



An IoT Based Real-Time Weather Monitoring System Using Raspberry Pi

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ABSTRACT: This paper presents the real-time monitoring of different environmental parameters using IoT at low-cost. For this purpose we have used ARM based Raspberry Pi board. Raspbian operating system is selected to use with Linux kernel for Raspberry Pi. Python language is used for programming because IDLE understand Python. IDLE is the text editor in Raspbian. In this system some digital as well as analogue sensors like DHT11, BMP180, LDR and marked scale with ULN2803 are used for environmental parameter measuring. This data from input sensors is then read by server that is Raspberry Pi itself and stored in CSV as well as text files. Client can access this real-time data from anywhere in the world on thingspeak.com. For networking of server with client HTTP protocol is used.

KEYWORDS: Raspberry Pi, ARM, Sensors, Raspbian, SPI, I2C, IoT, HTTP

I. INTRODUCTION

Many things affect the weather. And weather also have affect on most of living as well as non-living things. At Weather station study of different environmental parameters using some instruments and equipments has been done. So to meet the goal of weather monitoring we have designed IoT based real-time, low-cost, portable and high speed weather station using Raspberry Pi. At our weather station we are measuring some environmental parameters like temperature, humidity, light intensity, rain water level, pressure and altitude. GSM module, ZigBee module, Ethernet module along with ADC and microcontroller are used by many weather monitoring system for environmental parameters monitoring. ARM based Raspberry Pi board can handle many operations and same one is used in this system. In this system there is no need of any external module, microcontroller and ADC. The proposed system uses IDLE text editor where programs can be written in Python. Output data can be seen on thingspeak.com using HTTP protocol.

IoT means Internet of Things. It provides inter-networking of physical devices, buildings, vehicles and other components like sensors and actuators. By giving network connectivity to systems embedded with electronics, software, sensors and actuators; these objects are able to collect and exchange data. By using IoT objects to be sensed or controlled remotely through existing network. It gives opportunity to connect physical world with computer-based systems. IoT improves efficiency, accuracy, economic benefits along with reduced manpower. IoT frameworks help for the interaction between “things”. Also supports for more complex structures like distributed computing and development of distributed applications. Now a days most of IoT frameworks seem to focus on real-time data logging solutions.

II. LITERATURE SURVEY

Arko Djajad et al. have presented their system for ambient environmental quality monitoring using IoT sensor network. In this system sensors are connected to Net Client via serial interfaces such as Modbus or I2C. Data collection is then sent to Fognet by TCP/IP. Data from all environmental sensors act as input to Arduino ATmega2560 board. This board needs Wi-Fi module to connect to Wi-Fi router. This result can be sent to the web-server to achieve online monitoring purpose. Result can be accessed by electronic devices such as laptop or hand phone as long as it is connected to internet. Sensors used are ambient light sensor, DHT11 for temperature and humidity sensor, sound sensor, sensor



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MG811 for carbon dioxide, sensor MQ7 for carbon monoxide, sensor MQ6 for LPG and sensor MQ3 for alcohol. All environmental sensors used are analog sensors. Hence, these sensors can be connected to analog pin of Arduino. In this research two communications are used, Serial0 for communication between Arduino and PC, and Serial1 for communication between Arduino and ESP8266. The Wi-Fi connection allows for data transmission from the Arduino node directly to web servers using standard HTTP protocol. They can be local servers or global external servers, such as free IoT server thingspeak.com in this case. Outputs can be seen in graphical form. [2]

Tamilarasi B. et al. have proposed the system that deals with the functional design and implementation of WSN platform, which can be used for long-term environmental monitoring in IoT application. [3]

Nikhil Ugale et al. have proposed the system based on IoT for environmental condition monitoring in homes. The proposed system use different sensors light, temperature, level and humidity to collect the data to monitor the environmental conditions and also to detect any fault in devices. PIC microcontroller is used to control and monitor all the sensors connected to it. Different sensors are placed against different devices to check the functionality of the devices. Once device turn on sensor will sense the functionality of the device if it is not working properly then automatically e-mail or SMS will send to the service provider as well as user. Also one more functionality is added that device can turn on and off through cell phone as well as to get full functionality details of device through SMS. This system has successfully demonstrated a new IoT architecture that lets existing embedded systems be integrated into the IoT network. "Internet of Things" is very effective for home automation and effective utilization of home appliances. Using this Low-cost system device can be connected easily and corresponding information can be globally accessible. [4]

Kondamudi Siva Sai Ram et al. have proposed the system is an advanced solution for monitoring the weather conditions at a particular place and make the information visible anywhere in the world. Internet of Things (IoT) technology is used for this. This system is designed for monitoring and controlling the environmental conditions like temperature, relative humidity, light intensity and CO2 level with sensors and sends the information to the web page and then sensor data is plot in graphical form. Output from the system can be accessible in the internet from anywhere in the world. In this system microcontroller (LPC2148) is used as a main processing unit for the entire system and all the sensor and devices can be connected with the microcontroller. Data from the sensors can be retrieved by the microcontroller and this sensor data is sent to the internet through ESP8266 Wi-Fi module having TCP/IP protocol stack integrated on chip connected to it. [5]

Ms. Padwal S. C. et al. have proposed the system to implement a WSN platform that can be used for a range of long-term environmental monitoring for IoT applications. This paper presents functional design of WSN for IoT application. [6]

III.SYSTEM DEVELOPMENT

This IoT based weather monitoring system is developed using powerful development platform Raspberry Pi board. Raspberry Pi board is helpful to minimize the system hardware. So here in this project use of any external microcontroller, ADC and communication module is avoided. This system uses Temperature and Humidity Sensor (DHT11), Light Intensity Sensor (LDR), Rain Water Level Measuring Sensor developed using marked scale with ULN2803, Pressure and Altitude Sensor (BMP180). All these sensors are interfaced with GPIO header of Raspberry Pi board. To get real time monitoring of data from sensors Ethernet network is used. Block diagram of complete system is as shown in Fig. 1. Interfacing diagram of sensors with Raspberry Pi board is as shown in Fig. 2. Flow chart for system data flow is as shown in Fig. 3.

1. Raspberry Pi: IoT based real time weather monitoring system is developed using Raspberry Pi platform. In proposed system architecture ARM11 processor is centre core as shown in figure 3.1. In this system single core 32 bit ARM11 processor is used. It is having 512MB RAM. This board has on-board USB ports, Ethernet port, HDMI port,

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SD card slot. It is easy to give internet connection to this board by using Ethernet port or USB port. Different sensors are interfaced with general purpose input output (GPIO) of Raspberry Pi board for environmental parameter monitoring. Also 5V, 1A power supply is given to the Raspberry Pi board through micro USB slot. An SD card of 8GB is used to store the operating system as well as all programs and files needed for this project. Keyboard and mouse is connected to the Raspberry Pi board through USB ports. Monitor is connected to the Raspberry Pi board through HDMI port using HDMI to VGA cable. Ethernet port is used to give internet connection to the system via LAN. This board also has a standard 3.5mm mini analog audio jack, intended to drive high impedance loads (like amplified speakers) and a standard RCA-type jack that provides composite NTSC or PAL video signals. Along with all this board is having 15 pin CSI (Camera Serial Interface) connector for camera module interfacing and 15 pin DSI (Display Serial Interface) connector for LED or LCD display.

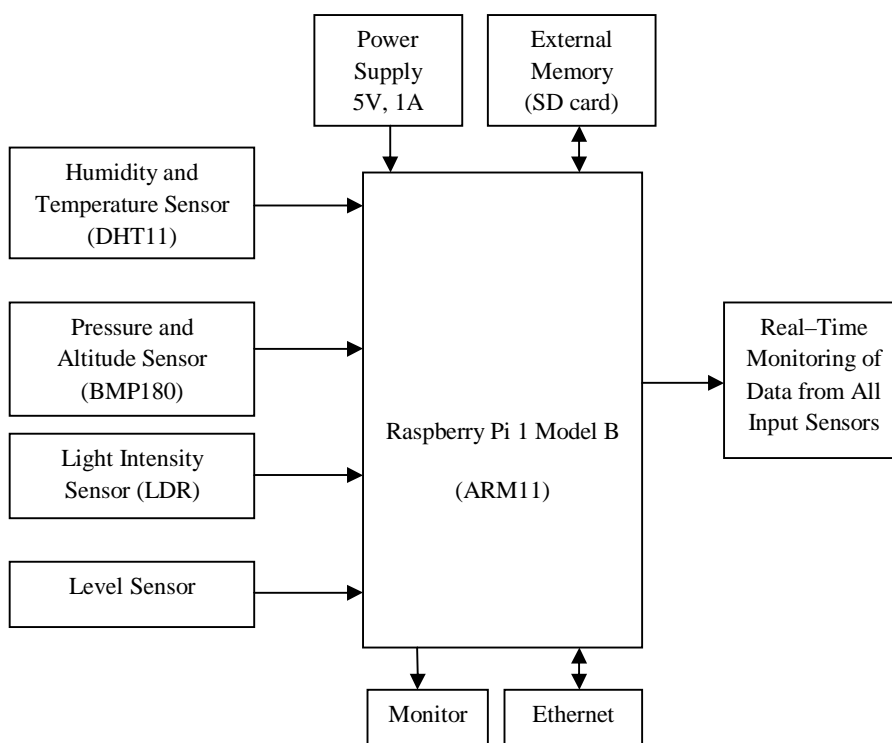


Fig. 1 Block Diagram of Complete System

2. Humidity and Temperature Sensor (DHT11): GPIO9 of Raspberry Pi is used to interface DHT11 with Raspberry Pi board for humidity (in %) and temperature (in °C) measurement using single wire serial interface (SPI). For humidity measurement resistive type component and for temperature measurement negative temperature coefficient (NTC) component is used by this sensor. Output of DHT11 is calibrated digital signal which Raspberry Pi can understand and no need to have analog to digital converter. DHT11 works on 3-5.5V voltage supply and 0.5-2.5mA current supply.

3. Pressure and Altitude Sensor (BMP180): BMP180 is interfaced with Raspberry Pi using I2C interface. SDA and SCL pins are used to interface. This sensor measures atmospheric pressure (in Pa) and altitude from sea level (in m) using piezo-resistive technology. Output from BMP180 is fully calibrated digital signal so there is no need of ADC. It works on 1.8-3.6V voltage and 5µA current supply in standard mode.

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4. Light Intensity Sensor (LDR): LDR is interfaced at GPIO10 of Raspberry Pi. Light Dependent Resistor (LDR) is used for light intensity measurement. It gives analog output. To avoid the use of ADC, using capacitor circuit is developed. By measuring capacitor charging time which is dependent on LDR resistance light intensity is measured. With the change in light intensity LDR resistance changes. So at high light intensity resistance is less and at low light intensity resistance is high. Depending on this principle capacitor charging time changes. Depending on capacitor charging time, light intensity is measured as High, Medium and Low. On thingspeak.com it is shown in terms of percentage.

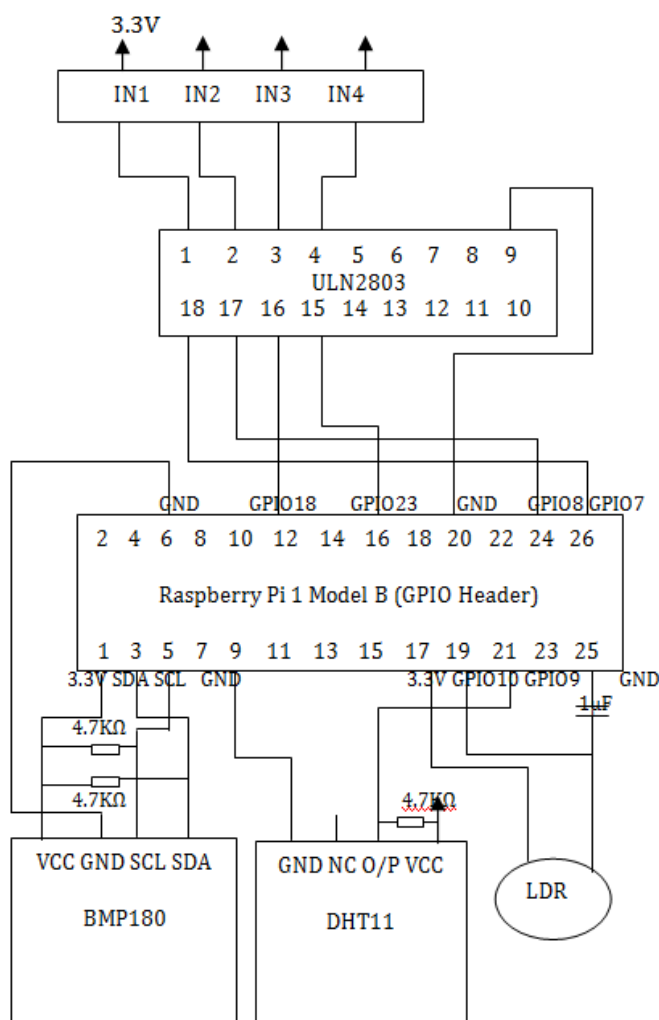


Fig. 2 Interfacing Diagram of Sensors with Raspberry Pi

5. Level Sensor: For rain water level measurement level measuring scale is designed which is interfaced with ULN2803. ULN2803 is interfaced at GPIO7, GPIO8, GPIO18 and GPIO23 of Raspberry Pi for IN1, IN2, IN3 and IN4 respectively. On thingspeak.com graphical representation is shown in terms of percentage.

6. Raspbian: Raspbian is free and open source software. Raspbian operating system is based on Linux kernel. An SD card is used to install an operating system.



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7. Python: Python is used for general purpose programming which is free to use and high level language. Python is a interpreted, interactive, object-oriented and beginner's language. Python can runs on Linux kernel. IDLE (Integrated Development and Learning Environment) is the special text editor software used for programming in python.

8. HTTP: REST (Representational State Transfer protocol) is a scalable architecture that allows things to communicate over Hyper Text Transfer Protocol and is easily adaptable for IoT applications to provide a communication from things to a central web server. Interoperability between computer systems on the internet is provided by the web services like REST or RESTful. Web service is a service offered via World Wide Web by an electronic device to another electronic device, communicating with each other. In that web technology such as HTTP was originally designed for human to machine communication and now utilized for machine to machine communication. HTTP (Hyper Text Transfer Protocol) is an application protocol used for data communication for the World Wide Web. HTTP is the protocol which is used to exchange or transfer hypertext. HTTP functions as request-response protocol in the client-server computing model. Here client is a web browser and application running on the computer or system is a server. In this system Raspberry Pi itself act as a server. HTTP request is sent by the client to the server. Then response message is sent by the server to the client. In the response completion status of request and requested content is sent.

9. System Flow Chart:

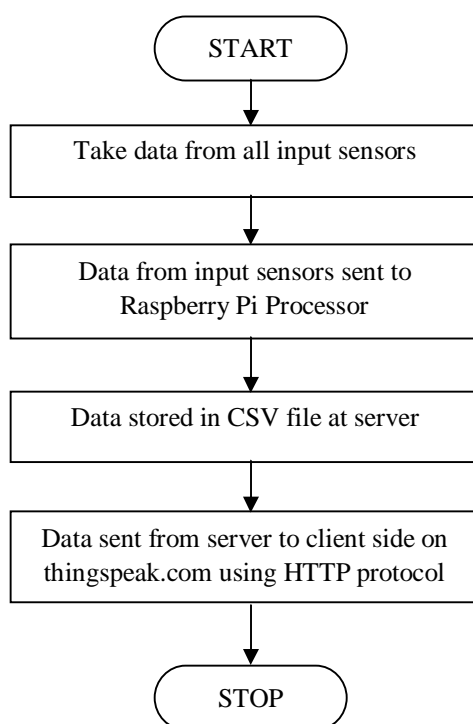


Fig. 3 System Flow Chart

IV. EXPERIMENTAL RESULTS

On the system side Raspberry Pi board operates as a data acquisition mode and as a web server mode. It collects data from Temperature and Humidity sensor, Pressure and Altitude sensor, Light intensity sensor and rain water Level sensor. This data is then sent to the client side using HTTP protocol. On client side real-time data can be seen from anywhere in the world on thingspeak.com. Internet connection to the board is given by using LAN through Ethernet



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port or by using USB dongle through USB port. Results on thingspeak.com are shown in graphical format. On this website one channel is created and all six fields are placed in this channel. Field 1 shows temperature, Field 2 shows humidity, Field 3 shows light intensity, Field 4 shows level, Field 5 shows pressure and Field 6 shows altitude. Real-time data of all six fields are shown in fig. 4, fig. 5, fig. 6, fig. 7, fig. 8 and fig. 9

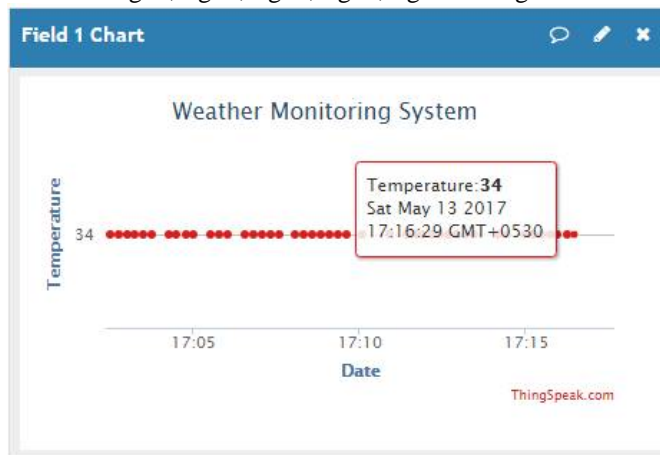


Fig. 4 Real-time graph of Temperature in °C

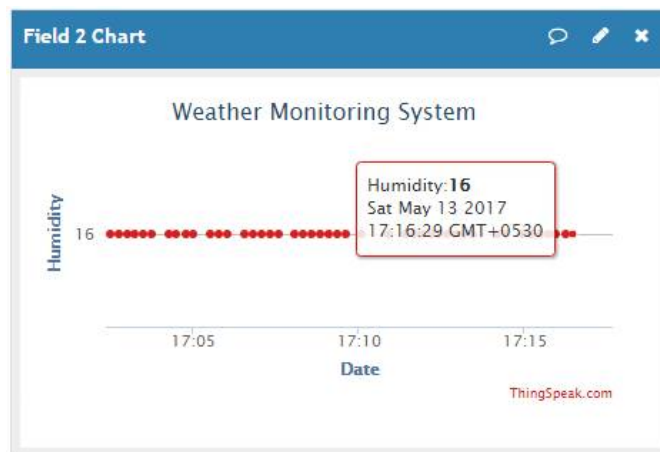


Fig. 5 Real-time graph of Humidity in %

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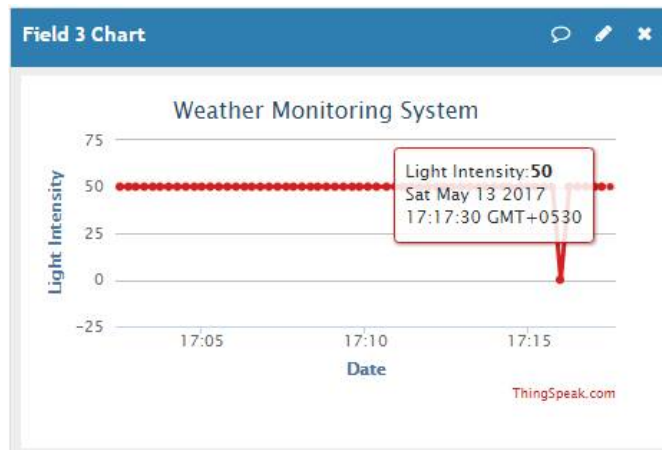


Fig. 6 Real-time graph of Light Intensity in %

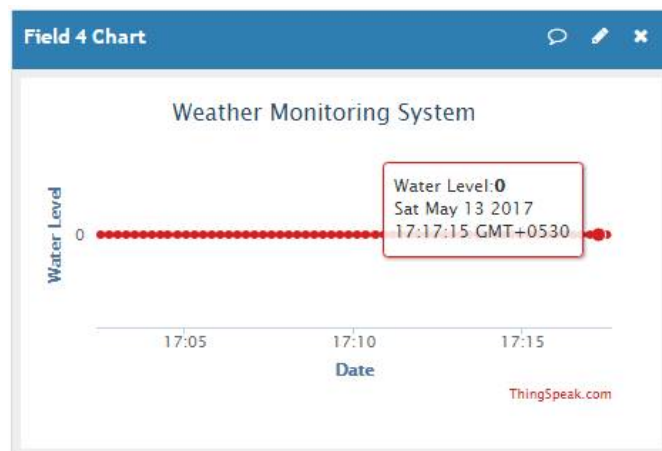


Fig. 7 Real-time graph of Level in %

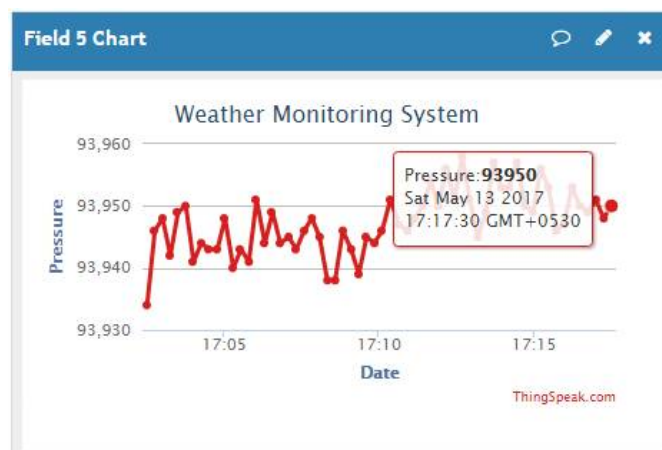


Fig. 8 Real-time graph of Atmospheric Pressure in Pa



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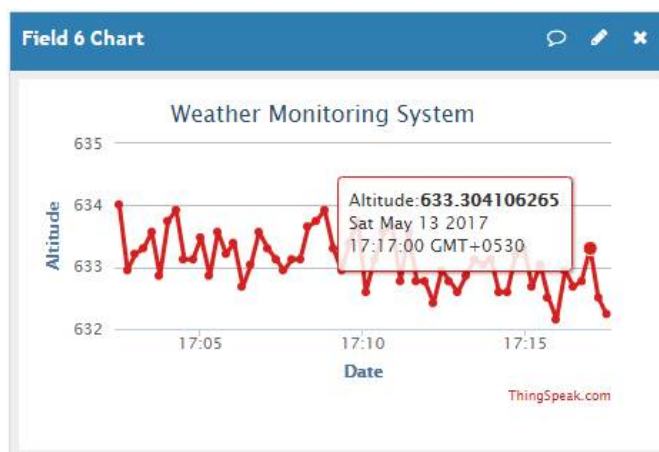


Fig. 9 Real-time graph of Altitude in m

V.CONCLUSION

This IoT based system gives real-time monitoring of environmental parameters. This system monitors temperature, humidity, pressure, altitude, light intensity and rain water level. Data can be seen from anywhere in the world. By using this system the client can continuously monitor different environmental parameters without any interaction with additional server. Raspberry Pi itself acts as a server. This is efficiently carried out by Raspbian operating system. This weather monitoring system is designed using Raspberry pi is having low cost, small size, low power consumption, fast data transfer, good performance and remote monitoring.

This system has some limitations, it do not have built-in Wi-Fi and built-in Real Time Clock. For networking direct internet connection has to be given. As well as all sensors has to be connect directly to the GPIO header. For future development improved version of Raspberry Pi board system can be used. More sensors can be added to expand the system also for remote location monitoring solar panel and wind mill can be used for supplying power to the system.

REFERENCES

- [1] Book "Getting Started with Raspberry Pi", written by Matt Richardson, Shawn Wallace, December 2012: First Edition.
- [2] Arko Djajadi, Michael Wijanarko, "Ambient Environmental Quality Monitoring Using IoT Sensor Network", Internetworking Indonesia Journal (IJ) - Vol.8/No.1 (2016).
- [3] Tamilarasi B, Saravanakumar P, "Smart Sensor Interface for Environmental Monitoring in IoT", International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE) - Volume 5, Issue 2, February 2016.
- [4] Nikhil Ugale, Prof. Mahesh Navale, "Implementation of IoT for Environmental Condition Monitoring in Homes", International Journal For Engineering Applications And Technology (IJFEAT) – Feb 2016.
- [5] Kondamudi Siva Sai Ram, A. N. P. S. Gupta, "IoT Based Data Logger System for Weather Monitoring Using Wireless Sensor Networks", International Journal of Engineering Trends and Technology (IJETT) – Volume 32 Number 2- February 2016.
- [6] Ms. Padwal S. C., Prof. Manoj Kumar, "Application of WSN for Environment Monitoring in IoT Applications", International Conference On Emerging Trends in Engineering and Management Research (ICETEMR-16) – 23rd March 2016.