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Design of IoT Based Framework for Predictive Weather Monitoring System

Alfiya A L[1], Rafeekha M,J[2]

P.G. Student, Department of ECE, TKM Institute of Technology, Kollam, Kerala, India[1]

Associate Professor, Department of ECE, TKM Institute of Technology, Kollam, Kerala, India[2]

ABSTRACT: The current changes in climate have increased the relevance of environmental monitoring, making it a highly active research area. Humans wants to stay updated about the weather conditions of any place or any other particular building. A number of methodologies for environmental monitoring have been used over the last decade. However most of the existing systems is based on ZigBee (IEEE 802.15.4) and is extensively used in a wide range of monitoring and control application that requires wireless connectivity. These solutions provide energy efficient designs, but cannot comply with tight latency and reliability requirements and require additional hardware for packaging data and for transmitting them to the internet. So here in this paper an advanced solution for monitoring the weather conditions at a particular place and make the information visible anywhere in the world is presented. Internet of Things (IoT), is the technology behind this which allows people and things to be connected anytime, anyplace, with anything and anyone, ideally using any path/network. The proposed system deals with monitoring and controlling the environmental conditions like temperature, humidity, pressure and co2 level with sensors and then sends the information to the web page. The data updated from the implemented system can be accessible in the internet from anywhere in the world. And also develop an android mobile application for weather monitoring by using Bluetooth low energy (BLE) module.

KEYWORDS: IoT; arduino; wireless sensor network; android application; WiFi module; BLE module

I. INTRODUCTION

For a long time weather monitoring was largely a pastime of enthusiastic amateurs, but over the last century it has evolved into a well organized and professional global activity that reflects its crucial importance for a wide range of economic, environmental, civil protection and farming activities. Today, the wind and other weather variables are of equal concern and can have an even greater impact on our modern, high-tech life style. Weather affects a wide range of man’s activities, including agriculture, transportation, and leisure time. Often the affects involve the movement of gases and particulates through the atmosphere. Modern weather monitoring systems and networks are designed to make the measurements necessary to track these movements in a cost effective manner.

The sensors are the miniaturized devices used to measure the physical and environmental parameters. By using the sensors for monitoring the weather conditions, the results will be accurate and the entire system will be faster and less power consuming. Sensors are essential components in many applications, not only in the industries for process control but also in daily life for buildings safety and security monitoring, weather condition monitoring and etc. The recent advancement in technology has made these sensors capable of monitoring weather parameters more favorably.

The system presented in this paper monitors the weather conditions and updates the information to the web page. And also develop an android application for weather monitoring by using Bluetooth low energy (BLE) technology. The reason behind sending the data to the web page is to maintain the weather conditions of a particular place can be known anywhere in the world. Being provided with internet connection capabilities, the developed system represent a part of the Internet of Things (IoT). It is the future technology of connecting the entire world at one place. As per the estimation of technological experts, 50 billion objects will be connected in IoT by 2020. IoT offers a wide range of

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connectivity of devices with various protocols and various properties of applications for obtaining the complete machine to machine interaction.

II. RELATED WORK

The literature has reported a large number of research efforts that make use of wireless sensors for achieving monitoring applications. Donno et al. [6] proposed the design and performance of a long- range self powered and programmable RFID augmented module for smart environmental sensing (RAMSES). It is equipped with temperature, light and acceleration sensors. It exhibits superior performance in terms of maximum communication distance with the reader, sensing capability and configurability. The design achieved a transmission range of up to 10 and 20 m in fully passive and battery-assisted-passive modes respectively. The implementation here proposed as a PCB design using COTs components has a number of drawbacks compared with an IC implementation, mainly in terms of cost and power consumption. The proposed system can be used for monitoring the ambient or outside weather parameters. An open-source wireless mesh networking module, which integrates the functions of network discovery, automatic routing control and transmission scheduling is presented by H. C. Lee and H. H. Lin [2]. The system is based on a low cost RF transceiver with more compact and less complex code than one of a ZigBee design and works in connection with a sensor node. The proposed wireless module is open-source in both hardware and software, therefore it can not only be integrated into a sensor system for environmental monitoring, but can also be used to study the wireless mesh networking in an actual experiment. The system was compared to an off-the-shelf product that can offer comparable or even better performance than commercial items. The major drawback of this consists in the requirement for a gateway in case data has to be sent over the internet, a basic requirement for IoT scenarios. S. C. Folea, G. Mois [3] proposed a low-power wireless sensor for online ambient monitoring. The developed system is a compact battery powered system that monitors the temperature, relative humidity, the carbon-dioxide level, the absolute pressure and the intensity of light in indoor spaces and that sends the measurement data using the existent wireless infrastructure based on the IEEE 802.11b/g standards. Its power consumption was tested in a real environment with a rate of one transmission per minute, indicating a battery lifetime close to one month. Further, tests and simulation revealed that the system can operate continuously for up to three years without any battery replacement. The device automatically self-calibrates the attached CO_2 sensor and offers the possibility of operation without maintenance for a long time. It can be used in a wide range of monitoring applications as a component in a WSN, in the IoT or in a cyber-physical system. Different kinds of monitoring solutions based on BLE technology have appeared and are important especially in the case of home automation, after its introduction in 2010 [6]. By offering low power, low cost and reduced device dimensions, the authors believe that this technology has a high potential of becoming important for both the IoT and for smart homes. With the continuous improvements brought to the protocol, such as the support for mesh networking and the extension of the range offered, it is believed that this technology will be taken into consideration for implementing environmental monitoring applications.

III. SYSTEM DESIGN

The implemented system consists of microcontroller ATmega2560 as main processing unit for the overall system and the sensors and the devices can be connected with the microcontroller. The microcontroller collects the data from the sensors and process the data and then updates it to the internet through the Wi-Fi module attached to it and also develop an android application for weather monitoring inorder to alert the user by using BLE module.

A. *Overview*

The block diagram of the proposed wireless framework of the weather monitoring system is shown in Fig. 1.

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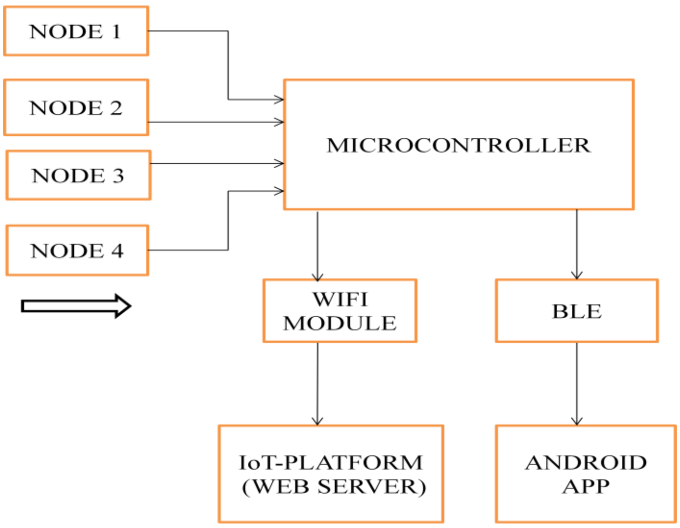

Fig.1: The Functional Block Diagram

B. *Design and Development*

The environmental monitoring system designed is an automated version of manually measuring the weather data. The system consists of a node unit and main unit. The node section consists of temperature and humidity sensor, co detection sensor.

1) *Temperature and Humidity Sensor*

The sensor array consists of DHT11 for detecting the temperature and relative humidity.

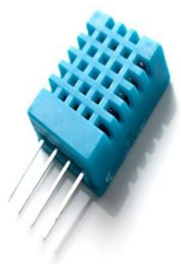

Fig.2: DHT11 Humidity and Temperature Sensor

DHT11 digital temperature and humidity sensor is a composite sensor contains a calibrated digital signal output of the temperature and humidity. The digital signal collecting technique and temperature and humidity sensing make the sensor highly reliable and it also provides long term stability. Its sensing element is connected with 8-bit single chip computer. This sensor consists of mainly three components a resistive-type humidity sensor, an NTC (negative temperature coefficient) thermistor (to measure the temperature) and an 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost effectiveness. It is suitable in all kinds of harsh applications. Single row packaged with four pins, making the connections very convenient. DHT11's power supply is 3-5.5v DC.

2) *CO Detection Sensor*

The weather monitoring system uses MQ-7 for detecting the carbon monoxide in the atmosphere.

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Fig.3: MQ-7 Sensor

The sensor is suitable for sensing the carbon monoxide concentration in the air. The MQ-7 can detect CO gas anywhere from 20 to 2000ppm. This sensor has a high sensitivity and fast response time. The sensor output is an analog resistance. It has a simple drive circuit and has long life span.

3) *Barometric Pressure Sensor*

The system uses BMP180 high-precision, low-power digital barometer for measuring the atmospheric pressure. It measures the absolute pressure of the air around it. The BMP180 offers a pressure measuring range from 300 to 1100 hPa with an accuracy down to 0.02 hPa in advanced resolution mode. The sensor communicates via I2C interface. This means that it communicate with the Arduino using just 2 pins. It is based on piezo-resistive technology for high accuracy and long term stability. VCC can be from 1.8V to 3.6V.

Fig.4: BMP180 Pressure Sensor

4) *Rain Sensor*
The rain sensor module is an easy tool for rain detection.

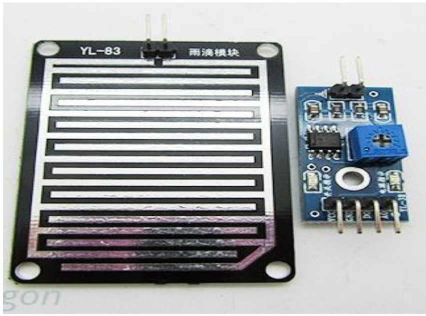

Fig.5: Rain Sensor Module

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It can be used as a switch when raindrop falls through the raining board and also for measuring rainfall intensity. The module features a rain board and the control board that is separate for more convenience, power indicator LED and an adjustable sensitivity through a potentiometer. The analog output is used in the detection of drops in the amount of rainfall. Connected to 5V power supply, the power LED will turn on when induction board has no rain drop, and DO output is high. When dropping a little amount of water, DO output is low, the switch indicator will turn on. Brush off the water droplets, and when restored to the initial state, outputs high level.

5) *Microcontroller*

In the design the microcontroller used is ATmega2560.

Fig.6: ATmega2560 Microcontroller

It is a high-performance, low-power Microchip8-bit AVR RISC based microcontroller that combines 256KB ISP flash memory, 8KB SRAM, 4KB EEPROM, 86 general purpose input/output lines, 32 general purpose working registers, real time counter, PWM, 4USARTs, byte oriented 2-wire serial interface, 16-channel 10-bit A/D converter and a JTAG interface for on-chip debugging. The device achieves a throughput of 16 MIPS at 16 MHz and operates between 4.5-5.5volts.

6) Wi-Fi module

The system uses ESP8266 Wi-Fi module, which is having TCP/IP protocol stack integrated on chip. So that it can provide any microcontroller to connect with Wi-Fi network.

Fig.7: ESP8266 Wi-Fi Module

ESP8266 is a preprogrammed SOC and any microcontroller has to communicate with it through UART interface. It works with a supply voltage of 3.3v. The module is configured with AT commands and the microcontroller should be programmed to send the AT commands in a required sequence to configure the module in client mode. The module can be used in both client and server modes.

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7) *BLE module*

The system uses HC-05 as Bluetooth low energy module. It is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. It can be used in a Master or Slave configuration, making it a great solution for wireless communication. By default the factory setting is slave. The role of the module can be configured only by AT commands.

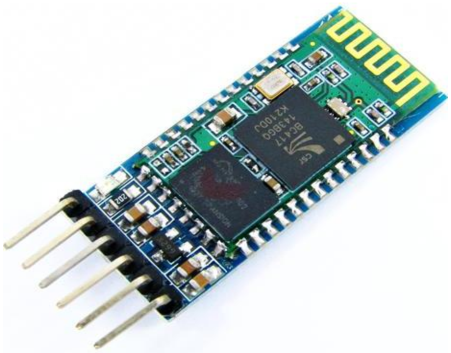

Fig.8: HC-05 BLE Module

8) *Arduino MEGA 2560*

The MEGA 2560 is a microcontroller board based on the ATmega2560. It is designed for more complex projects. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTS (hardware serial port), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller, simply connect it to a computer with a USB cable or power it with a AC to DC adapter or battery to get started.

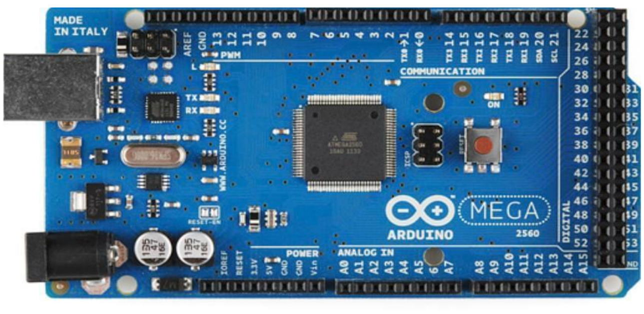

Fig 9: Arduino MEGA

9) *Cayenne IoT cloud*

Cayenne is one of the easiest and powerful IoT platform for developing beautiful UI for IoT solution. Cayenne builds drag and drop UI for IoT, so with drag and drop UI and CE plug and play hardware we can build IoT solution within few minutes. Cayenne supports master devices like Raspberry Pi, Arduino and much more. It helps in quick design of prototype and commercialize IoT solutions. By using this we can customize our mobile and online dashboard with drag and drop widget and can manage our system from anywhere in the world. It enable text messages and email notifications based on triggered events. And it also helps to access real-time historical device and sensor data.

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IV. SYSTEM FUNCTIONALITY

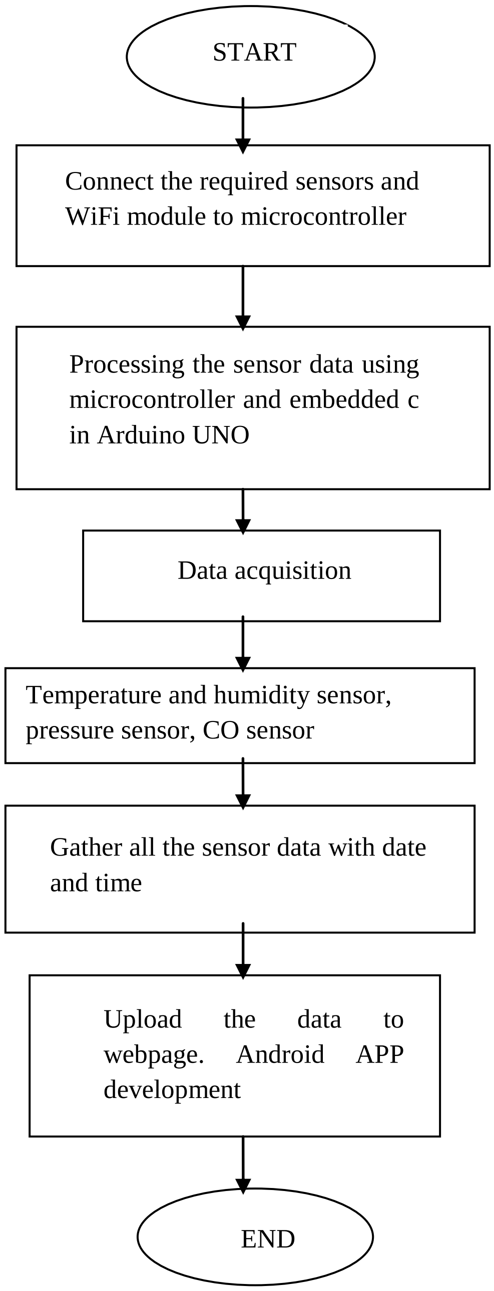

Fig.10: Flow Chart

The system functionality includes the working process of the entire system after integrating all the peripherals along with the software. Initially the sensors will be monitored and is read by the microcontroller. The output of some sensors are analog and some directly gives the digital output. The analog output of the sensors is converted into digital form

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through ADC. This is done by the data acquisition block of our system. Then process the data using embedded c and microcontroller in Arduino UNO. And then upload the data to the webpage and also develop an android app by using the BLE technology for weather monitoring.

V.RESULT

The figure given below shows all the sensor values that are updated to cayenne IoT platform in real time. It allows the user to display the acquired values in the form of a chart. These values will be updated as long as the Arduino is connected to internet.

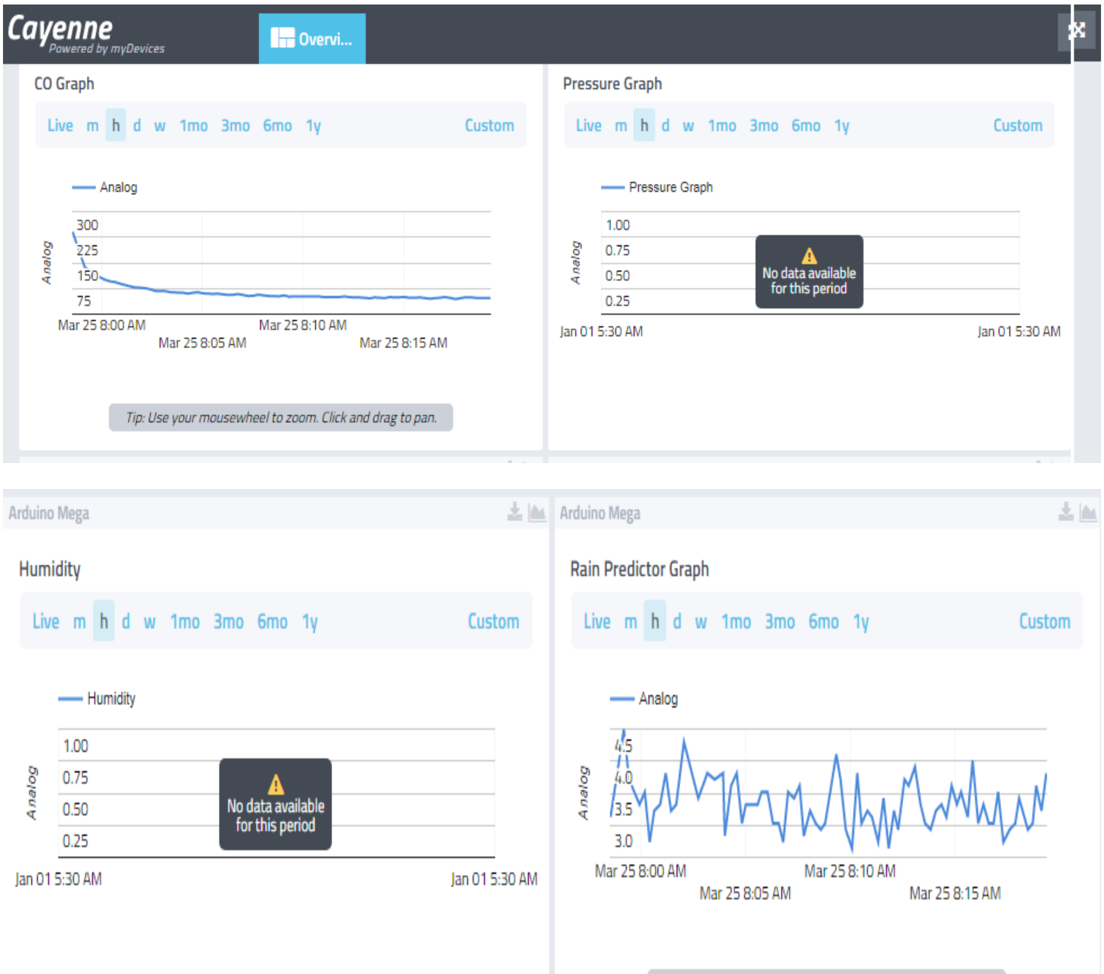

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Fig. 9 Weather Data Updated to Cayenne IoT Cloud

The figure given below shows the screenshot of android application developed for weather monitoring.

Fig.10: Android Application

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V.CONCLUSION

An efficient low cost embedded system to monitor the environment is presented in this paper. The proposed system utilizes temperature, humidity and pressure sensors to monitor the conditions of environment and updates those measured values to thing speak in real time. This allows the monitoring of the data uploaded on the cloud server from any location.

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