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Thingspeak Based Sensing and Monitoring System for IoT with Matlab Analysis

Sharmad Pasha

***Abstract*— As the expeditious of Internet of Things (IoT) is emerging and is accustom for remote monitoring of the surrounding parameters and other stuffs with the use of sensors that acquaint for wireless sensing of real time data and transfer them into the desired form and help to forward the sensed data across the network cloud via 'Internet Connection'. Here the project work deals with The IoT 'Thingspeak' web service which is a generous open API service that act as a host for the variety of sensors to monitor the sensed data at cloud level and composite a special feature of porting the sensed data to the MATLAB R2016a using a channel ID and read API key that is assigned by services and able to track data value at picky sample at particular intervals. This project also uses an Arduino UNO board, ESP8266 Wi-Fi Module that helps to process and transfer the sensed data to the Thingspeak Cloud.**

***Index Terms*—Arduino ESP8266, Arduino UNO, Channel ID, Matlab R2016a, API Key, Thingspeak IoT cloud.**

I. INTRODUCTION

Today, the increased demand of service over the internet necessitated the data collection and exchange in efficient manner. In this sense internet of things (IoT) had promised the ability to provide the efficient data storage and exchange by connecting the physical devices and vehicles via electronic sensors and internet. Thus, in order to achieve the efficient IoT accomplishment for an application; the proper sensing and monitoring system are essential. Generally a sensing unit is composed of different sensors like temperature, humidity, gas etc.; while a monitoring unit composed of current and voltage parameters. The IoT has created a revolution all over the world and fascinatingly it has become integral part of our lives [01]. The day has arrived that the government sectors are also espouse the IoT because of its gigantic significance in each and every area [02]. In 2000, only RFID tags were used to categorize the object and routing. And later the idea of security, surveillance, transport supervision and healthcare are arrived. The present situation is that we can easily locate the every object and peoples. This technology advancement can create more job scopes and research ideas. It is been predicted that by 2020, the computers can perform like humans to manage the things. The complexity in sensors and connection of many sensors in a system has enhanced the data measurement, analysis and also data aggregation in localized level. Sinha et al. [03] proposed model comprises of detecting units which sees the ecological quality, (for example, Humidity, temperature, heat list, gas, and so on), voltage and current parameters of the different family unit machines for observing the measure of force devoured. And a controlled framework yielded the amassed information by using Xively IoT web service (Now provides trail version).

Sharmad Pasha, Department of Electronics and Communication, S.E.A College of Engineering and Technology, Bengaluru, India.

A. Thingspeak: A IoT web Service

Thingspeak is a web based open API IoT source information platform [04, 05, 06] that comprehensive in storing the sensor data of varied 'IoT applications' and conspire the sensed data output in graphical form at the web level. Thingspeak communicate with the help of internet connection which acts as a 'data packet 'carrier between the connected 'things' and the Thingspeak cloud retrieve, save/store, analyze, observe and work on the sensed data from the connected sensor to the host microcontroller such as 'Arduino, TI CC3200 module, Raspberry-pi etc. The Thingspeak helps to form a captivate sensor based logging applications, location/place tracing application and 'social network' of objects/things with updated status and alternatively we can have a control over 'Home automation' products that were connected to the public domain network (via Internet) from the location of existence and The most primary feature of Thingspeak functionality is the term 'Channel' that have field for data, field for location, field for status for varied sensed data. Once channels are created in the 'Thingspeak' the data can be implemented and alternately one can process and visualize the information using the MATLAB and respond to the data with tweets and other forms of alerts. Thingspeak also provide a feature to create a public based channel to analyze and estimate it through public. To Engage the 'Things/objects' in sensing the respective data and transmitting across the Internet and one involves to go further just connecting data from a PC, objects to collect (sensors)And to do so the data require to network uploaded that are in the form of servers (that runs applications) and such types are considered as Cloud .The 'Cloud' utilizes the operations of Graphical visualization and available in the form of Virtual server for the users and the objects are communicated with the cloud via possible 'wireless internet connections' available to the users and majority objects uses the sensors/actuator to tell regarding our environmental analogue data. The IoT Helps to bring all things together and permits us to communicate with our very own things and even more curiously allows objects/things to interact with other 'things'.

B. Arduino UNO Board: A Data processing Board

The Arduino expansion was emerged in 'Italy' to build up low cost hardware for communication design [07]. This Arduino Uno is an excellent choice for any IoT Application design and, one can except and carve programs according to the needs and able to form interface type circuits to interpret switches and added sensors, Arduino based microcontrollers tenders flexibility and prevails 'one board computer' that endow with an effective way for coding and circuit interface, creating to comprehend switches and diverse type of sensors and to manage the operational of motors and the lights with

Fewer efforts and the below Fig 1 shows the Arduino UNO that encloses 'ATmega328' and bestows a serial communication. Arduino UNO has an internal Boot loader

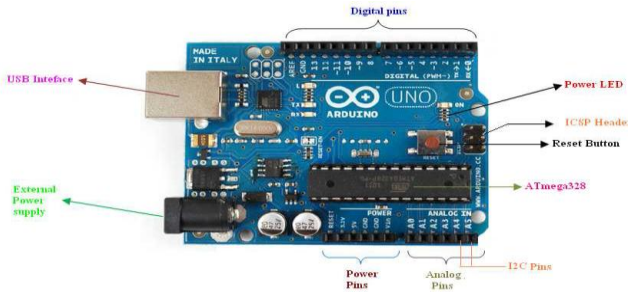


Fig 1: Arduino UNO Board

That permits uploading of most recent code devoid of using any type of exterior hardware programmer. The Coding is done by means of Arduino coding/programming language (APL) that tenders 'wiring' and the Arduino development environment (ADE) that tenders 'processing'. Users Entails to connect microcontroller [08] to a 'computer' with a USB cable or peripheral 'AC to DC' power adapter or to a 'battery power' that help to trigger the Uno task and it depart from all previous boards where no use of 'FTDI' USB to serial driver Chip is established

C. Arduino ESP8266: A Wi-Fi Module for IoT

The ESP8266 provides an absolute and self-reliant Wi-Fi networking resolution and permit it to either host the function or to divest every Wi-Fi networking function [09] from a supplementary application processor. As soon as ESP8266 hosts the function, it is the only 'application processor' in the device, it boot up straight-away from an External flash.

Fig 2: Arduino ESP8266 Wi-Fi Module

It encompasses an incorporated 'cache' to advance the functionality of the system alternately, portioning as a Wi-Fi Adapter, wireless internet admittance can be supplemented to any microcontroller platform design with effortless-connectivity via 'U A R T interface'. The above Fig 2 shows the Arduino ESP8266 Module

II. SENSORS USED FOR IOT

The Project uses a Five different kinds of sensors to implement the IoT Operation for sensing and monitoring the Heat, humidity, Temperature, Light intensity, Rain sensing, Air quality, Barometric pressure and sea level pressure of the surroundings and they are as follows:

A. D H T-22 Sensor

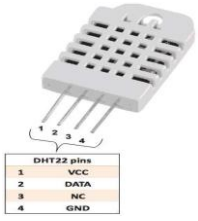


Fig 3: A DHT-22 Sensor

Fig 3 Shows the DHT-22 sensor which is a digital Humidity and Temperature [10] sensor used sense the real time Temperature, Humidity, Heat of the present location.

B. Light Dependent Resistor (L D R) Sensor

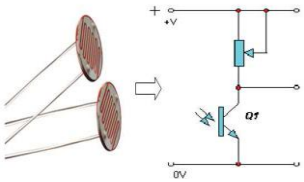
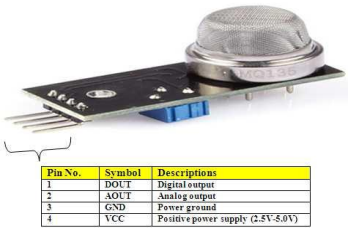


Fig 4: A Typical L D R Sensor

The above Fig 4 shows the Light sensor that used to sense the Light intensity [11] of the present location through the resistor variation depending on the light strength i.e if higher light then less resistivity and vice versa.

C. MQ-135 Air Quality Sensor



Pin No.	Symbol	Descriptions
1	DOUT	Digital output
2	AOUT	Analog output
3	GND	Power ground
4	VCC	Positive power supply (2.5V-5.0V)

Fig 5: A Typical M Q-135 Sensor

The Above Fig 5 Shows the air quality sensor that is used to sense the quality [12] of air when leaked from gas lighter ignition and non-ignition of flame. A gas such as Ammonia,-Sulfide and Benzene are detected by MQ-135 very effectively and also senses smoke and other injurious gases.

D. FC-37 Rain Sensor

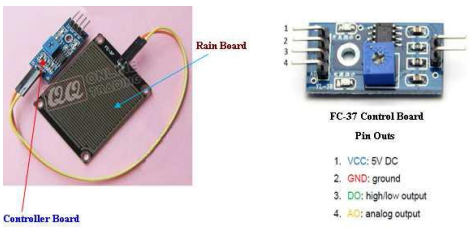


Fig 6: A FC-37 Rain Sensor

Above Fig 6 shows the rain sensor that is used to sense the rain drop intensity when fallen on the rain board i.e. in presence of rain drop the intensity decrease [13] when compare to no rain drop.

E. B M P-180 Sensor

Fig 7: A BMP-180 Sensor

The Above Fig 7 shows a barometric Pressure sensor that helps to detect the Barometric pressure [14] and sea level Air pressure at an Altitude of 950.0m

III. PROPOSED MODEL AND HARDWARE SETUP

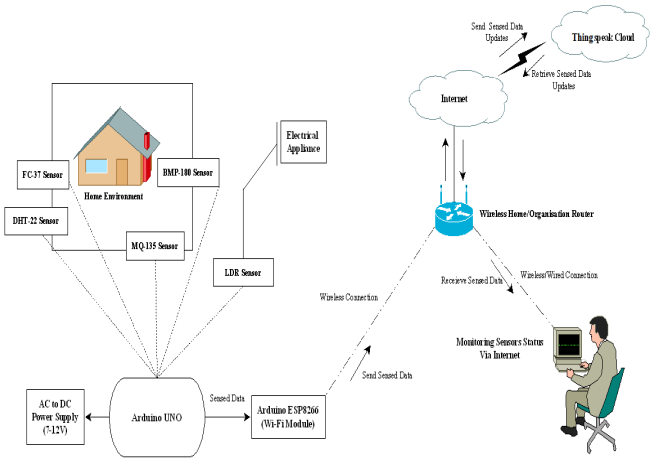


Fig 8: A Proposed model

The Above Fig 8 Shows the proposed model for Thingspeak based Sensing and Monitoring system where the model exhibit all the sensors and internet cloud, Thingspeak cloud are interfaced with one another using the arduino IDE software-platform.

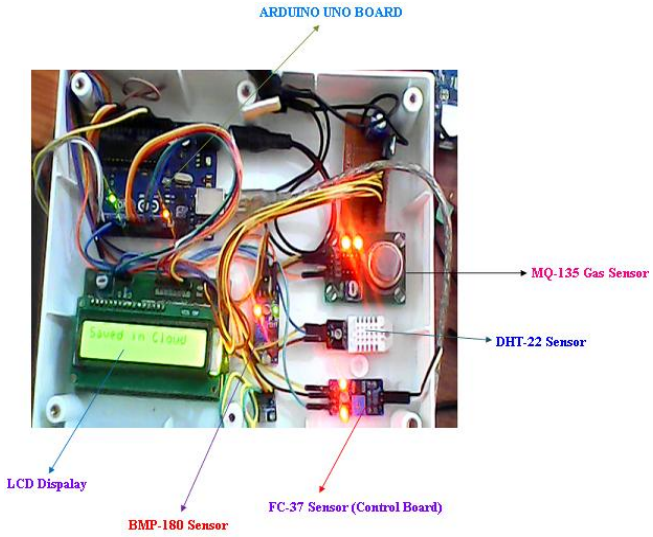


Fig 9: A Hardware Setup

Above Fig 9 shows the hardware support for the above proposed model and below Fig 10 shows the Component Block Connections for the Hardware setup.

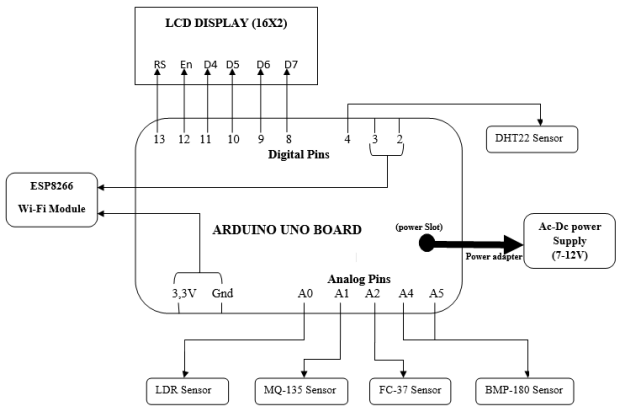


Fig 10: Component Block Connections

IV. SOFTWARE USED

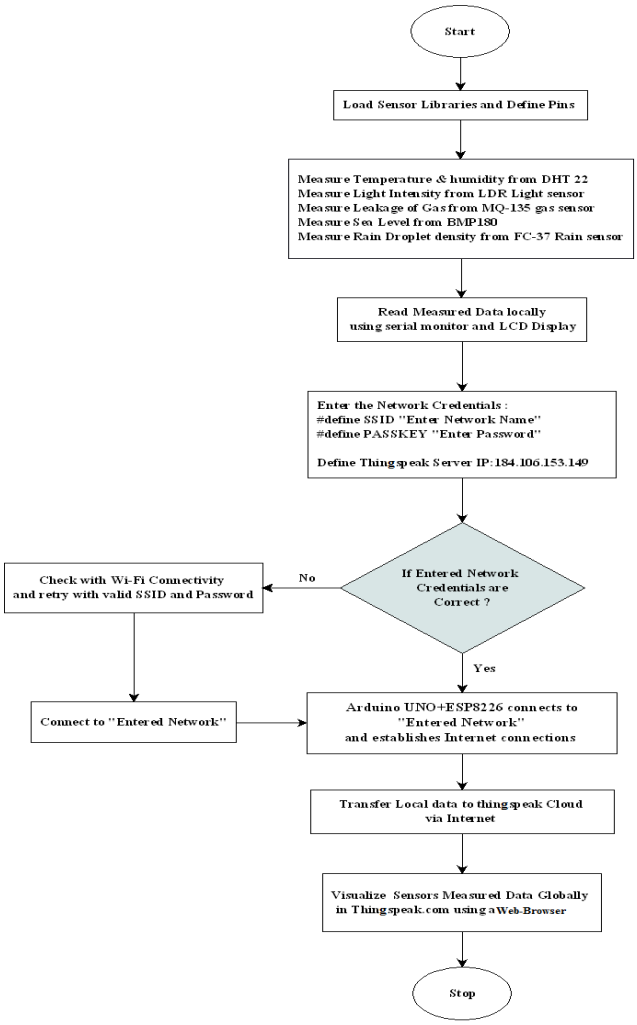
A. *Arduino IDE Software*

The Arduino IDE is integrated development software present for arduino device and helps to code the Arduino microcontrollers to interface the sensors and other type of components and perform the operation on both local and global domain with the help of library functions.

B. *Matlab R2016a*

The Matlab R2016a is a recent release from the Mathworks and is a new opportunity to offer reliability for the IoT projects and presently Thingspeak is the only IoT web service that offers the data analysis on the Matlab platform as open source with full profile access and a thorough analyzing is possible as per need of the project implementation in the respected areas such as hospitals, oil gas industries etc.

V. SENSING AND MONITOING OPERATION FLOW

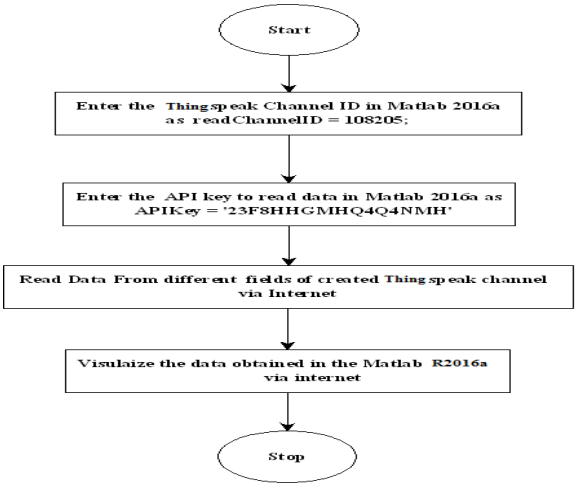


Flowchart 1: Thingspeak Based Sensing-Monitoring System process Flowchart for IoT

Step.1 Load sensor libraries in Arduino IDE Software

Step.2 Execute the program and visualize sensed data on a LCD

Step.3 Enter the Network credentials in IDE and execute the program one more time and visualize the output in Thingspeak cloud.



Flowchart 2: Matlab process flow chart to demonstrate the IoT sensor data analysis

The Above Flow chart shows the data analysis in the Matlab R2016a.once the data is visualized in the Thingspeak next step is to analyze the sensed in the Matlab R2016a and for this we need to have a Thingspeak supporting toolbox that facilitates to port the sensed data from the Thingspeak cloud and after installing the toolbox then we need to code using Matlab such that it can successfully get the data from the cloud and we use a channel ID and API key to help for reading and collecting the data from the cloud. The below Fig 11 highlights the unique Thingspeak channel ID and Read API key which is used in this project.

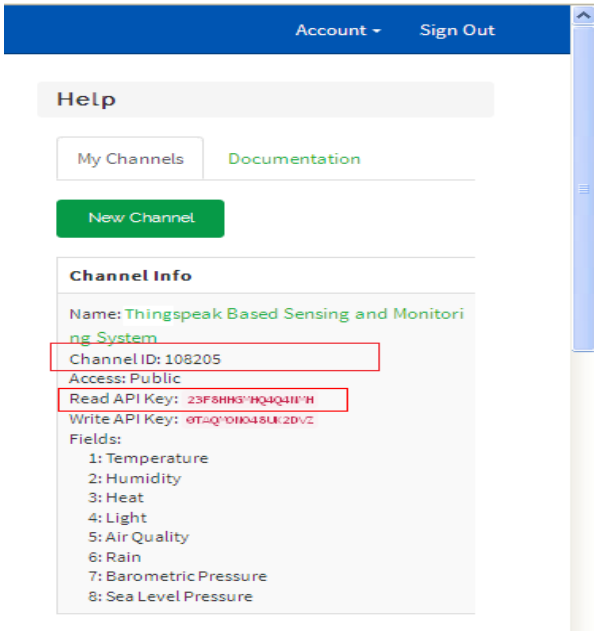


Fig 11: Channel ID and API Key used in Matlab Analysis

Step.1 Enter the Channel ID and API key with the following Matlab Syntax to read Channel ID and API Key as below:

- readChannelID=108205
- readAPIKey=23F8HHGMHQ4Q4NMH

Step.2 Run Matlab code and the code starts reading the channel ID and API key and the sensed data in the Matlab is ported into the Matlab R2016a as a graphical plot and can be discussed in the following results and discussion section.

VI. RESULTS AND DISCUSSION

Once the error free coding is established then the program gets executed and one can able to see the senor output on a Local platform such as LCD 16x2 display and later the local data is transferred to the Thingspeak Cloud via Internet and we can able to visualize it on global platform.

A. LCD Output Results

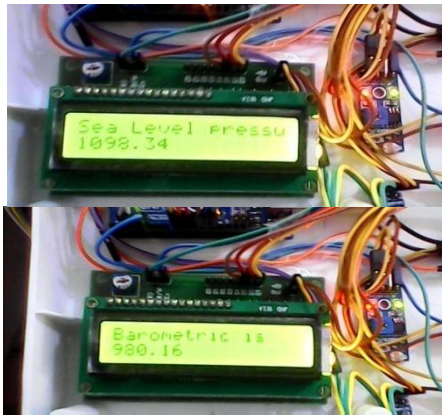


Fig 12: LCD Output results

The above Fig 12 shows the sample of LCD reading for the project and similar output format holds good for the other parameters such as Temperature, humidity, Heat, rain, Light, air quality and can be viewed on the LCD display.

B. Thingspeak IoT Output Results

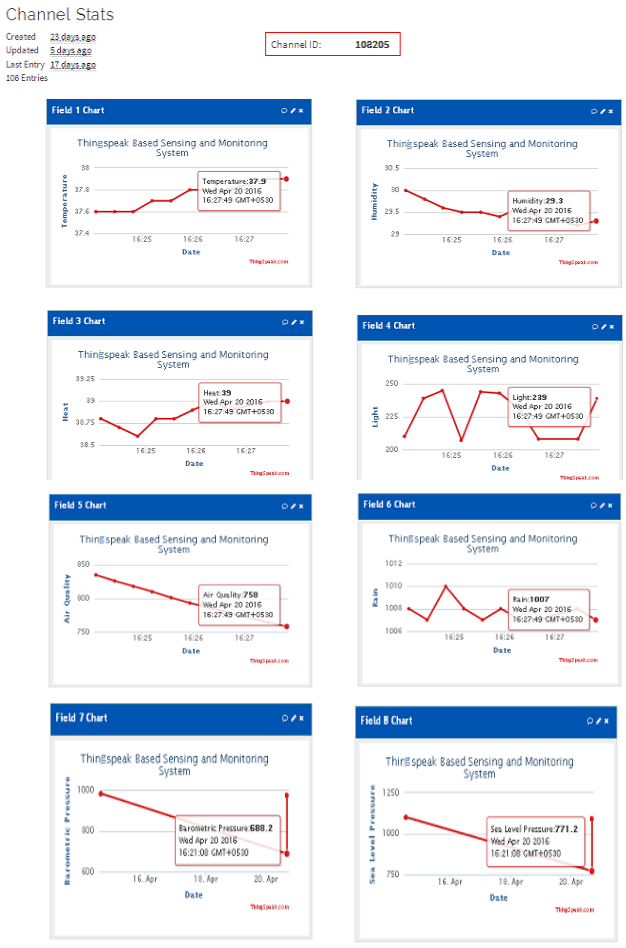


Fig 13: Thingspeak IoT Cloud Output results

The above Fig 13 shows the graphical output at the Thingspeak cloud and can be able to observe only after logging in the Thingspeak website with the help of created username and password and the cloud provides a reliable output.

C. Matlab R2016a IoT Output Results

When we obtained the channel ID and Read API key now ready to exploit the analysis of the IoT sensed in the Matlab R2016a and for this we need to follow the procedure that is earlier discussed in the section of sensing and monitoring operation for Matlab Process and the below Fig 14 shows the Matlab R2016a output. Here we can see the sub plots for different IoT sensed data.

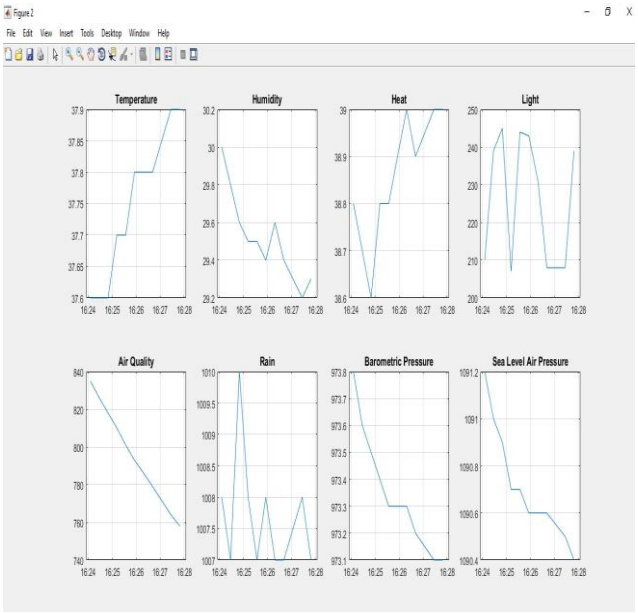


Fig 14: Matlab R2016a Output results

VII. CONCLUSION

The Internet of Things facilitates a numerous benefits to the society and from our project we can provide and prove the strength of IoT using the Thingspeak API that is capable to contribute the services for the purpose of building vast number of IoT applications and help to implement them on the public platform.This Design Provide an Moderate and less expensive way of Sensing and Monitoring system in the field of Domestic and as well industrial standards to implement the IoT.The future of MATLAB in Thingspeak and vice versa provides an even deep study and analysis of sensed data at an critical level that is to manage the surrounding environment where the parameters are important to measure.

At an final note we conclude that Microcontrollers will get minimize and vanish into the environment, and IoT Leads to become everywhere and universal and in every prospect and the Thingspeak IoT Web service is definitely a fascinating web based technology that encompasses the ability to form the expectations of the engineers.

VIII. ACKNOWLEDGMENT

I am greatly indebted to our guide Dr. N.J Krishna Kumar Professor, Department of Electronics and Communication, S.E.A.C.E.T Bengaluru for his valuable suggestions, guidance, moral support and encouragement in completion of this project successfully. I have been fortune for having his precious help.

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Sharmad Pasha
M.Tech final Semester Student, In Digital Communication and Networking from 2014-2016 in SEA College of Engineering and Technology Bengaluru, having completed B.E in Electronics and Communications in 2011 from Alpha College of Engineering and Technology, Bengaluru and In pursuit of professional career, Worked as an IT Support Engineer in companies such as CMS, IBM, HCM and posses 1.5 years experience in related field, As per VTU M.Tech academics, have been industrially trained for 4 months in IoT Technology during the year 2015 at RTST Pvt Ltd Bengaluru.