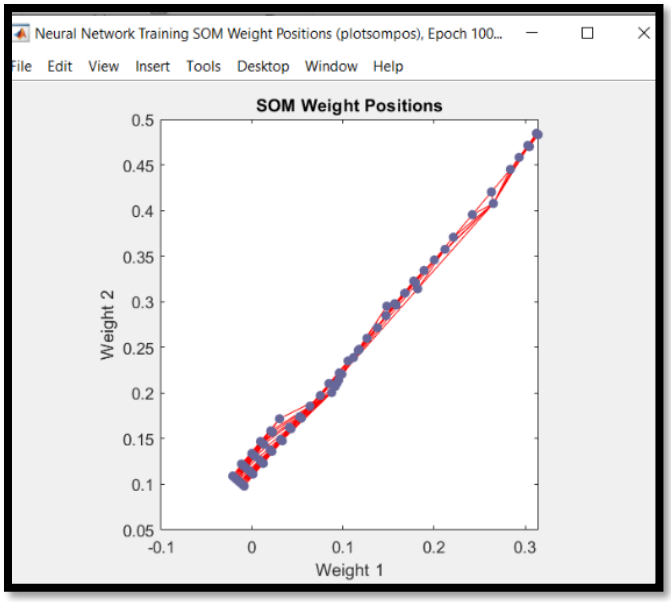
Chart of thingspeak channel can be shown as follows,



Performances of SOM Neural Network can be shown as follows,



SOM Neighbor connections

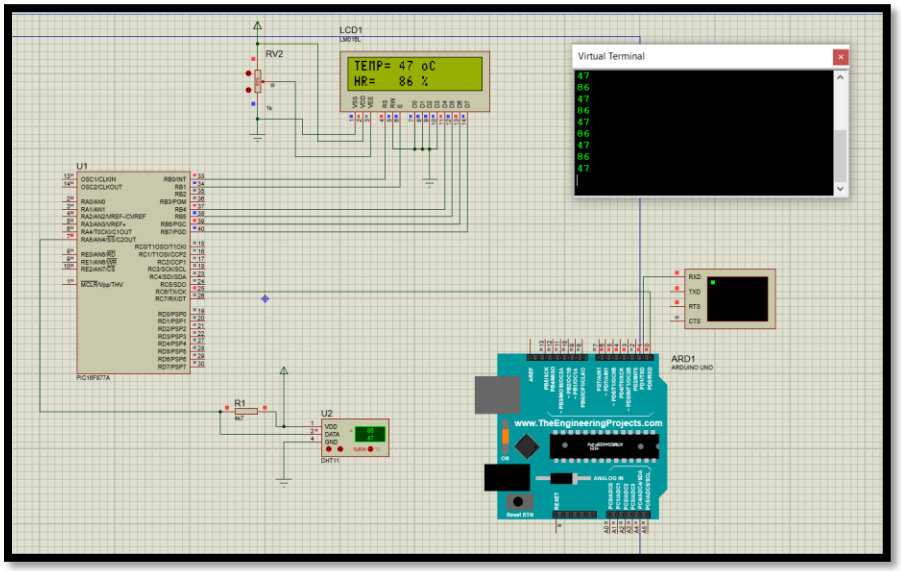


SOM weight Position

SOM Weight Positions which are Weight 1 and weight 2 have linear alignment approximately. And Cluster Connection between neural network has been generated properly between neighbor clusters, Therefore, Accuracy of the SOM Neural network can be obtained with around 80%.

9.2 CREATING TEMPERATURE AND HUMIDITY CONTROL SYSTEM

Proteus simulation of the DHT11 sensor can be shown as follows,



In all the simulations, Arduino nano broad has been used instead of the NodeMCU board because NodeMCU is not available in proteus. Virtual terminal has used to display the serial communication (USART) values that receive from PIC16F877A to nodeMCU.

Results of hardware part can be shown as follows,

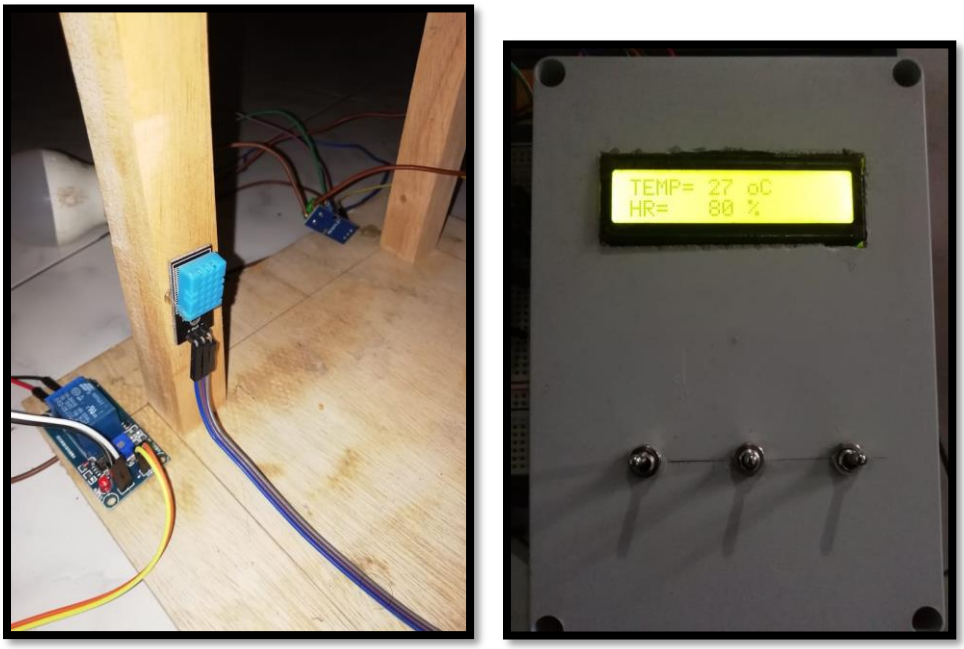


Figure 48:DHT11 and Control Panel of DHT11

9.3 CREATING SMART DEVICE CONTROL SYSTEM

Result of hardware part can be shown as follows,

when switch 3 is on, light no 3 has been light up according to Blynk app command via WIFI.

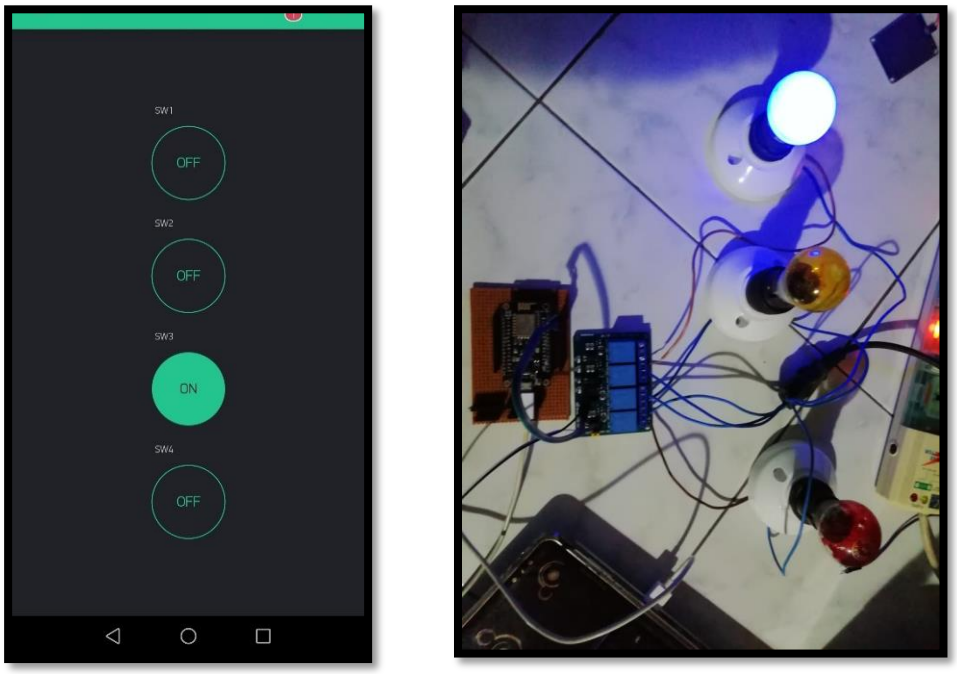
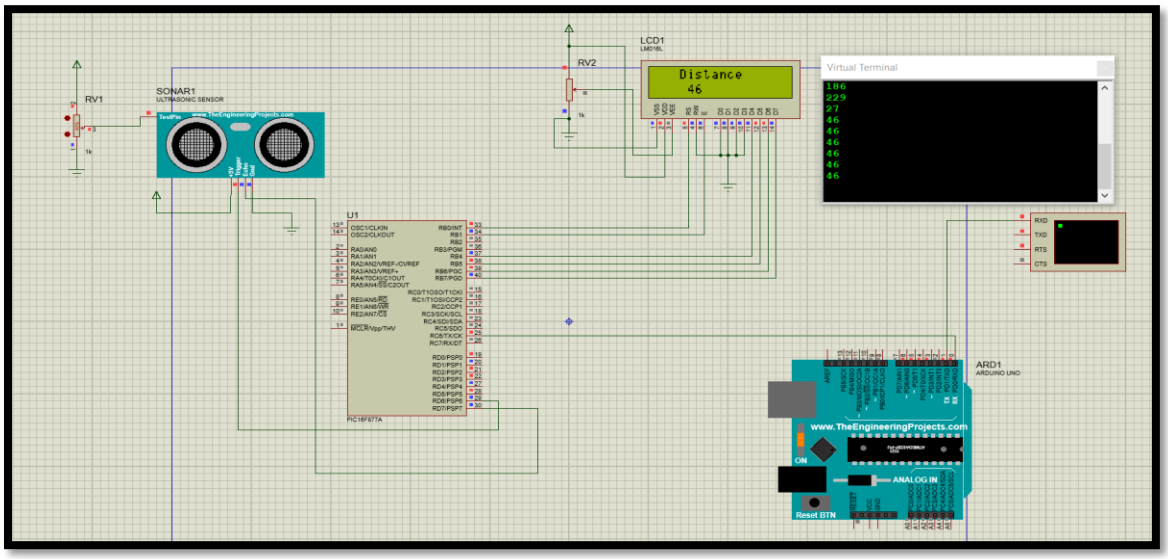


Figure 49:Blynk app and Connection relay module

9.4 CREATING WATER CONTROL SYSTEM

Proteus simulation of the Ultrasonic sensor can be shown as follows,



Result of hardware part can be shown as follows,

When distance to the water level is 12 cm.

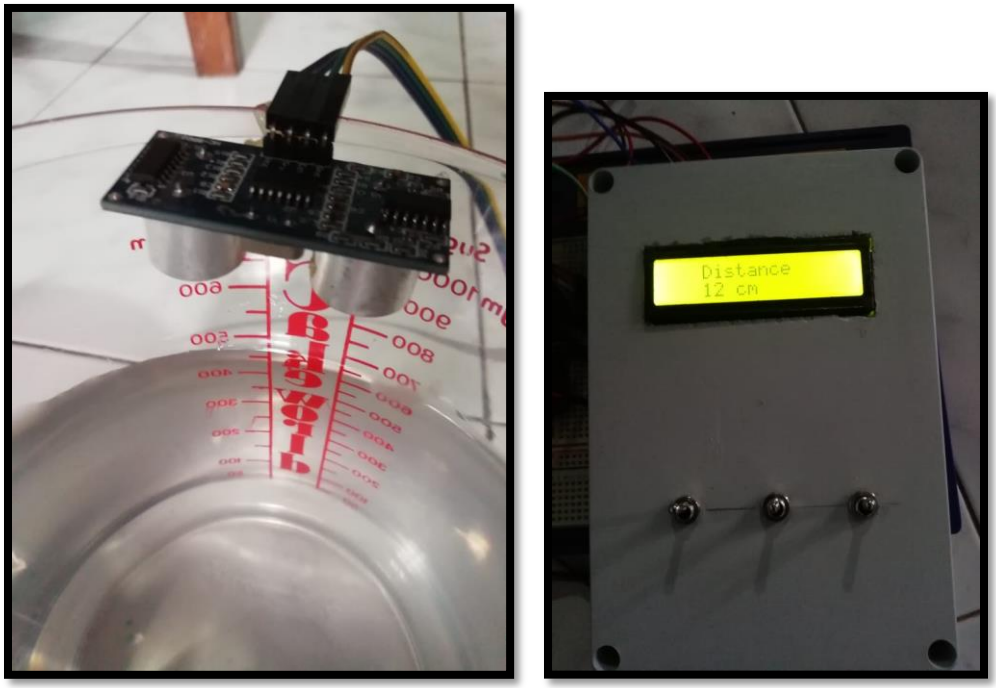
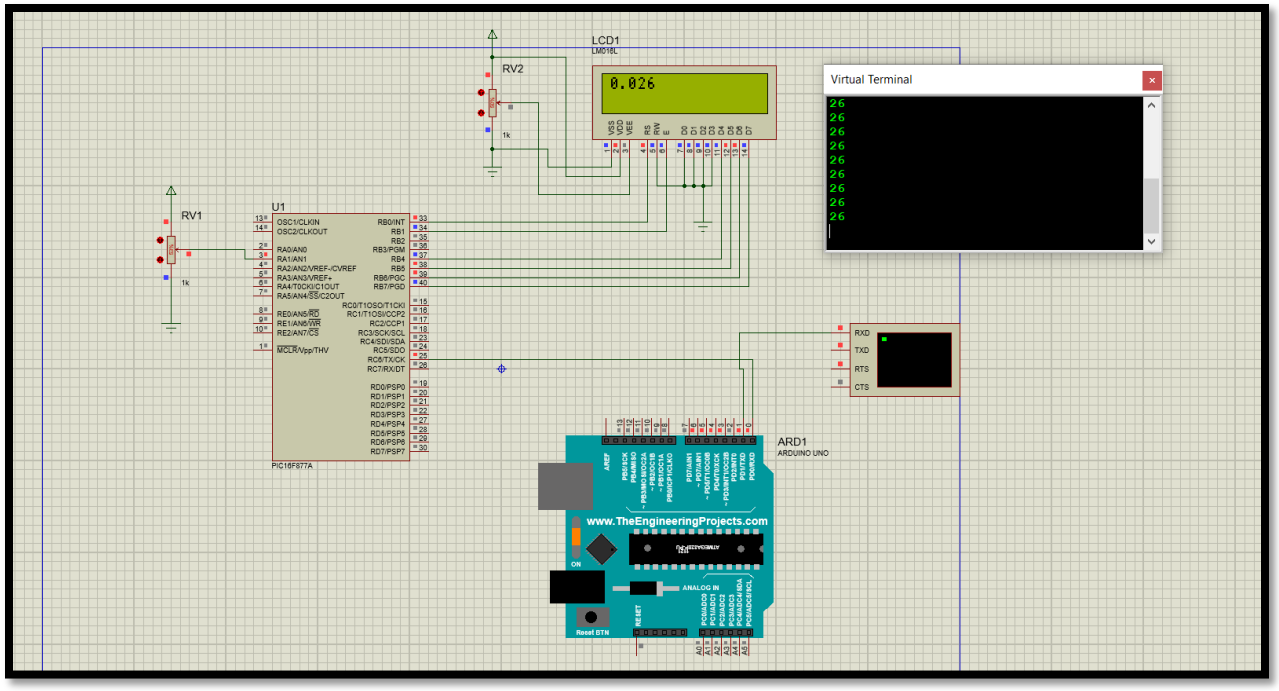


Figure 50:Ultarsonic sensor and Control Panel display of Ultrasonic sensor

9.5 CREATING POWER CONSUMPTION CONTROL SYSTEM

Proteus simulation of the ACS712 Current sensor can be shown as follows,



In here, Current sensor values are sent to nodeMCU multiplying 1000 because decimal number cannot be sent through the serial communication. Values received are divided by 1000 in the nodeMCU and sensor values are sent the thingspeak Subsequently.

Result of hardware part can be shown as follows,

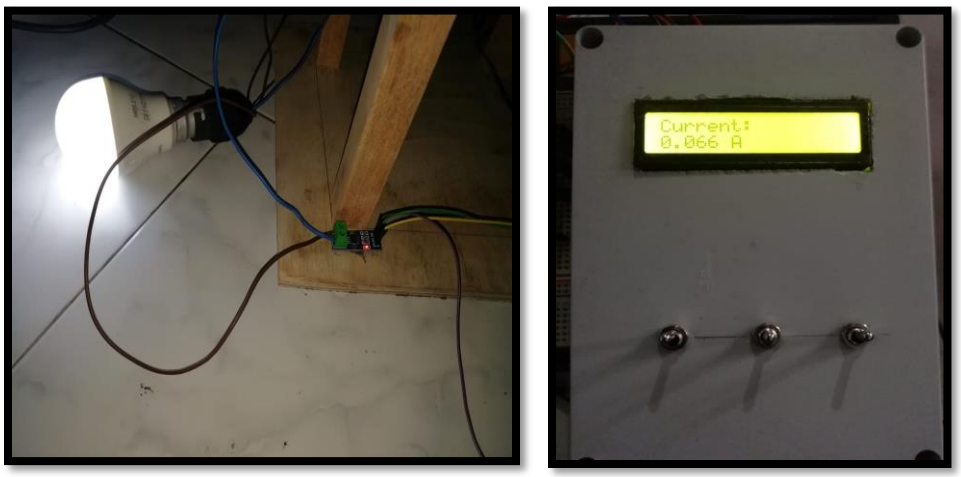
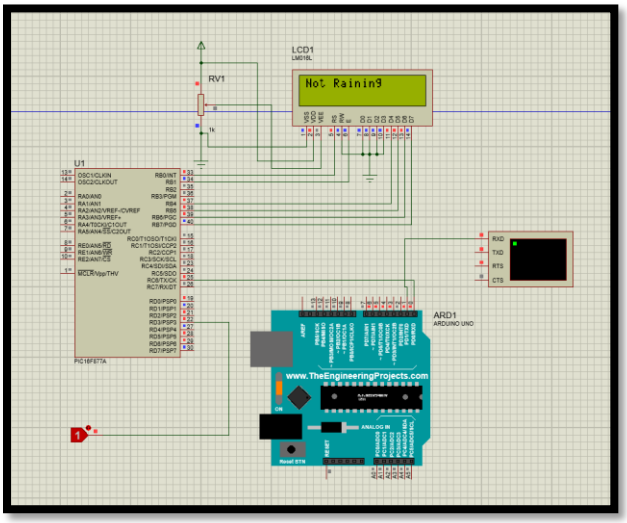


Figure 51:ACS712 sensor and Control Panel display of ACS712 sensor

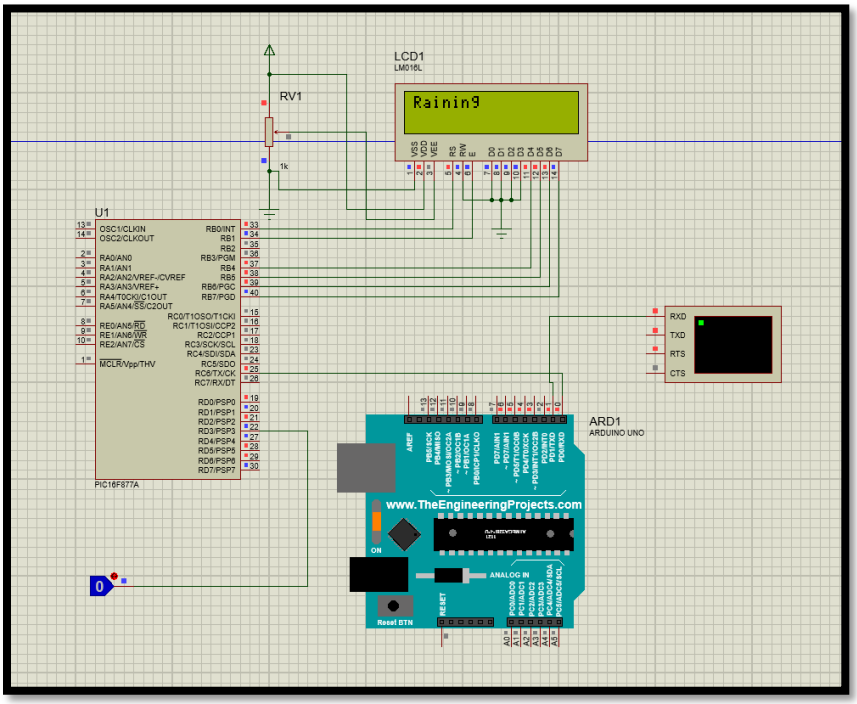
9.6 CREATING RAIN DETECTION SYSTEM

Proteus simulation of the Rain Drop sensor can be shown as follows,

- When signal of Rain drop sensor relay is 1, microcntroller detectes that “Not Raining”.



- When signal of Rain drop sensor relay is 0, microcntroller detectes that “Raining”.



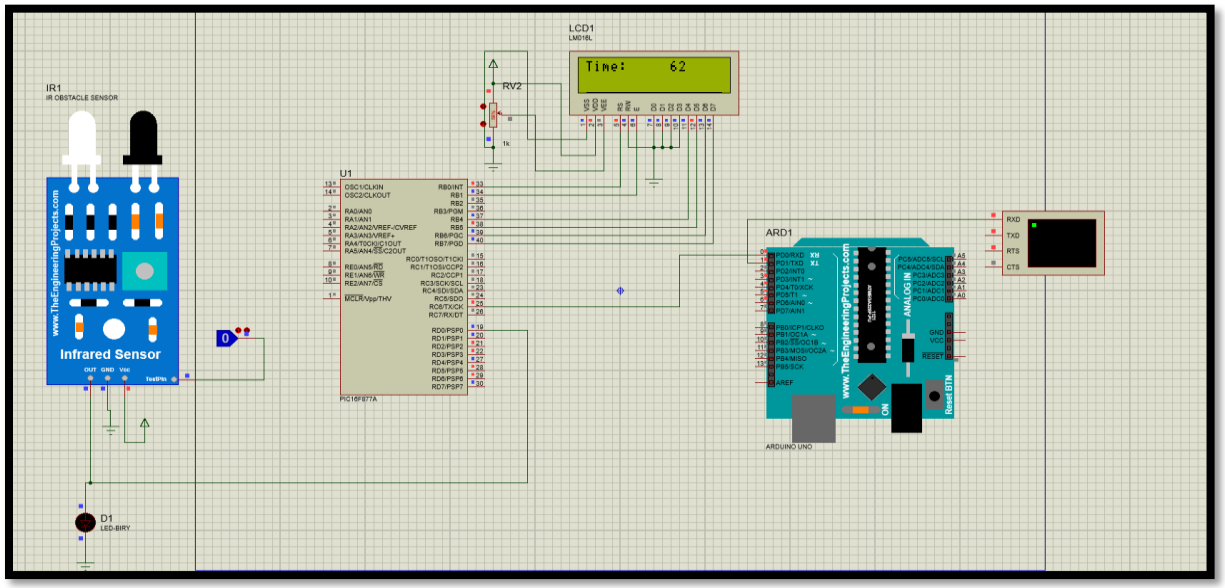
Result of hardware part can be shown as follows,

When Water drops are on the iron plate of Rain Drop Sensor.

Figure 52:Rain drop sensor and Control Panel display of rain drop sensor

9.7 MEASURING WIND SPEED

Proteus simulation of the hall effect sensor can be shown as follows,



Only for the simulation, infrared sensor has been used to obtain the pulse and calculate the pulse width because Hall effect sensor is not available in the Proteus Software. Wind speed can be calculated according to time period of pulse width. Pulse width has been calculated in milliseconds.

Result of hardware part can be shown as follows,

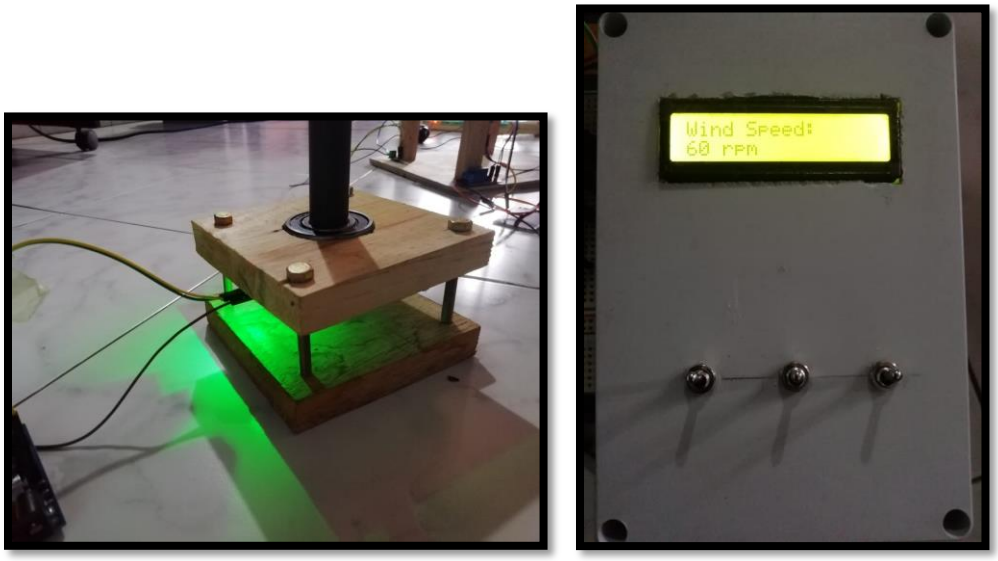


Figure 53:Hall effect sensor and Control Panel display of Hall effect sensor

In this system, magnet has been fixed to core of anemometer to measure wind speed. When the magnetic field is detected by hall effect sensor, digital pulse would be generated. Following figure shows how the hall effect senor is placed on the core of the anemometer.

Figure 54:Hall effect sensor on anemometer

9.8 MEASURING HEART RATE

Result of hardware part can be shown as follows,

Pulse sensor has been connected to the nodeMCU board.

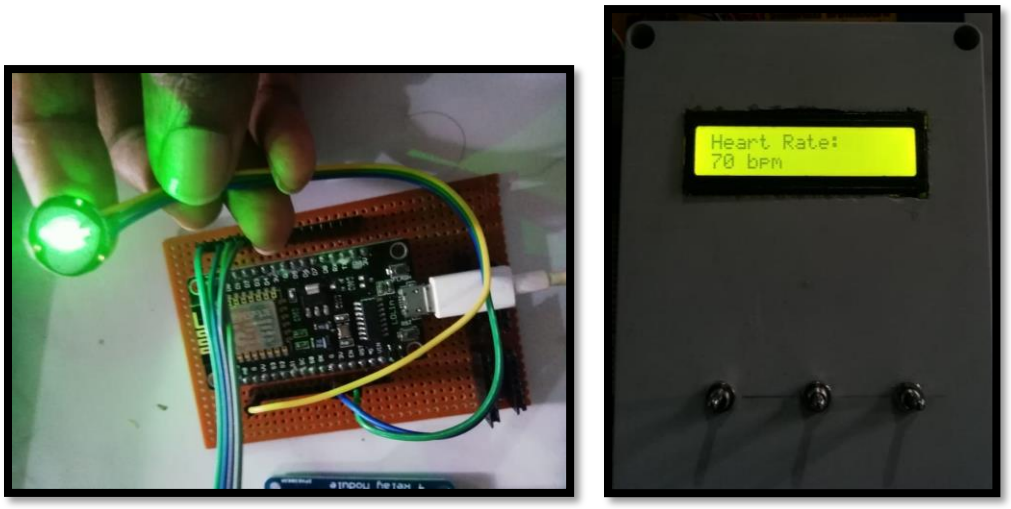
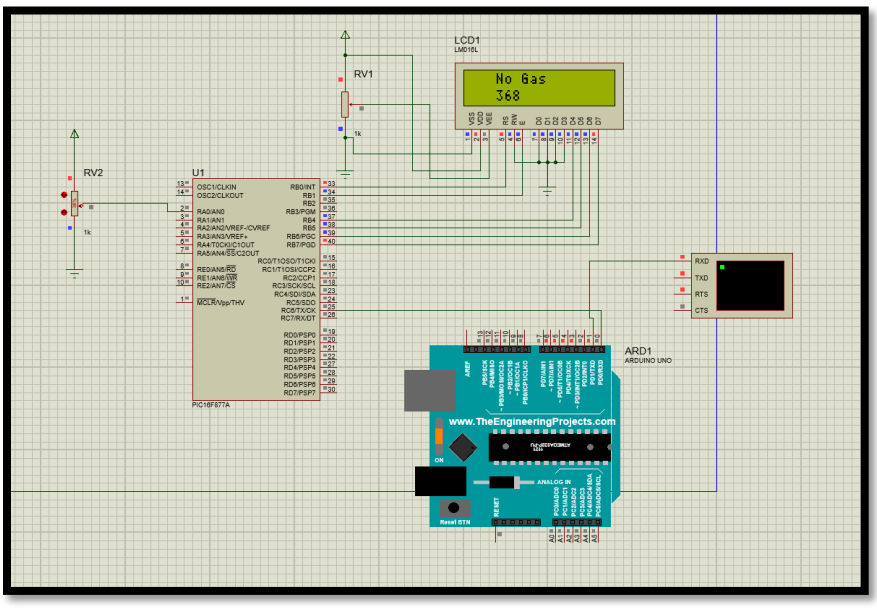


Figure 55:Heart rate sensor and Control Panel display of heart rate sensor

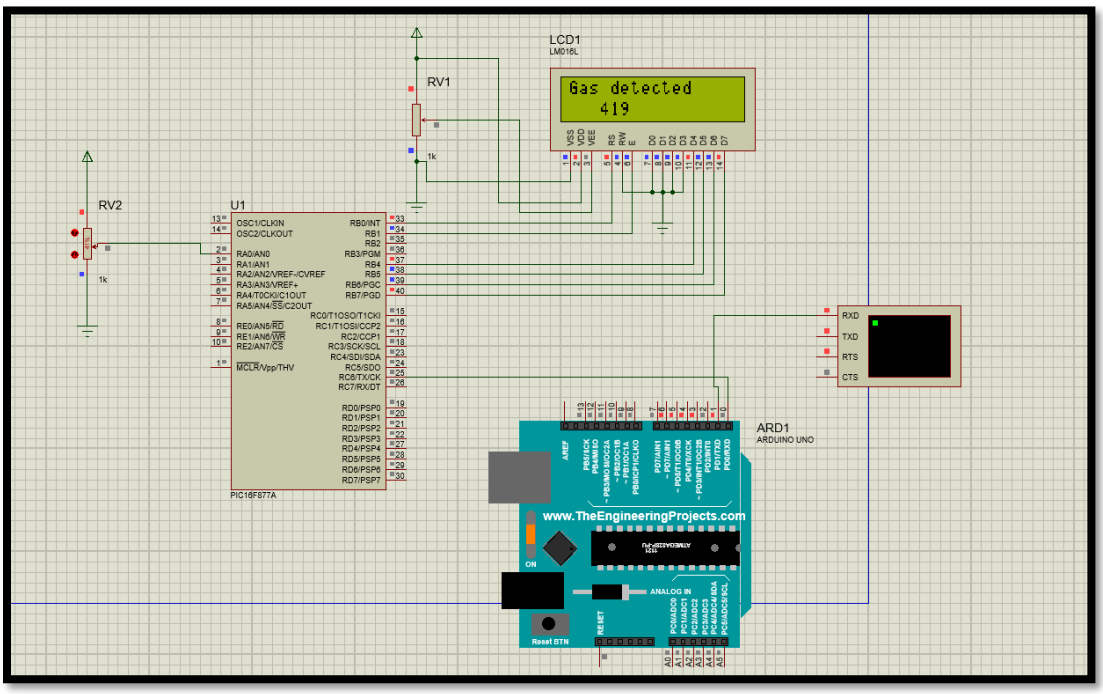
9.9 CREATING GAS DETECTING SYSTEM

Proteus simulation of MQ-2 Gas sensor can be shown as follows,

- When the sensor value is below the limit (400),



- When the sensor value is above the limit (400),



Result of hardware part can be shown as follows,

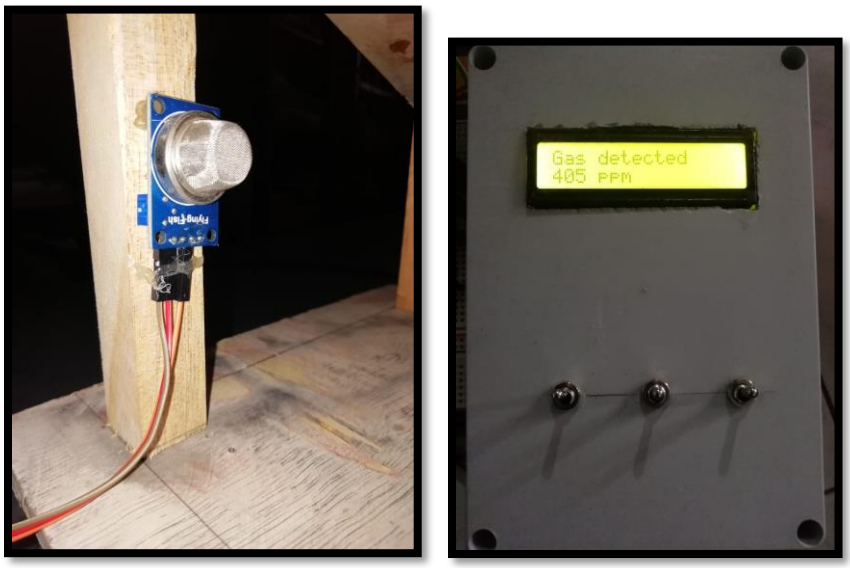
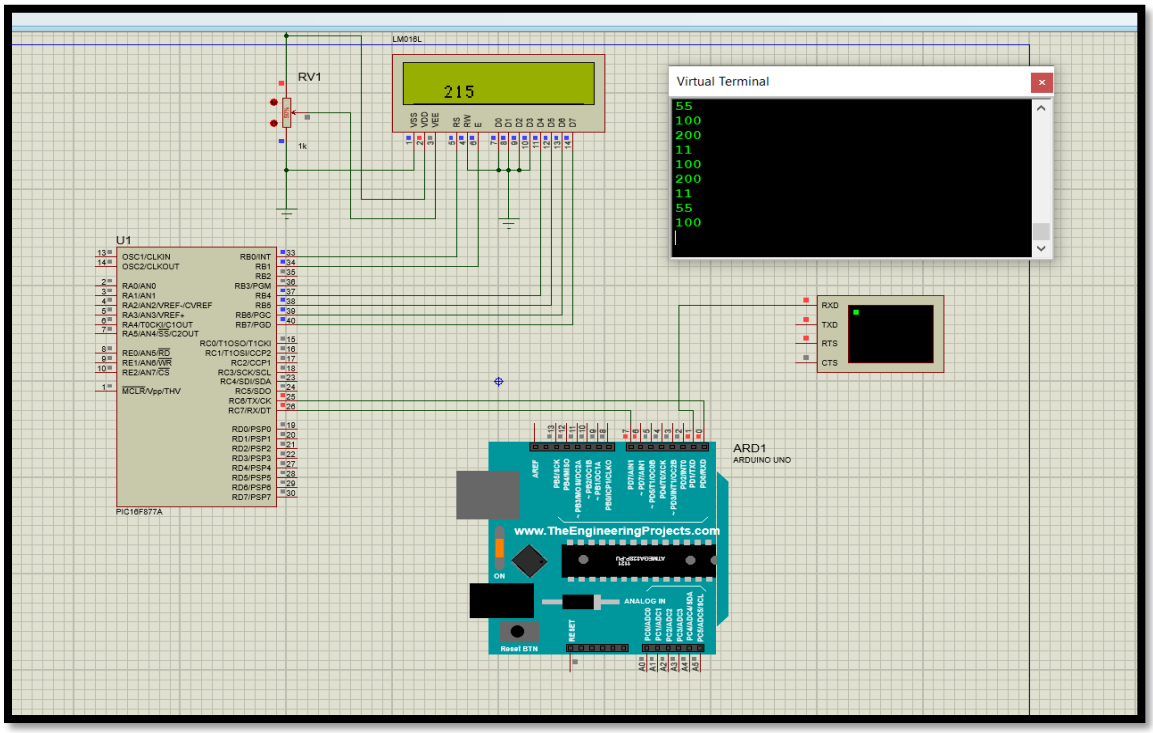


Figure 56:MQ-2 sensor and Control Panel display of MQ-2 sensor

9.10 CONNECTING nodeMCU USING SERIAL COMMUNICATION

Proteus simulation of serial communication between PIC16F877A and nodeMCU can be shown as follows,



In this simulation ,215 has been sent from nodeMCU to PIC16F877A and S1, S2, S3, S4 variables have been sent from PIC16F877A to nodeMCU. These values can be shown as follows,

```
4  int a=215;
5  int s1;
6  int s2;
7  int s3;
8  int s4;
9
```

```
int s1=100;
int s2=200;
int s3=11;
int s4=55;
```

Result of hardware part can be shown as follows,

In this process, NodeMCU and PIC16F877A was connected UART serial communication protocol.

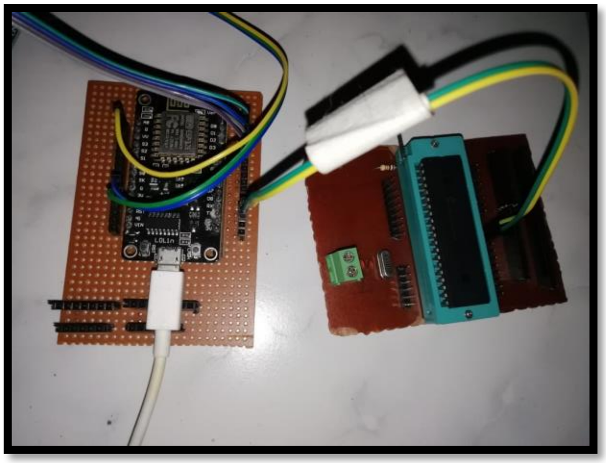


Figure 57:Serial Communication between nodeMCU and PIC16F877A

Arduino serial monitor values can be shown as follows,

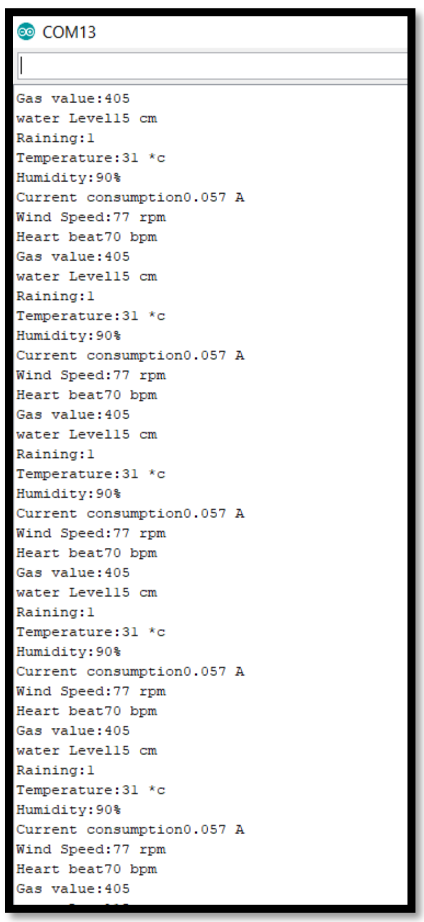


Figure 58:Serial monitor

9.11 CREATING MESSAGE ALERT SYSTEM USING GSM800L

Result of hardware part can be shown as follows,

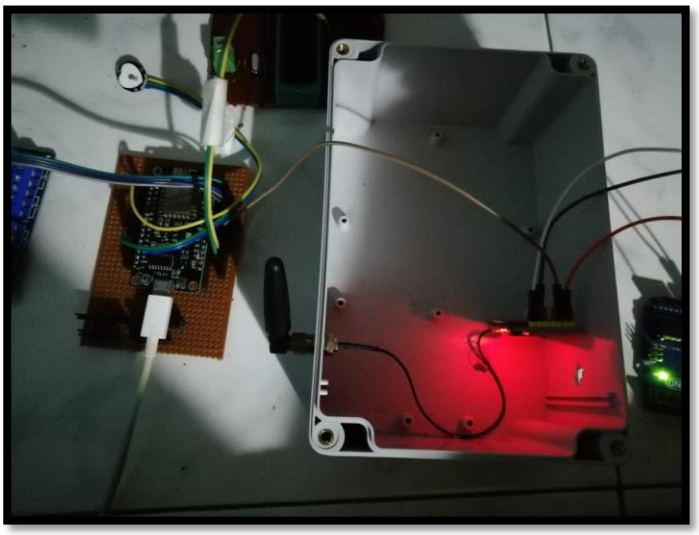


Figure 59:Connection between NodeMCU and GSM800L Module

When GSM switch of control panel is on, Sensor values can be obtained to the mobile phone as a message.

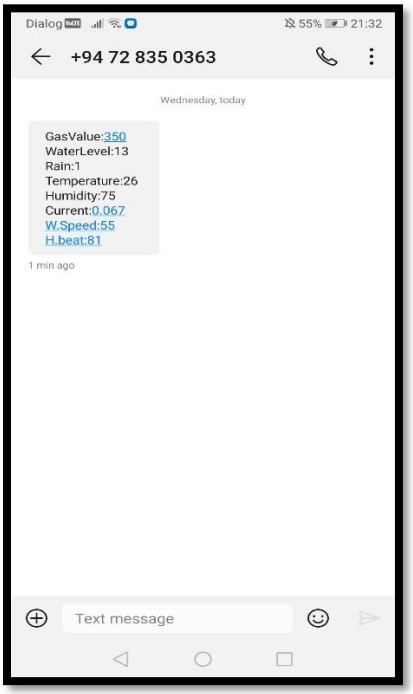


Figure 60:Received message form GSM

9.12 CONNECTING MATLAB WITH nodeMCU

Result can be shown as follows,

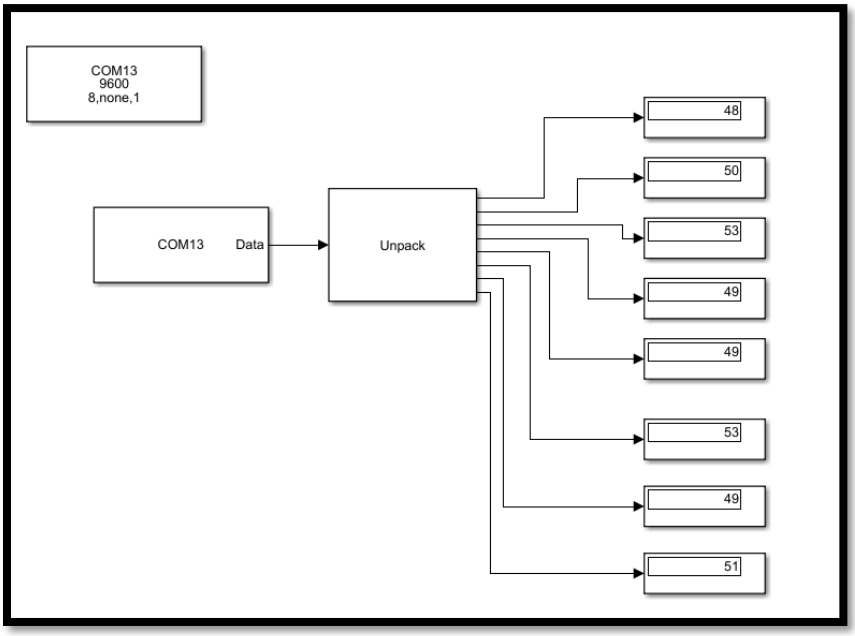


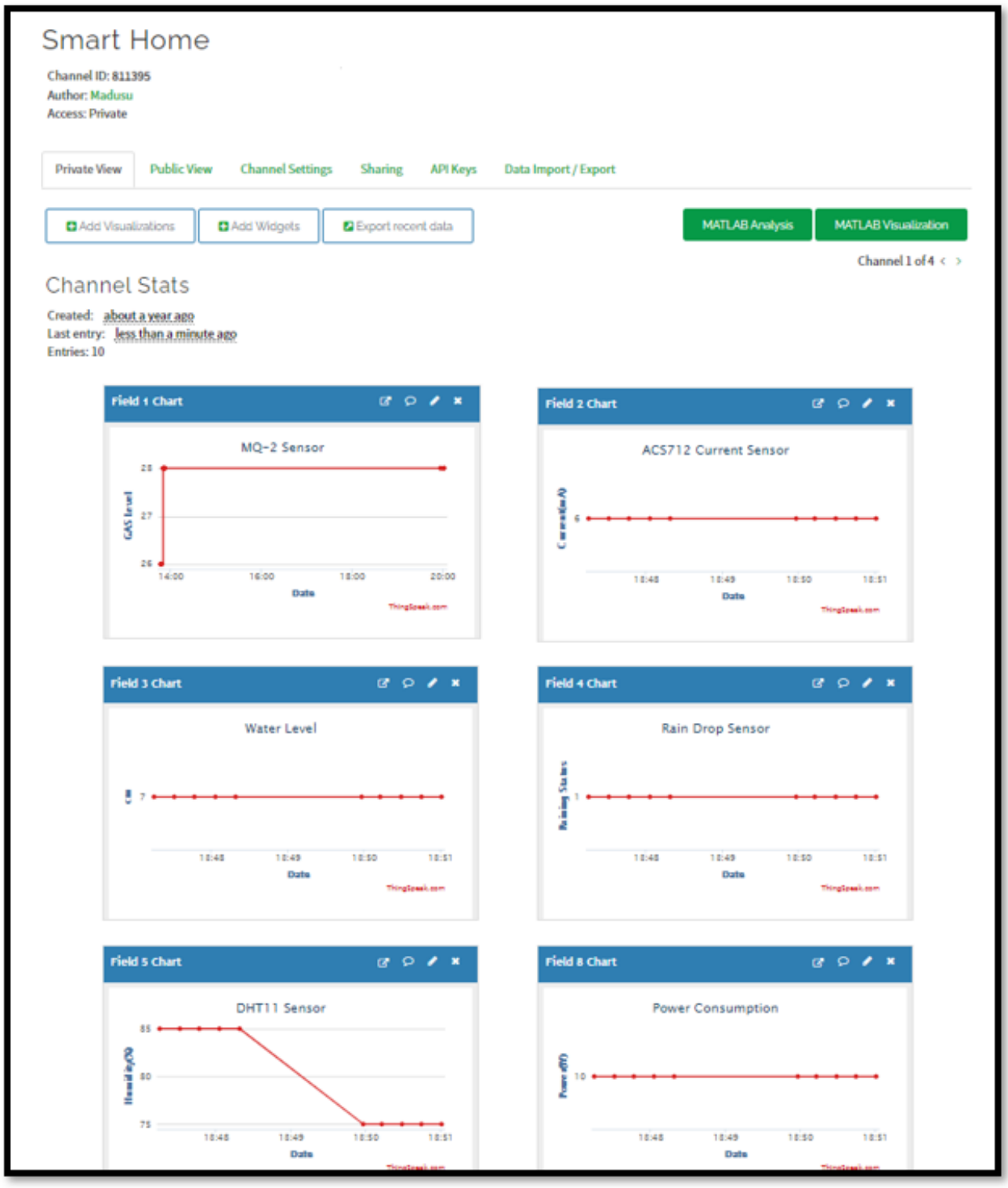
Figure 61:MATLAB simulink Block for serial communication

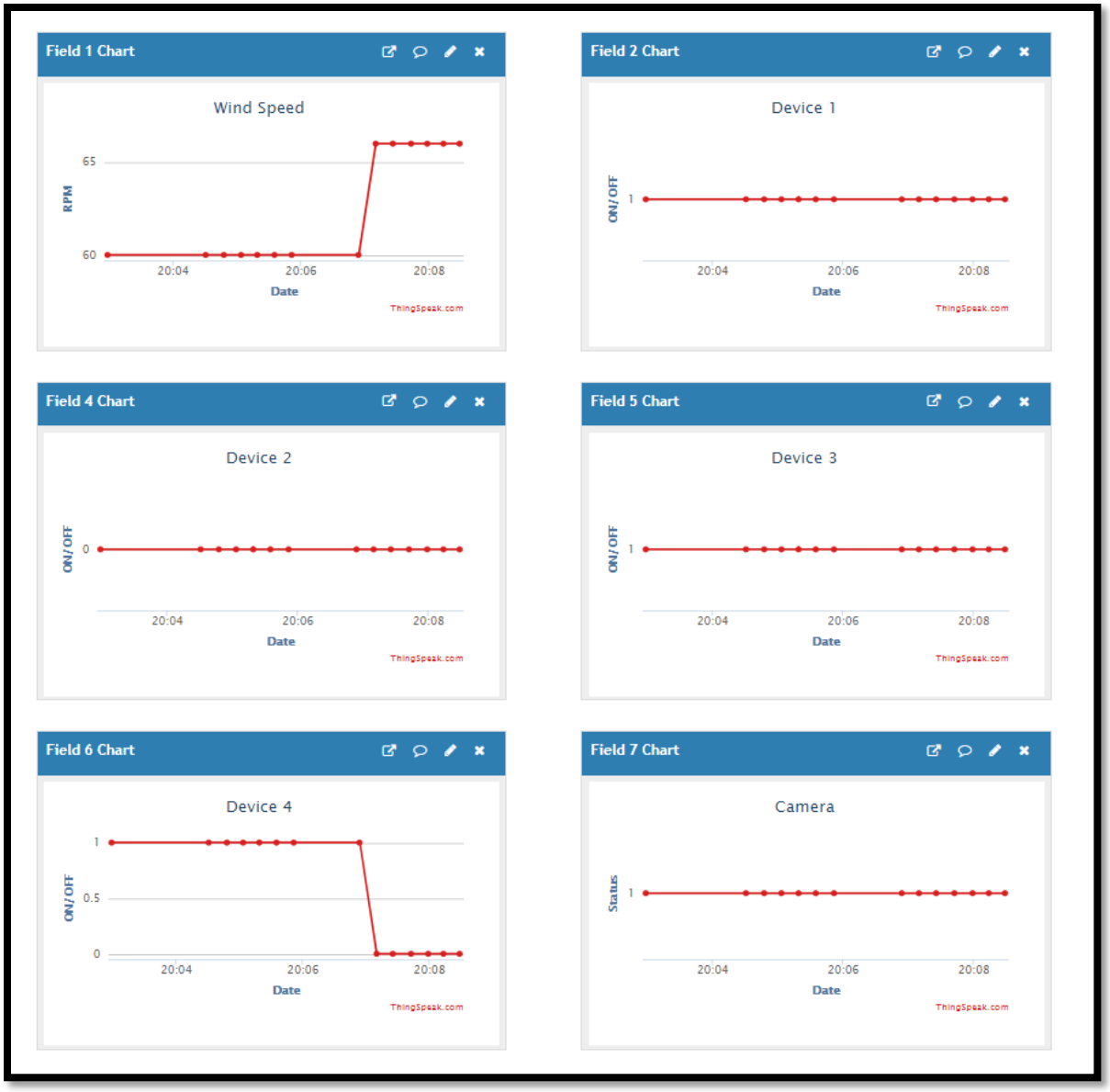
Above simulation process has been used to give sensor values for neural network of AI mode of the smart home.in this process, comport data from NodeMCU has been split into bytes according to the number of sensors.

9.13 CONNECTING NODEMCU WITH THINGSPEAK IOT PLATFORM

Result can be shown as follows,

IOT platform channel of Smart home can be shown as follows,


Smart Home
Channel ID: 811395
Author: Madusu
Access: Private
Private View
Public View
Channel Settings
Sharing
API Keys
Data Import / Export
Add Visualizations
Add Widgets
Export recent data
MATLAB Analysis
MATLAB Visualization
Channel 1 of 4
Channel Stats
Created: about a year ago
Last entry: less than a minute ago
Entries: 10
Field 1 Chart
MQ-2 Sensor
Field 2 Chart
ACS712 Current Sensor
Field 3 Chart
Water Level
Field 4 Chart
Rain Drop Sensor
Field 5 Chart
DHT11 Sensor
Field 8 Chart
Power Consumption
Date



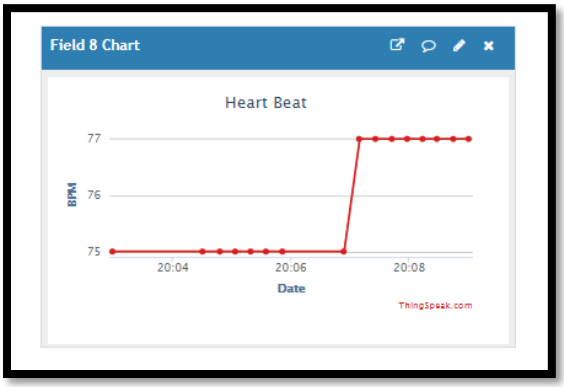


Figure 62:Thingspeak Channel

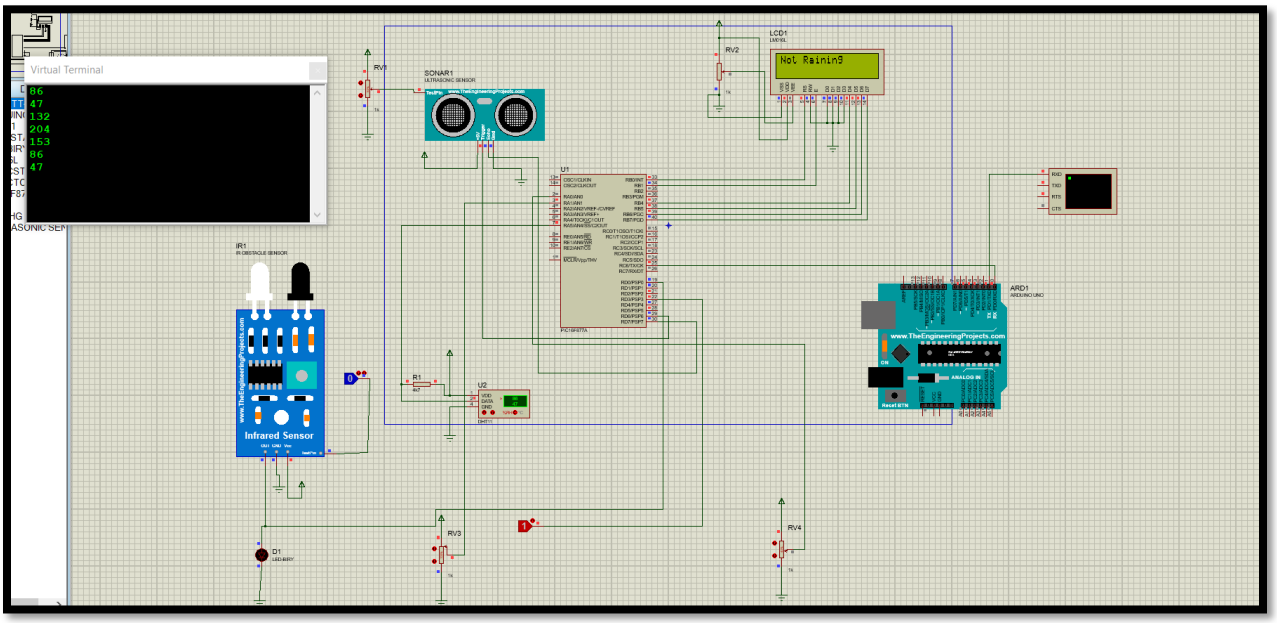
Twitter messages that were received from Reaction system of Thinhspeak can be shown as follows,

- When the face recognition system rejects the user identification,

- When the water level is low,

- When the temperature is above the limits,

- Simulation of Entire project can be shown as follows,



9.14 CREATING 12V TO 5V REGULATOR PCB FOR POWERING THE CIRCUIT.

Simulation of regulator circuit can be shown as follows,

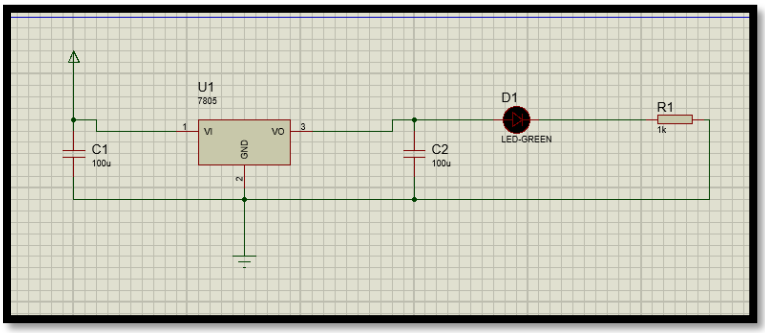


Figure 63:12V to 5V regulator

PCB design of regulator circuit,

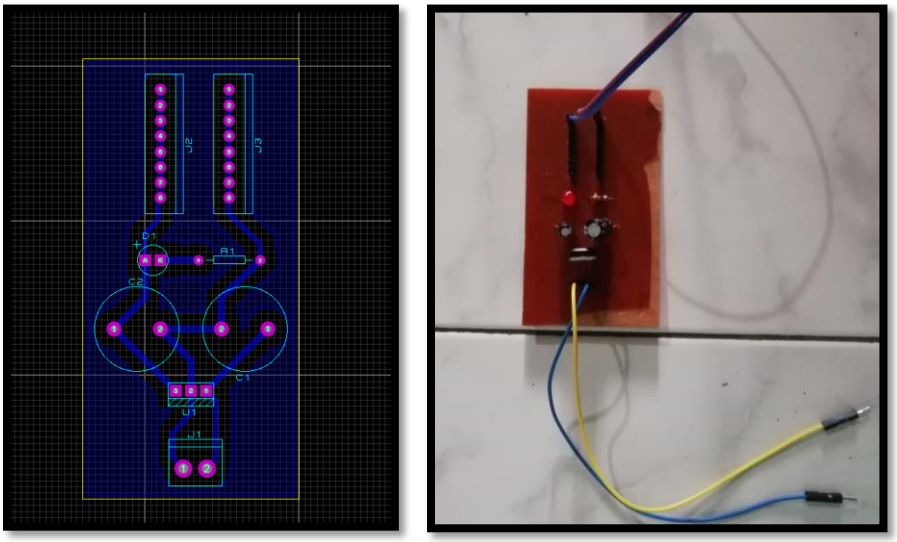


Figure 64:PCB design of regulator circuit

Above Circuit has been used as the Power Supply unit in this project.

9.15 DESIGNING PCB FOR THE PROJECT

PCB design of circuit which was created using proteus software can be shown as follows,

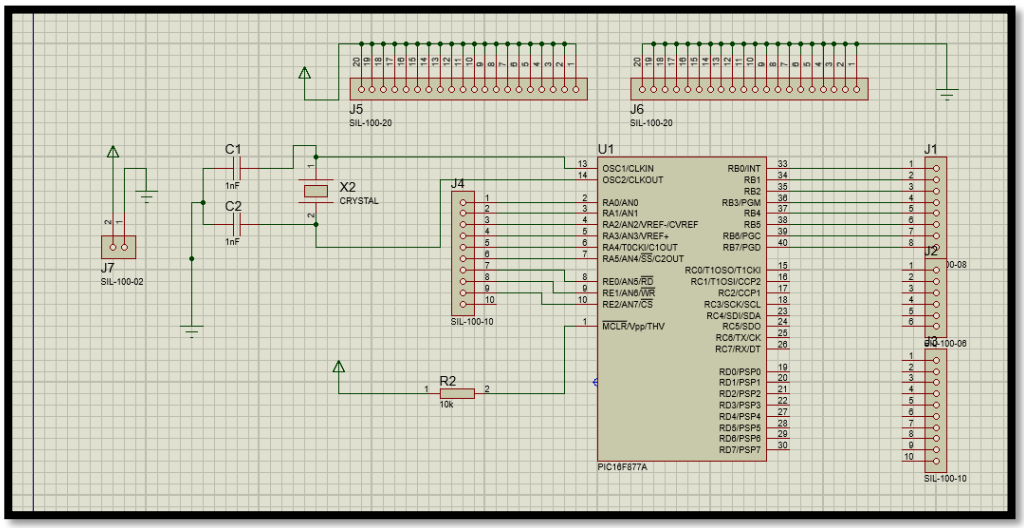


Figure 65:schematic in proteus

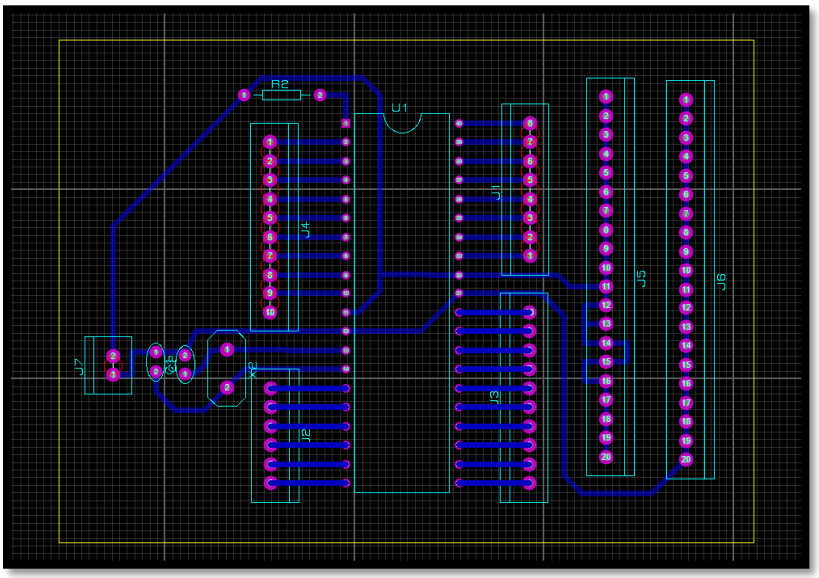


Figure 66:PCB design in proteus

3D view of the circuit,

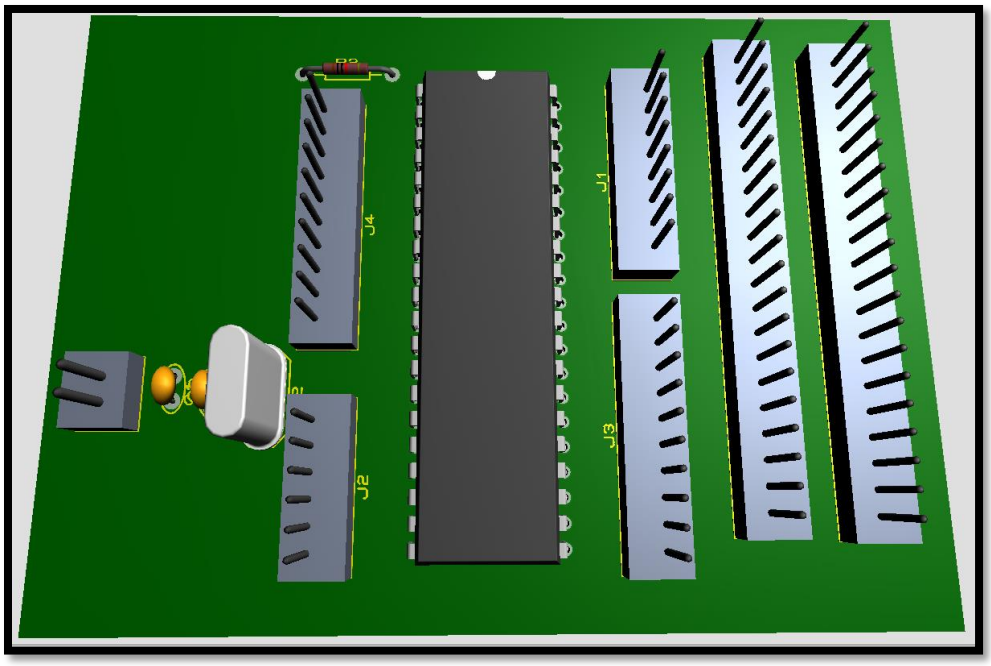


Figure 67:3D view in proteus

Hardware result can be shown as follows,

Figure 68:Created PCB

Combined Regulator circuit and PIC microcontroller circuit,

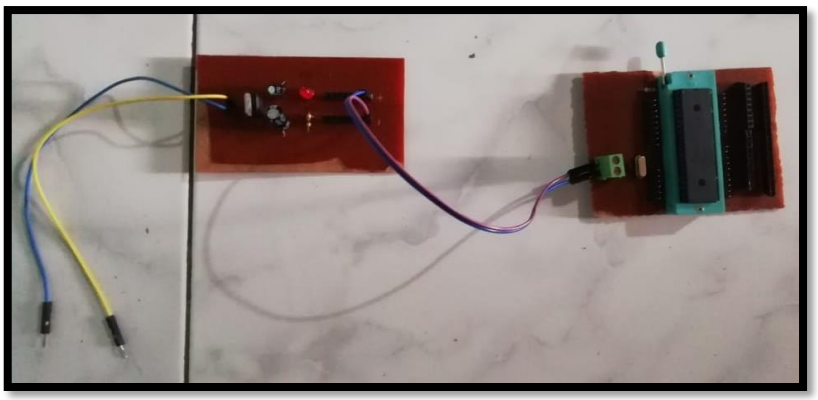


Figure 69:Regulator circuit with PICF877A circuit

Completed hardware of the project can be show as follows,

Figure 70:Completed Hardware protocol of Smart home

9.16 CREATING CONTROL PANEL

Control Panel consist of All the circuits, GSM model and nodeMCU Board. Control panel can be established inside of the Home as a system controller which is capable to obtain data from the Sensors and to control the Home devices according to data, because All the sensors are connected to the control panel. This control panel also consists of switch board which is capable to turn on the wind speed, heart rate sensor values and to send the messages which consist of sensor values via GSM module.

Figure 71:Front of the control panel

When user wants to check heart rate, heart rate switch should be on. Then BPM value would be displayed in LCD display and sent to “Thingspeak”. When user wants to obtain wind speed, wind speed switch should be on. Then values would be updated in LCD display and “Thingspeak”. Moreover, if user wants to obtain sensor details into the mobile phone via SMS. GSM switch should be on.

Inside of the control panel can be shown as follow,

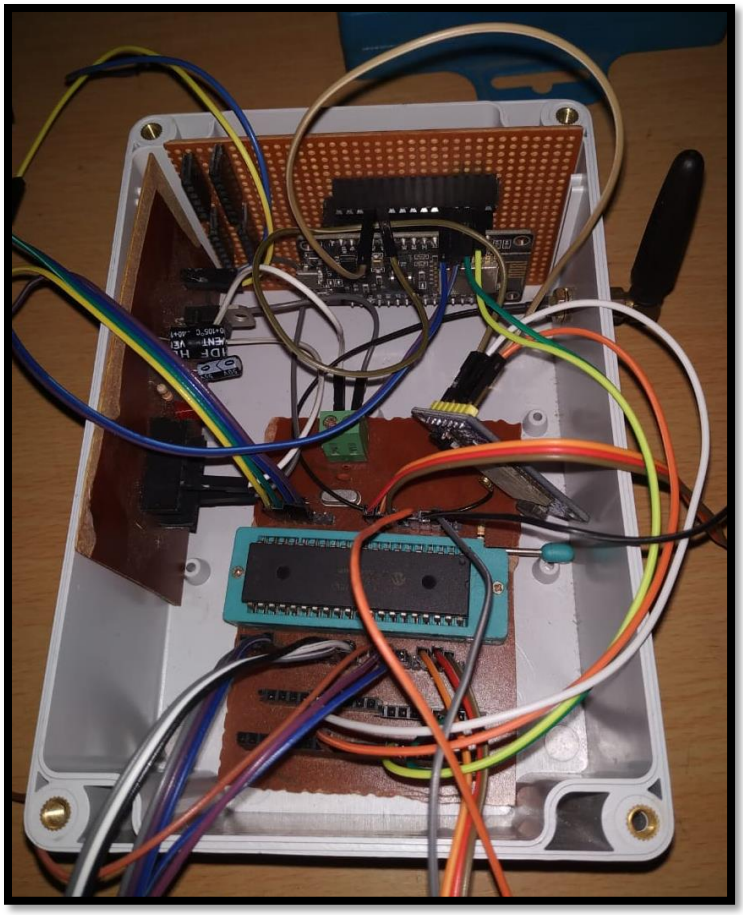


Figure 72:Inside of the Control Panel (GSM Module microcontroller Circuit, nodeMCU,12V to 5V Power Supply Circuit)

9.17 CREATING A SOFTWARE USING NEURAL NETWORK

Inter face of the GUI can be shown as follows,

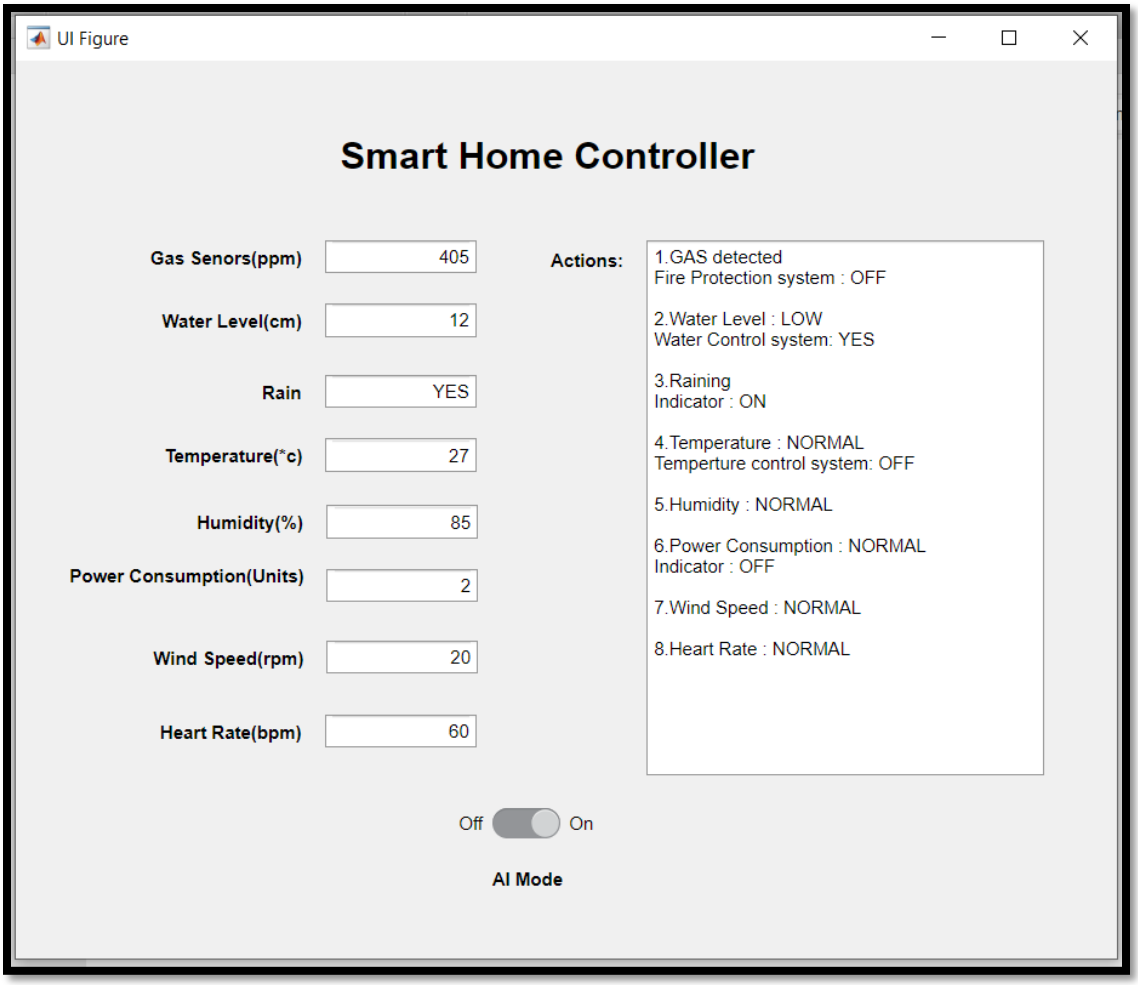


Figure 73:GUI for AI mode

This Software is to be introduced as a feature for the smart home system. when user wants to use AI mode, Entire home would be controlled by a neural network which has been pre-trained with data of the sensors using MATLAB. In order to create this software, “MATLAB appdesingner” toolbox has been used. Furthermore, the real time data, that are obtained from the NodeMCU using USB comport, have been fed into the neural network and GUI has been programmed to display sensor values and Actions of the systems according to the neural network. The, Sensor values are sent to the IOT platform to take the necessary actions. When actions are received from thignspeak to NodeMCU, NodeMCU would control relay modules to control home devices.

Performances of the Neural network that was developed for the AI mode of the control system can be shown as follows.

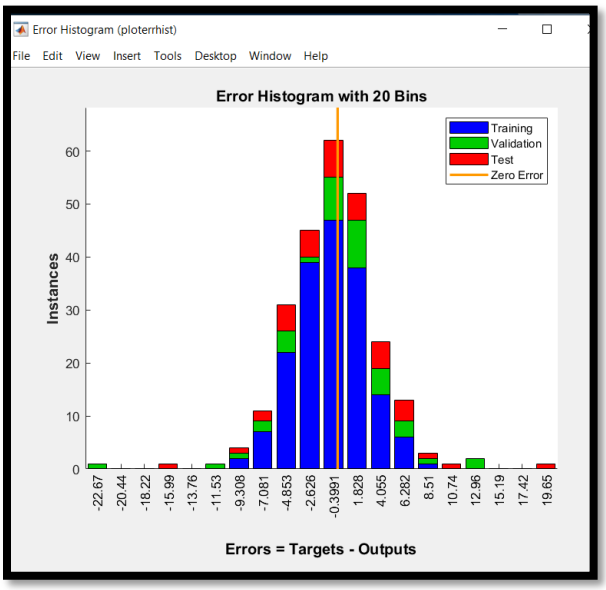


Figure 74:Error Histogram

Errors of the Neural Network is around 0.3991. therefore, Target outcome is able to be achieved using the AI control system.

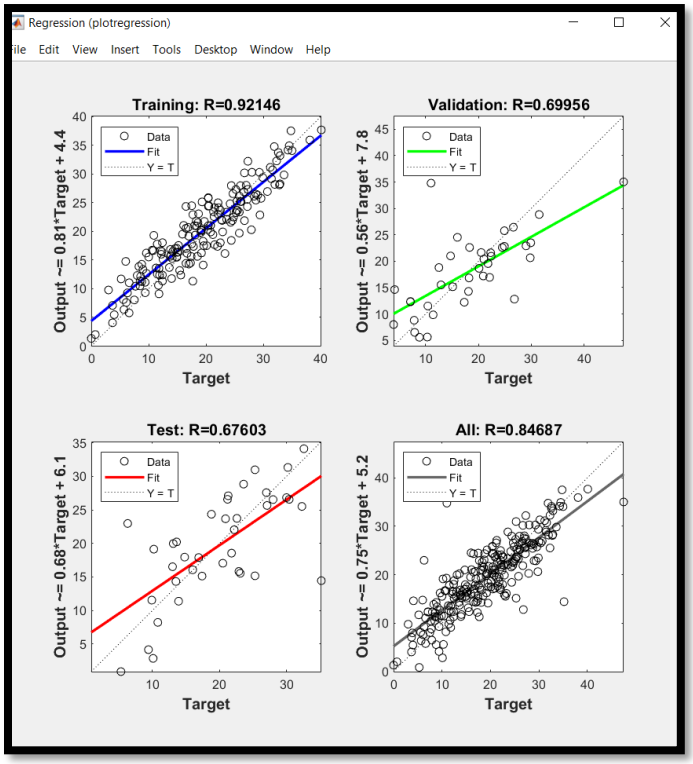


Figure 75:Regression

Regression of Training, Validation, Test has been approximately achieved to Fitting Values. According to the above figure. It can be shown that Neural Network has been achieved an optimum level to predict and produce outputs with high accuracy.

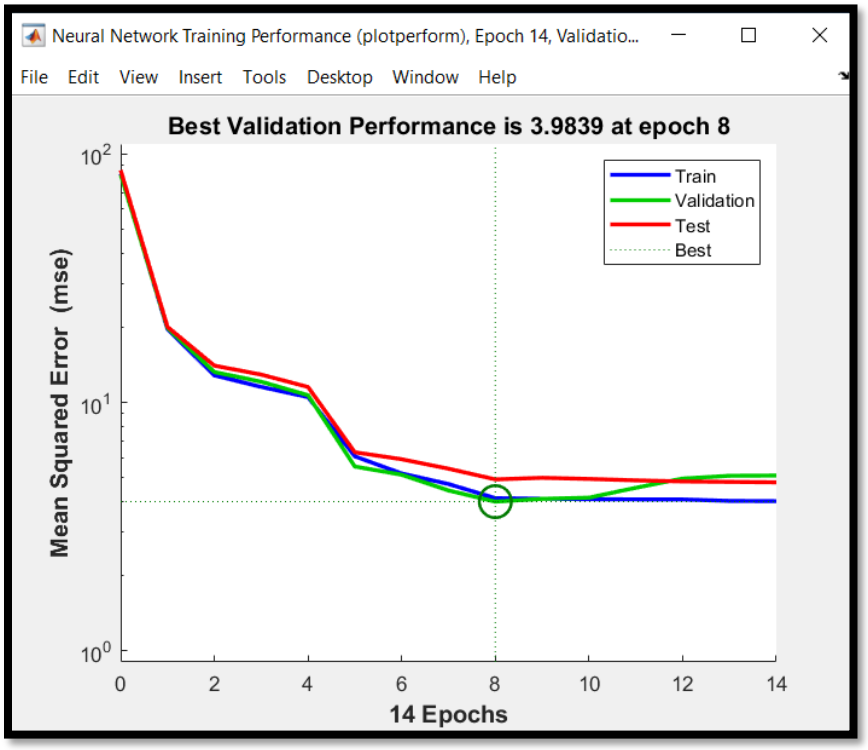


Figure 76:Performance of Neural Network

Best validation performance has been achieved at 8 Epochs and Mean Squared Error between Train, Validation, Test and Best is equal approximately.

10 CONCLUSION

IOT is a widely used technology and this technology is based on Internet. Due to high quality, accuracy and remitting speed, this technology can be used connect devices via Internet. This technology is very important for medical industry and data base management. In this project smart home has been built to maintain data base and control home devices as desire of user. Moreover, it is important to be aware of water level of a home to keep water supply of the home in a stable way. therefore, ultrasonic sensor has been used to create a water controlling unit. In addition to that, Protection of a home is a very important fact. Because of that security system are needed to maintain properly therefore, Gas sensor, temperature sensor and gas sensor have been used in this project to develop idea of smart home. When it comes to the power consumption, it is important to be aware of power consumption of home devices otherwise power can be overused. Therefore, current sensor has been used in this project to indicate power consumption. Anemometer has been created to detect wind speed using hall effect sensors as well. Heart measuring system has been added to this project for user to be used as a health caring measure and raining detecting system has been developed in smart home as well. Another important fact is the ability to experience AI technology with MATLAB neural network tools in this project.

Smart home concept provides a lot of features for users. Home can be controlled not staying inside of home and home can be controlled from any way in the world. Database system help user to make decisions correctly and precisely without making any wrong decisions. Because of smart Home, it is easy to people to live. It saves valuable time of user therefore, people who use smart home system can spend their time leisurely or for inventing new things and new technologies. Humans cannot store data for a long period of time to process or access according to information. But the electronic devices can obtain precise value and store for a long period of time. Because of the above-mentioned facts, IOT has become the most used and developing technology in the world while making people convinced. In the future this technology will be developed more for the well-being of the people.

11 FURTHER DEVELOPMENT

The neural network is able to be developed more to control home devices. For security camera system, quality cameras can be used for accuracy and better efficiency. Water level indicator can be created using light system to indicate water level. Moreover, automatically control system is able to be made to turn on or off without any interference. Instead of using DHT11 sensor, high accuracy sensor can be used for temperature measuring sensor. And automated cooling system can be created to decrease or increase temperature automatically. The neural network also can be developed to react according to sensor values. The gas level of home can be connected to fire protection system with more efficiency. if gas level is increases. Devices controlling system can be developed for more devices. moreover, GUI app can be more developed to be user friendly. Instead of “Thingspeak”. IOT platform, the website can be created as iot database to collect data and analyze data according to that data, it is possible to control devices more effectively. Furthermore, Motion detection sensors can be added to security system to protect home. The microcontroller circuit is able to be developed to control devices instead of utilizing manufactured development boards. In addition to that, FPGA development board can be used to develop the Automated home instead of microcontrollers. the smart home concept can be introduced for market as an affordable product.

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For literature review[ONLINE]:

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https://ieeexplore.ieee.org/document/7955836 (An IoT based home automation using android application)

https://ieeexplore.ieee.org/document/8261311 (Voice controlled home automation system using Natural Language Processing (NLP) and Internet of Things (IoT))

Available at: https://www.electroschematics.com/heart-rate-sensor

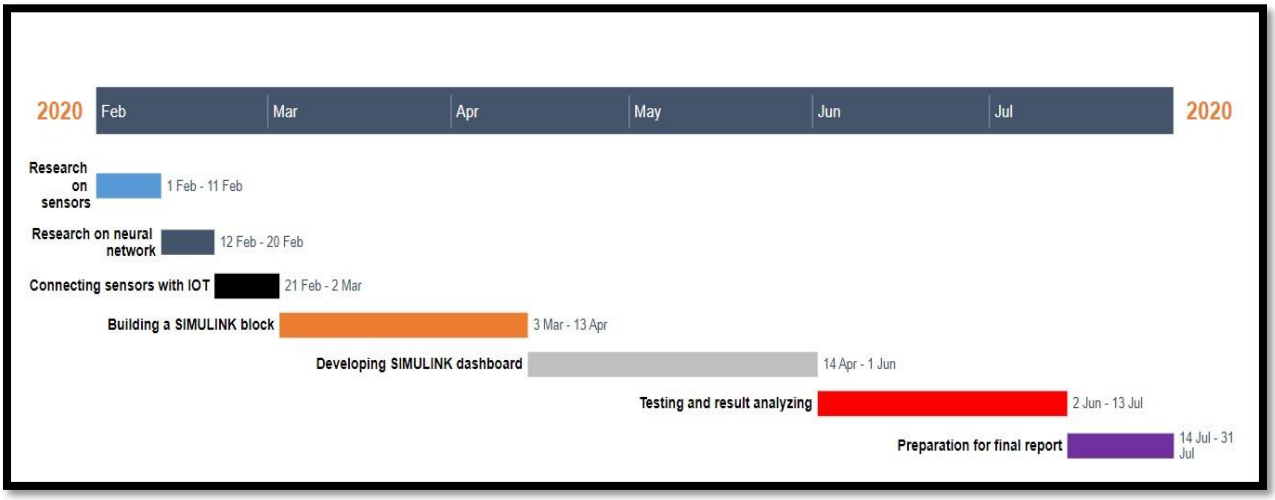
Available at: https://www.electrical4u.com/voltage regulator7805/#:~:text=The%20voltage%20regulator%20IC%207805,5V%20DC%20regulated%2

ESP8266 Home Automation Projects: Leverage the Power of This Tiny Wifi Chip to Build Exciting Smart Home Projects (English Edition).

Everything You Need to Know to Make Your Home Smart durch John R. Patrick.

13 APPENDICES

13.1 Appendix A: Gantt chart



13.2 Appendix B: Contact register

Contact Type Meeting	Date: 10/02/2020	Time: 11.00 am	Place: office	Key Actions Agreed: Advices were given to initial to project.
Student Signature:			Supervisor Signature:	
Contact Type Meeting	Date: 20/03/2020	Time: 1.30 pm	Place: office	Key Actions Agreed: Discussion about neural networks.
Student Signature:			Supervisor Signature:	
Contact Type email	Date: 20/05/2020	Time: 4.40 pm	Place:	Key Actions Agreed: Informed about progress of project.
Student Signature:			Supervisor Signature:	
Contact Type email	Date: 29/06/2019	Time: 11.00 pm	Place:	Key Actions Agreed: Informed about progress of project.
Student Signature:			Supervisor Signature:	
Contact Type email	Date: 1/08/2020	Time: 10.30 am	Place:	Key Actions Agreed: informed about progress of project and thingspeak
Student Signature:			Supervisor Signature:	

13.3 Appendix C: Code for ACS712 sensor

```
// LCD module connections
sbit LCD_RS at RB0_bit;
sbit LCD_EN at RB1_bit;
sbit LCD_D4 at RB4_bit;
sbit LCD_D5 at RB5_bit;
sbit LCD_D6 at RB6_bit;
sbit LCD_D7 at RB7_bit;

sbit LCD_RS_Direction at TRISB0_bit;
sbit LCD_EN_Direction at TRISB1_bit;
sbit LCD_D4_Direction at TRISB4_bit;
sbit LCD_D5_Direction at TRISB5_bit;
sbit LCD_D6_Direction at TRISB6_bit;
sbit LCD_D7_Direction at TRISB7_bit;
// End LCD module connections

unsigned long adcVoltage;
unsigned long sensitivity=100;
unsigned long offsetVoltage=0;
unsigned long currentValue;
unsigned int i;
char digit[]="0.000";
unsigned long x;

void main() {

TRISA=0xFF;


ADCON0=0x01;
ADCON1=0x0E;
```

```
 UART1_Init(9600);
 Lcd_Init();                    // Initialize LCD

 Lcd_Cmd(_LCD_CLEAR);           // Clear display
 Lcd_Cmd(_LCD_CURSOR_OFF);      // Cursor off
  Delay_ms(1000);

 do {
   adcVoltage = ADC_Read(1);   // Get 10-bit results of AD conversion
   adcVoltage=adcVoltage*5000/1023;   //Convert ADC value to mV
   currentValue = ((adcVoltage - offsetVoltage) / sensitivity);



   digit[0]=(currentValue/1000)+48;
   digit[2]=((currentValue%1000)/100)+48;
   digit[3]=(((currentValue%1000)%100)/10)+48;
   digit[4]=(((currentValue%1000)%100)%10)+48;
   //LongToStr(currentValue,digit);
   LCD_Cmd(_LCD_CLEAR);
   LCD_Out(1,1,digit);

  // x = xtoi(currentValue)*10000;
   UART1_Write(currentValue);
   Delay_ms(500);

 } while(1);
}
```

13.4 Appendix D: Code for DHT11 sensor

```
sbit LCD_RS at RB0_bit;
sbit LCD_EN at RB1_bit;
sbit LCD_D4 at RB4_bit;
sbit LCD_D5 at RB5_bit;
sbit LCD_D6 at RB6_bit;
sbit LCD_D7 at RB7_bit;

sbit LCD_RS_Direction at TRISB0_bit;
sbit LCD_EN_Direction at TRISB1_bit;
sbit LCD_D4_Direction at TRISB4_bit;
sbit LCD_D5_Direction at TRISB5_bit;
sbit LCD_D6_Direction at TRISB6_bit;
sbit LCD_D7_Direction at TRISB7_bit;

unsigned char Check;
unsigned char uniT=0,decT=0,uniHR=0,decHR=0;
unsigned char  T_byte1, T_byte2,RH_byte1, RH_byte2;
unsigned Sum;


sbit DataDHT      at    PORTA.B5;
sbit InDataDHT    at    TRISA.B5;

//*************************************************************************************
**********************************
//*************************************************************************************
**********************************
//*************************************************************************************
**********************************
void StartSignal()
{
 TRISA.F5 = 0;
 DataDHT = 0;
```

```
 delay_ms(18);
 DataDHT = 1;
 delay_us(30);
 TRISA.F5 = 1;
}
//////////////////////////////
void CheckResponse()
{
 Check = 0;
 delay_us(40);
 if(DataDHT == 0)
 {
  delay_us(80);
  if (DataDHT == 1)
  Check = 1;
  delay_us(40);
 }
}
//////////////////////////////
char ReadData()
{
 char i, j;
 for(j = 0; j < 8; j++)
 {
  while(!DataDHT);
  delay_us(30);
  if(DataDHT == 0)
   i&= ~(1<<(7 - j));
  else
  {
   i|= (1 << (7 - j));
   while(DataDHT);
  }
```

```
 }
 return i;
}
//*************************************************************************************
**********************************
//*************************************************************************************
**********************************
//*************************************************************************************
**********************************


void main()
{
UART1_Init(9600);
ADCON1=0x06;

Lcd_Init();
Lcd_Cmd(_LCD_CLEAR);
Lcd_Cmd(_LCD_CURSOR_OFF);


while(1)
{
 StartSignal();
 CheckResponse();
 if(Check == 1)
 {
  RH_byte1 = ReadData();
  RH_byte2 = ReadData();
  T_byte1 = ReadData();
  T_byte2 = ReadData();
  Sum = ReadData();

  if(Sum == ((RH_byte1+RH_byte2+T_byte1+T_byte2) & 0XFF))
```

```
  {
   decHR=RH_byte1/10;
   uniHR=RH_byte1%10;
   decT=T_byte1/10;
   uniT=T_byte1%10;

   decHR=decHR+0x30;
   uniHR=uniHR+0x30;
   decT=decT+0x30;
   uniT=uniT+0x30;

   Lcd_Out(1,1, "TEMP= ");
   Lcd_Chr(1,7, decT);
   Lcd_Chr(1,8, uniT);
   Lcd_Out_Cp(" oC");

   Lcd_Out(2,1, "HR= ");
   Lcd_Chr(2,7, decHR);
   Lcd_Chr(2,8, uniHR);
   Lcd_Out_Cp(" %");

  }
 }
 else
 {
  Lcd_Cmd(_LCD_CLEAR);
  Lcd_Out(1, 1, "error");
 }
  UART1_Write(RH_byte1);
  UART1_Write(T_byte1);
  Delay_ms(500);
 delay_ms(1000);
}
```

```
}
```

13.5 Appendix E: Code for MQ-2 sensor

```
#include <built_in.h>
unsigned int  SomeInt1;
int gas_value;
char text[10];
// LCD module connections
sbit LCD_RS at RB0_bit;
sbit LCD_EN at RB1_bit;
sbit LCD_D4 at RB4_bit;
sbit LCD_D5 at RB5_bit;
sbit LCD_D6 at RB6_bit;
sbit LCD_D7 at RB7_bit;

sbit LCD_RS_Direction at TRISB0_bit;
sbit LCD_EN_Direction at TRISB1_bit;
sbit LCD_D4_Direction at TRISB4_bit;
sbit LCD_D5_Direction at TRISB5_bit;
sbit LCD_D6_Direction at TRISB6_bit;
sbit LCD_D7_Direction at TRISB7_bit;

void main(void)
{

ADC_Init(); // it will initialize the adc module of pic16f877a microcontroller
Lcd_Init(); // Initialize LCD
Lcd_Cmd(_LCD_CLEAR); // Clear display
Lcd_Cmd(_LCD_CURSOR_OFF); // Cursor off
Lcd_Out(1,1,"MQ-2 sensor" ); // Write text in first
delay_ms(2000);
Lcd_Cmd(_LCD_CLEAR); // Clear display
```

```
while(1)
{ // Endless loop

gas_value = ADC_Read(0); // It will read the gas value of sensor
if( gas_value > 400 )
Lcd_Out(1,1, "Gas detected" );
else
Lcd_Out(1,4, "No Gas " );
intToStr(gas_value, Ltrim(text));
Lcd_Out(2,1, text );
delay_ms(1000);

}
}
```

13.6 Appendix F: Code for Rain drop sensor

```
#include <built_in.h>
unsigned int  SomeInt1;
int moisture_value;
float rain_value;
char text[10];
// LCD module connections
sbit LCD_RS at RB0_bit;
sbit LCD_EN at RB1_bit;
sbit LCD_D4 at RB4_bit;
sbit LCD_D5 at RB5_bit;
sbit LCD_D6 at RB6_bit;
sbit LCD_D7 at RB7_bit;

sbit LCD_RS_Direction at TRISB0_bit;
sbit LCD_EN_Direction at TRISB1_bit;
sbit LCD_D4_Direction at TRISB4_bit;
sbit LCD_D5_Direction at TRISB5_bit;
```

```
sbit LCD_D6_Direction at TRISB6_bit;
sbit LCD_D7_Direction at TRISB7_bit;
// End LCD module connections

void main() {
UART1_Init(9600);
ADC_Init(); // it will initialize the adc module of pic16f877a microcontroller
Lcd_Init(); // Initialize LCD
Lcd_Cmd(_LCD_CLEAR); // Clear display
Lcd_Cmd(_LCD_CURSOR_OFF); // Cursor off
Lcd_Out(1,1,"Rain sensor" ); // Write text in first
delay_ms(2000);
Lcd_Cmd(_LCD_CLEAR); // Clear display

while(1)
{ // Endless loop

moisture_value = ADC_Read(1); // It will read the moisture value of sensor

moisture_value = (moisture_value * 100)/(1023); // it converts the moisture value on percentage
FloatToStr(moisture_value,text);
Lcd_Out(2,1,text );
Lcd_Out_cp("%");
Lcd_Cmd(_LCD_CLEAR);
Lcd_Cmd(_LCD_CURSOR_OFF);
SomeInt1= moisture_value;
UART1_Write(Lo(SomeInt1));
}
}
```

13.7 Appendix G: Code for UART sensor

```
/*#include <built_in.h>
unsigned int SomeInt1;*/
```

```
// LCD module connections
sbit LCD_RS at RB0_bit;
sbit LCD_EN at RB1_bit;
sbit LCD_D4 at RB4_bit;
sbit LCD_D5 at RB5_bit;
sbit LCD_D6 at RB6_bit;
sbit LCD_D7 at RB7_bit;

sbit LCD_RS_Direction at TRISB0_bit;
sbit LCD_EN_Direction at TRISB1_bit;
sbit LCD_D4_Direction at TRISB4_bit;
sbit LCD_D5_Direction at TRISB5_bit;
sbit LCD_D6_Direction at TRISB6_bit;
sbit LCD_D7_Direction at TRISB7_bit;
// End LCD module connections
float receive;
char text[10];
int s1=100;
int s2=200;
int s3=11;
int s4=55;
void main() {
UART1_Init(9600);
Lcd_Init();
Lcd_Cmd(_LCD_CLEAR);
Lcd_Cmd(_LCD_CURSOR_OFF);
while(1){
if (UART1_Data_Ready() ==1) {
 receive = UART1_Read();
 }
 //SomeInt1= receive;
 intToStr(receive,text);
```

```
 Lcd_Out(2,1,text);
 UART1_write(s1);
 UART1_write(s2);
 UART1_write(s3);
 UART1_write(s4);
}
}
```

13.8 Appendix H: Code for Hall effect sensor

```
#include <built_in.h>
unsigned int SomeInt1;
unsigned int a;
unsigned int time;
char text[15];
//unsigned int SomeInt2;

sbit LCD_RS at RB0_bit;
sbit LCD_EN at RB1_bit;
sbit LCD_D4 at RB4_bit;
sbit LCD_D5 at RB5_bit;
sbit LCD_D6 at RB6_bit;
sbit LCD_D7 at RB7_bit;

sbit LCD_RS_Direction at TRISB0_bit;
sbit LCD_EN_Direction at TRISB1_bit;
sbit LCD_D4_Direction at TRISB4_bit;
sbit LCD_D5_Direction at TRISB5_bit;
sbit LCD_D6_Direction at TRISB6_bit;
sbit LCD_D7_Direction at TRISB7_bit;



void main() {
```

```
UART1_Init(9600);
Lcd_Init();
Lcd_Cmd(_LCD_CLEAR);
Lcd_Cmd(_LCD_CURSOR_OFF);
TRISD = 0b0000001;
T1CON = 0x10;

while(1)
 {
   TMR1H = 0;
   TMR1L = 0;

   while(!PORTD.F0);
   T1CON.F0 = 1;
   while(PORTD.F0);
   T1CON.F0 = 0;

  a = (TMR1L | (TMR1H<<8));
  time= (200*a)/1000;
  SomeInt1=time;
  UART1_Write(Lo(SomeInt1));
  IntToStr(time,text);
  //UART1_Write(Hi(SomeInt1));
  Lcd_Out(1,1, "Time:");
  Lcd_Out(1,7,text);
  delay_ms(100);
  }
}
```

13.9 Appendix I: Code for Ultrasonic sensor

```
//int a=500;
#include <built_in.h>
unsigned int SomeInt1;
//unsigned int SomeInt2;
```

```
void main() {
UART1_Init(9600);
delay_ms(10);
TRISD = 0b00000010;
T1CON = 0x10;              //Initialize Timer Module
while(1)
 {
   TMR1H = 0;              //Sets the Initial Value of Timer
   TMR1L = 0;              //Sets the Initial Value of Timer

   PORTD.F0 = 1;           //TRIGGER HIGH
   Delay_us(10);           //10uS Delay
   PORTD.F0 = 0;           //TRIGGER LOW

   while(!PORTD.F1);       //Waiting for Echo
   T1CON.F0 = 1;           //Timer Starts
   while(PORTD.F1);        //Waiting for Echo goes LOW
   T1CON.F0 = 0;           //Timer Stops

   a = (TMR1L | (TMR1H<<8));  //Reads Timer Value
   a = a/58.82;            //Converts Time to Distance
   a = a + 1;              //Distance Calibration

  UART1_Write(a);
  SomeInt1=a;
  UART1_Write(Lo(SomeInt1));
  //UART1_Write(Hi(SomeInt1));
   delay_ms(100);
  }
}
```

13.10 Appendix J: Final PIC16f887A Code

//////////////////ultrasonic

```
int ultara;
char ultratext[10];

//////////////////////ACS712
unsigned long adcVoltage;
unsigned long sensitivity=100;
unsigned long offsetVoltage=0;
unsigned long currentValue;
unsigned int i;
char digit[]="0.000";
unsigned long x;

//////////////////////MQ-2
int gas_value;
char gasstext[10];

//////////////////////hall effect
#include <built_in.h>
unsigned int SomeInt1;
unsigned int a;
unsigned int time;
char halltext[15];

//////////////////////BPM
int RxBMP;
char btext[10];

// LCD module connections
sbit LCD_RS at RB0_bit;
```

```
sbit LCD_EN at RB1_bit;
sbit LCD_D4 at RB4_bit;
sbit LCD_D5 at RB5_bit;
sbit LCD_D6 at RB6_bit;
sbit LCD_D7 at RB7_bit;

sbit LCD_RS_Direction at TRISB0_bit;
sbit LCD_EN_Direction at TRISB1_bit;
sbit LCD_D4_Direction at TRISB4_bit;
sbit LCD_D5_Direction at TRISB5_bit;
sbit LCD_D6_Direction at TRISB6_bit;
sbit LCD_D7_Direction at TRISB7_bit;
// End LCD module connections


//DHT11

unsigned char Check;
unsigned char uniT=0,decT=0,uniHR=0,decHR=0;
unsigned char  T_byte1, T_byte2,RH_byte1, RH_byte2;
unsigned Sum;


sbit DataDHT      at    PORTA.B5;   //assigning pins for DHT11
sbit InDataDHT    at    TRISA.B5;

////////////////////////////////
void StartSignal()
{
```

```
 TRISA.F5 = 0;   //configuration of reciving data
 DataDHT = 0;
 delay_ms(18);
 DataDHT = 1;
 delay_us(30);
 TRISA.F5 = 1;
}
//////////////////////////////
void CheckResponse()
{
 Check = 0;                //checking respond from the DHT11 sensor
 delay_us(40);
 if(DataDHT == 0)
 {
  delay_us(80);
  if (DataDHT == 1)
  Check = 1;
  delay_us(40);
 }
}
//////////////////////////////
char ReadData()
{
 char i, j;
 for(j = 0; j < 8; j++)    //Reading data Array
 {
  while(!DataDHT);
  delay_us(30);
  if(DataDHT == 0)
```

```
    i&= ~(1<<(7 - j));
   else
   {
    i|= (1 << (7 - j));
    while(DataDHT);
   }
 }
 return i;
}

void dht11(){

UART1_Init(9600);
ADCON1=0x06;

Lcd_Init();
Lcd_Cmd(_LCD_CLEAR);
Lcd_Cmd(_LCD_CURSOR_OFF);



//while(1)
//{
 StartSignal();
 CheckResponse();
 if(Check == 1)
 {
  RH_byte1 = ReadData();
  RH_byte2 = ReadData();
  T_byte1 = ReadData();
```

```
  T_byte2 = ReadData();
  Sum = ReadData();

  if(Sum == ((RH_byte1+RH_byte2+T_byte1+T_byte2) & 0XFF))
  {
   decHR=RH_byte1/10;
   uniHR=RH_byte1%10;
   decT=T_byte1/10;
   uniT=T_byte1%10;

   decHR=decHR+0x30;
   uniHR=uniHR+0x30;
   decT=decT+0x30;
   uniT=uniT+0x30;

   Lcd_Out(1,1, "TEMP= ");
   Lcd_Chr(1,7, decT);
   Lcd_Chr(1,8, uniT);
   Lcd_Out_Cp(" oC");

   Lcd_Out(2,1, "HR= ");
   Lcd_Chr(2,7, decHR);
   Lcd_Chr(2,8, uniHR);
   Lcd_Out_Cp(" %");

  }
 }
 else
 {
```

```
  Lcd_Cmd(_LCD_CLEAR);
  Lcd_Out(1, 1, "error");
 }
   UART1_Write(RH_byte1);
   UART1_Write(T_byte1);
   Delay_ms(500);
 delay_ms(1000);
//}

}
//////////////////////////////

//////////////////////////////rain drop sensor

void rain() {
TRISD = 0b00001000;
UART1_Init(9600);
Lcd_Init(); // Initialize LCD
Lcd_Cmd(_LCD_CLEAR); // Clear display
Lcd_Cmd(_LCD_CURSOR_OFF); // Cursor off
Lcd_Out(1,1,"Rain sensor" ); // Write text in first
delay_ms(2000);
Lcd_Cmd(_LCD_CLEAR); // Clear display

//while(1){
if(PORTD.F3 == 1)
{
Lcd_Out(1,1,"Not Raining");
delay_ms(2000);
```

```
Lcd_Cmd(_LCD_CLEAR);
Lcd_Cmd(_LCD_CURSOR_OFF);
}
else
{
Lcd_Out(1,1,"Raining");
delay_ms(2000);
Lcd_Cmd(_LCD_CLEAR);
Lcd_Cmd(_LCD_CURSOR_OFF);
}
//}
}
////////////////////////////////////

////////////////////////////////////ultrasonic

void ultrasonic() {
UART1_Init(9600);
delay_ms(10);
Lcd_Init(); // Initialize LCD
Lcd_Cmd(_LCD_CLEAR); // Clear display
Lcd_Cmd(_LCD_CURSOR_OFF); // Cursor off
delay_ms(2000);
TRISD = 0b10000000;
T1CON = 0x10;              //Initialize Timer Module

   TMR1H = 0;              //Sets the Initial Value of Timer
   TMR1L = 0;              //Sets the Initial Value of Timer
```

```
   PORTD.F6 = 1;            //TRIGGER HIGH
   Delay_us(10);           //10uS Delay
   PORTD.F6 = 0;            //TRIGGER LOW

   while(!PORTD.F7);        //Waiting for Echo
   T1CON.F0 = 1;           //Timer Starts
   while(PORTD.F7);         //Waiting for Echo goes LOW
   T1CON.F0 = 0;           //Timer Stops

   ultara = (TMR1L | (TMR1H<<8));   //Reads Timer Value
   ultara = ultara/58.82;             //Converts Time to Distance
   ultara = ultara/2;               //Distance Calibration

  UART1_Write(ultara);
  //SomeInt1=ultara;
  //UART1_Write(Lo(SomeInt1));
  //UART1_Write(Hi(SomeInt1));
  delay_ms(100);
  Lcd_Out(1,1, "Distance(cm)" );
  intToStr(ultara,ultratext);
  Lcd_Out(2,1,ultratext);
  delay_ms(1000);

}

////////////////////////////////ACS712

void ACS712() {
```

```
//TRISA=0xFF;
ADCON0=0x01;
ADCON1=0x0E;
UART1_Init(9600);
Lcd_Init();                    // Initialize LCD

Lcd_Cmd(_LCD_CLEAR);           // Clear display
Lcd_Cmd(_LCD_CURSOR_OFF);      // Cursor off
LCD_Out(1,1,"Current Sensor");
Delay_ms(1000);

   adcVoltage = ADC_Read(0);   // Get 10-bit results of AD conversion
   adcVoltage=adcVoltage*5000/1023;   //Convert ADC value to mV
   currentValue = ((adcVoltage - offsetVoltage) / sensitivity);



   digit[0]=(currentValue/1000)+48;
   digit[2]=((currentValue%1000)/100)+48;
   digit[3]=(((currentValue%1000)%100)/10)+48;
   digit[4]=(((currentValue%1000)%100)%10)+48;
   //LongToStr(currentValue,digit);
   LCD_Cmd(_LCD_CLEAR);
   LCD_Out(1,1,"Current(mA)");
   LCD_Out(2,1,digit);

  // x = xtoi(currentValue)*10000;
   UART1_Write(currentValue);
   Delay_ms(500);
```

```
}

////////////////////////////////////////////// MQ-2
void gas()
{

ADC_Init(); //
Lcd_Init(); // Initialize LCD
Lcd_Cmd(_LCD_CLEAR); // Clear display
Lcd_Cmd(_LCD_CURSOR_OFF); // Cursor off
Lcd_Out(1,1,"MQ-2 sensor" );
delay_ms(2000);
Lcd_Cmd(_LCD_CLEAR); // Clear display

//while(1)
//{

gas_value = ADC_Read(0); // It will read the gas value of sensor
if( gas_value > 400 )
Lcd_Out(1,1, "Gas detected" );
else
Lcd_Out(1,4, "No Gas " );
intToStr(gas_value, Ltrim(gasstext));
Lcd_Out(2,1,gasstext);
UART1_Write(gas_value);
delay_ms(1000);
}
```

```
//////////////////////////////////////////hall effect sensor
void hall() {

UART1_Init(9600);
Lcd_Init();
Lcd_Cmd(_LCD_CLEAR);
Lcd_Cmd(_LCD_CURSOR_OFF);
TRISD = 0b0000011;
T1CON = 0x10;               //Initialize Timer Module

//while(1)
 //{
 if (PORTD.F1==1){
   TMR1H = 0;               //Sets the Initial Value of Timer
   TMR1L = 0;

   while(!PORTD.F0);         //Waiting for Edge a toggle
   T1CON.F0 = 1;             //Timer Starts
   while(PORTD.F0);          //Waiting for Edge a togle again
   T1CON.F0 = 0;             //Timer Stops

  a = (TMR1L | (TMR1H<<8));   //Reads Timer Value
  time= (200*a)/1000;
  SomeInt1=time;
  UART1_Write(Lo(SomeInt1));
  IntToStr(time,halltext);
  //UART1_Write(Hi(SomeInt1));
  Lcd_Out(1,1, "Speed:");
  Lcd_Out(1,7,halltext);
```

```
  delay_ms(100);
 // }
 }
}
//////////////////////////////////////Heart rate Sensor
void BPM(){

UART1_Init(9600);
Lcd_Init();
Lcd_Cmd(_LCD_CLEAR);
Lcd_Cmd(_LCD_CURSOR_OFF);
//while(1){
if (UART1_Data_Ready() ==1) {    // Serial read(BPM value) from nodeMCU
 RxBMP = UART1_Read();
 }
 //SomeInt1= receive;
 intToStr(RxBMP,btext);
 Lcd_Out(1,1, "Heart Rate:");
 Lcd_Out(2,1,btext);
//}

}

void main() {
 while(1){
 dht11();
 rain();
 ultrasonic();
 ACS712();
```

```
 gas();
 hall();
 BPM();
 }
}
```

13.11 Appendix K: Code for nodeMCU

```
#include <ESP8266WiFi.h>     //thingspeak
#include "ThingSpeak.h"
#include <SoftwareSerial.h>

const char* ssid="Madusha";
const char* password="madusha12345";

unsigned long myChannelNumber =1001400;
const char* myWriteAPIkey="6Q72P02Q5GEMHBF0";// thingspeak
const char* myReadAPIkey="EMNYDVST5A5I70FU"; //thingspeak

unsigned long myChannelNumber1 =1091314;
const char* myWriteAPIkey1="WLJOQ05IKWD5OYQN";// thingspeak
const char* myReadAPIkey1="JDGBVK55N9MRYTGG"; //thingspeak
//////////////////////////////////////////////////////////////////

//////////////////////////////////////////////////////////////////
WiFiClient client;
SoftwareSerial s(4,5);
SoftwareSerial sim(7,8);
//////////////////////////////////////////////////////////////////
#include <Wire.h>

//Heart rate sensor initiation
#define USE_ARDUINO_INTERRUPTS true    // Set-up low-level interrupts for most acurate BPM math.
#include <PulseSensorPlayground.h>     // Includes the PulseSensorPlayground Library.
```

```
const int PulseWire = 0;       // PulseSensor PURPLE WIRE connected to ANALOG PIN 0
int Threshold = 550;           // Determine which Signal to "count as a beat" and which to ignore.
                               // Use the "Gettting Started Project" to fine-tune Threshold Value beyond default setting.
                               // Otherwise leave the default "550" value.

PulseSensorPlayground pulseSensor;  // Creates an instance of the PulseSensorPlayground object called "pulseSensor"
//////////////////////////////////////////////////////////////////////////
////////////Blynk app
#define BLYNK_PRINT Serial // Enables Serial Monitor
#include <SPI.h>
#include <Ethernet.h>
#include <BlynkSimpleEthernet.h>
char auth[] = "JnpEiz2ouz30e74NB0ZbQvxZgYhcs598";


float MQ;  // Assigning variables
float ACS;
float wlevel;
float DHT11;
float tem;
float humidity;
float power;
float Device1;
float Device2;
float Device3;
float Device4;
float rpm;


void setup() {
Serial.begin(115200);
```

```
s.begin(115200);
WiFi.begin(ssid,password);
Blynk.begin(auth);

 while(!Serial) continue;

 while( WiFi.status() != WL_CONNECTED)
 {
  delay(500);
  Serial.println("connecting.....");
 }

  Serial.println("WiFi is connected");
  ThingSpeak.begin(client);  //thingspeak
}

void loop() {

 if (Serial.available()){
  MQ =Serial.read();
  Serial.print("MQ:");
  Serial.println(MQ);
 }
 if (Serial.available()){
  Serial.print("ACS:");
   ACS =Serial.read();
  Serial.println(ACS);
 }
 if (Serial.available()){
  wlevel =Serial.read();
  Serial.print("wlevel:");
  Serial.println(wlevel);
 }
```

```
 if (Serial.available()){
  Serial.print("DHT11:");
  DHT11 =Serial.read();
  Serial.println(DHT11);
 }
 if (Serial.available()){
  humidity =Serial.read();
  Serial.print("humidity:");
  Serial.println(humidity);
 }
 if (Serial.available()){
  power =Serial.read();
  Serial.print("power:");
  Serial.println(power);
 }
  if (Serial.available()){
  rpm =Serial.read();
  Serial.print("rpm:");
  Serial.println(rpm);
 }

 BPM();
 blyk();
 tothingspeak();
 tothingspeak1();
 SendMessage();

}


void tothingspeak(){  //For channel1
 ThingSpeak.setField(1,MQ);
```

```
  ThingSpeak.setField(2,ACS);

  ThingSpeak.setField(3,PulseWire);

  ThingSpeak.setField(4,humidity);

  ThingSpeak.setField(5,power);

  ThingSpeak.setField(6,Device1);

  ThingSpeak.setField(7,Device2);

  ThingSpeak.setField(8,Device3);

  ThingSpeak.writeFields(myChannelNumber,myWriteAPIkey);


}
 ////////////////////////////////////////////////////////
void tothingspeak1(){ //For channel2
  ThingSpeak.setField(1,Device4);

  ThingSpeak.setField(2,PulseWire);

  ThingSpeak.setField(3,rpm);

  ThingSpeak.writeFields(myChannelNumber1,myWriteAPIkey1);
}

void BPM() {

  Serial.begin(9600);         // For Serial Monitor
```

```
 // Configure the PulseSensor object, by assigning our variables to it.
 pulseSensor.analogInput(PulseWire);
 pulseSensor.setThreshold(Threshold);

 // Double-check the "pulseSensor" object was created and "began" seeing a signal.
  if (pulseSensor.begin()) {
   Serial.println("We created a pulseSensor Object !");  //This prints one time at Arduino power-up,  or on Arduino reset.
   s.print(PulseWire);
 }
}

void blyk()
{
 // All the Blynk process happens here...
 Blynk.run();
 if (D0 == 1){
   Device1 = 1;
 if (D1 == 1){
   Device2 = 1;
 if (D2 == 1){
   Device3 = 1;
 if (D3 == 1){
   Device4 = 1;
 }
 }
 }
 }
 else{
   Device1 = 0;
   Device2 = 0;
   Device3 = 0;
   Device4 = 0;
 }
```

```
}

void SendMessage()
{
  String dataMessage = ("Temperature: " + String(temp) + "*C " + " Humidity: " + String(himudity) +
"BPM: " + String(bpm)  + " windspeed: " + String(rpm) + "Water Level:" + String(wlevel)"%");

 //if (Serial.available()>0){
 //char a = Serial.read();
 if (D6 == 1){  // if GSM Switch is on
   Serial.println("AT+CMGF=1");
   sim.println("AT+CMGF=1");
  delay(1000);
  Serial.println("AT+CMGS=\"+94779408269\"\r");
  sim.println("AT+CMGS=\"+94779408269\"\r");
  delay(1000);
  sim.println(dataMessage);
  delay(1000);
  Serial.println((char)26);
  sim.println((char)26);
  delay(1000);
 }
}
```

13.12 Appendix L: Code for MATLAB face recognition

- Code to take user images,

```
%web cam
camList = webcamlist;
cam=webcam;

for i=1:6
    img =snapshot(cam);
    subplot(2,3,i)
    image(img);
```

```
            pause(2); %Delay between different screenshots
            img_wg= getFace(img,1);

            %Saving Reshaped Compressed Image of User
            if i==1
                TMP1=img_wg;
            elseif i==2
                TMP2=img_wg;
            elseif i==3
                TMP3=img_wg;
            elseif i==4
                TMP4=img_wg;
            elseif i==5
                TMP5=img_wg;
            end
        end
        user_images=[TMP1 TMP2 TMP3 TMP4 TMP5]; %Collect all in one
matrix
        save user.mat user_images
        load ('user.mat')
        delete(cam);
```

- code for face detection

```
function faceimage= getFace(img,contrast)
faceimage=rgb2gray(img); % make it gray scale
%Detect the face
faceDetector = vision.CascadeObjectDetector;
for i=1:2:50
    set(faceDetector,'MergeThreshold',i)
    bboxes=step(faceDetector,faceimage);
    if size(bboxes,1)==1
        break;
    end
end

faceimage=imcrop(faceimage,bboxes);
figure(2)
imshow(faceimage)
if contrast
    faceimage = imadjust(faceimage);
end

%Prepare img for password check

faceimage=imresize(faceimage,[16,16],'nearest'); %Resizing the
Image to be 16x16 pixels.
faceimage=im2double(faceimage); %Converting Image Data to
Double(Required to DCT function).
Time = dctmtx(8);
```

```
dct = @(block_struct) Time * block_struct.data * Time';
Box = blockproc(faceimage,[8 8],dct);
mask = [1,1,1,1,0,0,0,0;
        1,1,1,0,0,0,0,0;
        1,1,0,0,0,0,0,0;
        1,0,0,0,0,0,0,0;
        0,0,0,0,0,0,0,0;
        0,0,0,0,0,0,0,0;
        0,0,0,0,0,0,0,0;
        0,0,0,0,0,0,0,0];
Box = blockproc(Box,[8 8],@(block_struct) mask .*
block_struct.data);
inversedct = @(block_struct) Time' * block_struct.data * Time;
faceimage = blockproc(Box,[8 8],inversedct);
faceimage=reshape(faceimage,256,1);
```

- code for neural network

```
function nn
%web cam
camList = webcamlist;
cam=webcam;
preview(cam);
%take a picture
frame =snapshot(cam);
figure(1);
image(frame)
FACE=getFace(frame,1);
load user
net = selforgmap([16 16]);
net.trainParam.epochs=1000;
[net,~] = train(net,user_images);
sx=net(user_images);
[~,m]=size(sx);
for u=1:1:m
    sm(u)=find(sx(:,u));
end
initial_result=sim(net,FACE);
final_result=find(initial_result);

temp=find((sm - final_result)==min(abs((sm-final_result))))
if isempty(temp)
    say('Sorry, I do not know you');
    channelID = 811395;
```

```
thingSpeakWrite(channelID,'Fields',[5],'Values',{50},'WriteKey','AE9YB
CK1NHDTQJS0','Timeout',5)

       elseif (temp > 0) && (temp <= 5)
           say('Welcome MADUSHA How are you today?');
           channelID = 811395;

thingSpeakWrite(channelID,'Fields',[5],'Values',{100},'WriteKey','AE9Y
BCK1NHDTQJS0','Timeout',5)
       end
```

- code for control GUI

```
classdef con3 < matlab.apps.AppBase
    % Properties that correspond to app components
    properties (Access = public)
        UIFigure      matlab.ui.Figure
        SwitchLabel   matlab.ui.control.Label
        Switch        matlab.ui.control.ToggleSwitch
        Switch2Label  matlab.ui.control.Label
        Switch2       matlab.ui.control.ToggleSwitch
    end
    methods (Access = private)
        function SwitchValueChanged(app, event)
            value = app.Switch.Value;
            channelID = 811395;
            if strcmp(value,'On')

thingSpeakWrite(channelID,'Fields',[6],'Values',{1},'WriteKey','AE9YBCK1NH
DTQJS0','Timeout',5)
           else

thingSpeakWrite(channelID,'Fields',[6],'Values',{0},'WriteKey','AE9YBCK1NH
DTQJS0','Timeout',5)
           end
        end
        % Value changed function: Switch2
        function Switch2ValueChanged(app, event)
            value = app.Switch2.Value;
            channelID = 811395;
            if strcmp(value,'On')

thingSpeakWrite(channelID,'Fields',[7],'Values',{1},'WriteKey','AE9YBCK1NH
DTQJS0','Timeout',5)
           else
```

```
thingSpeakWrite(channelID,'Fields',[7],'Values',{0},'WriteKey','AE9YBCK1NH
DTQJS0','Timeout',5)
            end
        end
    end
    % App initialization and construction
    methods (Access = private)
                function createComponents(app)
                        app.UIFigure = uifigure;
            app.UIFigure.Position = [100 100 640 480];
            app.UIFigure.Name = 'UI Figure';
            % Create SwitchLabel
            app.SwitchLabel = uilabel(app.UIFigure);
            app.SwitchLabel.HorizontalAlignment = 'center';
            app.SwitchLabel.Position = [185 179 41 22];
            app.SwitchLabel.Text = 'Switch';
            % Create Switch
            app.Switch = uiswitch(app.UIFigure, 'toggle');
            app.Switch.ValueChangedFcn = createCallbackFcn(app,
@SwitchValueChanged, true);
            app.Switch.Position = [195 237 20 45];
            % Create Switch2Label
            app.Switch2Label = uilabel(app.UIFigure);
            app.Switch2Label.HorizontalAlignment = 'center';
            app.Switch2Label.Position = [334 179 47 22];
            app.Switch2Label.Text = 'Switch2';
            % Create Switch2
            app.Switch2 = uiswitch(app.UIFigure, 'toggle');
            app.Switch2.ValueChangedFcn = createCallbackFcn(app,
@Switch2ValueChanged, true);
            app.Switch2.Position = [348 237 20 45];
        end
    end
    methods (Access = public)
                function app = con3
                        createComponents(app)
                        registerApp(app, app.UIFigure)
            if nargout == 0
                clear app
            end
        end
                function delete(app)

        end
    end
end
```

Student Declaration:

I certify that I have not plagiarized the work of others or participated in unauthorized collusion when preparing this assignment.

I am aware that I may be required to resubmit this assignment for review or for re-assessment even after it has been assessed and returned to me.

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