IoT Based Environmental Monitoring System for Real Time Using Arduino

[1]VEMULA NAVEEN [2] N.PRAKASH BABU
[1]M.Tech Student, [2]Associate Professor
[1,2]Department of ECE, VEMU Institute of Technology, P.Kothakota, Andhra Pradesh, India.

Abstract: **Present innovations in technology mainly focus on controlling and monitoring of different activities. These are increasingly emerging to reach the human needs. Most of these technologies are focused on efficient monitoring and controlling different activities. An efficient environmental monitoring system is required to monitor and assess the conditions. For exceeding the prescribed level of parameters such as noise, CO and radiation levels. When the objects like environment equipped with sensor devices, microcontroller and various software applications becomes a self-protecting and self-monitoring environment and it is also called as smart environment. The Internet of Things (IoT) is playing a vital role in our daily lives in order to accomplish tasks by incorporating the use of sensor networks encompassing our environment. The systems developed to observe the physical tendency that creates data and the created data is stored in the cloud. The stored information is then utilized for designing applications for controlling necessary actions. This paper describes the application and experimentation of a system composed of sensors for monitoring temperature and humidity of the area surrounding. This observed information is used to perform ephemeral actions such as, controlling the electronic gadgets for warming or cooling that takes more time. The recorded data is loaded to cloud for storage and further accessed through an Android application and displays the results to the mobile-users. The framework presented in this paper employed Arduino UNO board, DHT11 sensor, ESP8266 Wi-Fi module, Atmosphere Pressure (BMP180) Air Quality Sensor (MQ 135), CO_2 Sensor (MQ 9) which makes information to open IoT based API administration Ubi Dots through which it is investigated and kept a side. An Android application is created which gets to the cloud and shows results for end-clients through REST API Web administration. The experimental results shown prove the effectiveness of the system**

Index Terms **– Industrial Automation; Internet of Things; Arduino.**

1. INTRODUCTION

The development of Internet of Things (IoT) has radically changed the world through the use of electronic sensors and several such devices for controlling and monitoring environment at critical situations. These sensors and wireless devices are capable of sensing, storing and transmitting data to store into logical pools remotelynamely a cloud thereby analyzes and presents required data in a way to survive the purpose of the end user. This information in the cloud is available to different end users provided through an interface for several mobile applications as per the requirement. Internet plays a major role in this transformation for an effective, reliable and swift transformation of data from devices to the cloud and to the end-users. The concept behind this prototype is that an end system constitutes number of devices or things at the host end, thus the title "Internet of Things". The devices referred to the things are capable of performing activities like sensing and transmission of information like temperature, humidity, pollution rates etc.The concept of IoT is effectively applied where the manual involvement is not frequently possible such as environmental monitoring.

Environmental monitoring applications require transient data as input through which necessary controlling actions are responded by the system through sensors like remote controlling. This paper provides the details of implementation and experimentation results of an environmental monitoring system. The proprietary component of the system is the Arduino UNO board that acts as an interfaceby accepting temperature and humidity as input readings obtained via monitoring sensor DHT11 and the output obtained by sensing the data is transmitted through ESP8266Wi-Fi module to remote cloud storage open IoT API ThingSpeak. With the help of Thing Speak, MATLAB analysisis carried out about the data and generates a trigger. A mobile application is designed for an Android operating system where data is extracted from ThingSpeak which would be displayed from any part in the world. The application developed is a low-cost economical system that insights the implementation of a complete IoT application involving several actionsnamely sensing and wireless transmission to store in cloud and information extraction from the cloud via the developed application. This paper also presents a detailed study of the deployment of Arduino board along with its interfacing of input and output modules implemented by employing sensors and Wi-Fi module, the utilization of ThingSpeak open-source API and ends with the demonstration of the application.

The experimental results provided at the end of this paper shows the monitoring and statistical analysis of temperature and humidity levels from any location in the world. This implementation of this application can be further extended to enable remote controlling of appliances through sensing data.

2. INTERNET OF THINGS TECHNOLOGY

Internet of Things Technology The Internet of Things (IoT) is the network of physical objects that enables these objects to collect and exchange data through internet. The Internet of Things allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer based systems, and resulting in improved efficiency, accuracy and economic benefit; when IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, smart homes, intelligent transportation and smart cities. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure.

3. RELATED WORKS

The implementation part of this paper accomplishes the recent development in the context of IoT through designing a mobile based application in a lesser cost by using boards such as Raspberry Pi and Arduino. These boards have already taken its shape in the development of applications like home automation, patient monitoring systems, and weather and environmental monitoring systems. In the paper[1], measurements of temperature, humidity, light intensity, gas leakage, sea level, and rain intensity are considered and the input is transmitted wirelessly through Thing Speak using Arduino UNO maintained using MATLAB. Authors in paper[2] also have monitored environmental conditions namely temperature, relative humidity, light intensity and CO2 level using sensors and LPC2148 microcontroller where the data was again sent to the Thing Speak cloud. In contrast, this paper is implemented with Arduino UNO developing the system which is user friendly, low cost and less complex to process smaller applications. Authors in [3] narrated an IoT based application to monitor real-time weather using Raspberry Pi which is difficult compared to Arduino due to Python language and Raspbian operating system. In paper[4], authors designed weather monitoring system incorporating Arduino to import data from multiple sensors. The same is presented in[5], that includes designing and development a wireless sensor network system using Raspberry Pi and Arduino by employing an Xbee module to implement the IEEE 802.15.4 standard for data collection from multiple sensor nodes at a base station (Raspberry Pi). The authors in [5] mentioned that their project can also be applied for larger applications, despite in the current scenario, the system lacks cloud connectivity.

3. PROBLEM STATEMENT

During past decades, as result of civilization and urbanization there is a huge growth in Polluting industries, open burning of refuse and leaves, massive quantities of construction waste, substantial loss of forests and vehicles (particularly diesel-driven cars) on roads that give rise to health endangering pollution. Therefore, it is necessary to regularly monitor and report the hazardous impacts from air pollution. To monitor the quality of air, a new framework is proposed that monitors the parameters of the environment around us such as CO2, CO, presence of smoke, alcohol, LPG, temperature and humidity with the help of GSM, Bluetooth and WSN.

4. IMPLEMENTATION

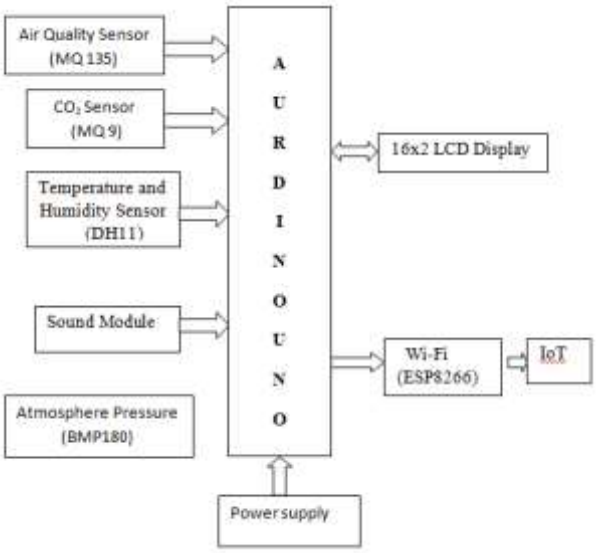

Fig.1 Proposed Block diagram

Arduino UNO is the central unit which acts as the main processing unit for the whole system. This is interfaced with the sensor chip to receive temperature and humidity as input readings. There by, integrated with the Wi-Fi module to produce output over receiving data from cloud. The microcontroller then initiates the sensor to receive data and transmit over the Internet via Ubi Dots cloud for further analysis.

A. *Arduino* Microcontroller

The core part of the system is the microcontroller, a central hardware component that interfaces with other components of the system. As the developing application requires a single sensor for monitoring temperature and humidity where no data is locally stored, Arduino UNO is selected as microcontroller which serves our purpose well due to its simplicity, robustness and low cost. This microcontroller board is developed on ATmega328P comprising 14 digital input/output pins, 6 analogue input pins, a USB connection, 16 MHz quartz crystal, a power jack, and a reset button. The microcontroller receives power through a battery,and implemented using Arduino IDE (Integrated Development Environment) via a type B USB cable.

Fig.2 Arduino UNO Board

B. Sensors (DHT11)

The implementation in this paper is performed using s single sensor to monitor temperature and humidity for environmental monitoring. This purpose is served with the DHT11 composite sensor chip, hence is included in the system for reading temperature and humidity at the same time. The outrating characteristic feature of this sensor is its high reliability and long-term stability. This is also popularly used because this is highly economical with smaller dimensions, quick response, strong anti-interference ability, digital signal output, and precise calibration. Also this is easily interfaced with the Arduino UNO board. The figure shows a picture of the DHT composite sensor which we used in our framework. It can read temperature ranging from 0 to 50°C and humidity ranges from 20 to 90%RH. It has a signal transmission range of 20m. To interface it with Arduino UNO, we connected the Ground and VCC of the DHT11 sensor with the Ground and 5V of the Arduino. Then we connect the Data pin of the DHT11 to pin 2 of the Arduino. Then we installed the DHT library and run the code for getting it started

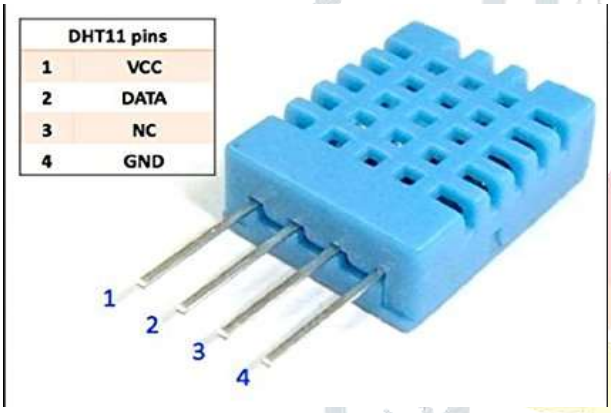

Fig.3 Temperature and Humidity Sensor

C. Wi-Fi

In order to upload sensor readings from all sensors to the open-source cloud ThingSpeak, Arduino UNO interfaces at the output with Wi-Fi module ESP8266. It is a low-cost Wi-Fi microchip with a full TCP/IP stack. It works on the 3.3V that is provided by Arduino UNO in our system. The module is configured through AT commands and needs the required sequence to be used as a client. The module can work as both client and server. It gets an IP on being connected to Wi-Fi through which the module and then communicates over the Internet. After testing our ESP8266 module, we connected it with Arduino UNO and then programmed Arduino UNO to configure the ESP8266 Wi-Fi module as TCP client and send data to ThingSpeak server which is an open IoT platform to visualize and analyse live data from sensors.

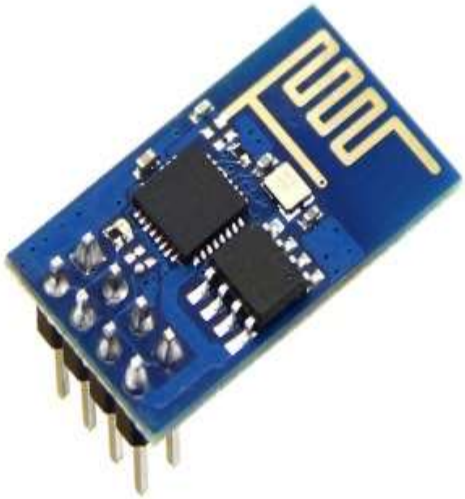

Fig.4 Wi-Fi Board

D. MQ 135 SENSOR

MQ-135 gas sensor applies SnO2 which has a lower conductivity in the clear air as a gas-sensing material. In an atmosphere where there may be polluting gas, the conductivity of the gas sensor raises along with the concentration of the polluting gas increases. MQ-135 performs a good detection to smoke and other harmful gas, especially sensitive to ammonia, sulfide and benzene steam. Its ability to detect various harmful gas and lower cost make MQ-135 an ideal choice of different applications of gas detection

Fig.5 MQ 135 Sesnor

E. MQ9 SENSOR

The MQ-9 is a Carbon Monoxide (CO) sensor suitable for sensing CO concentrations in the air. It can detect CO-gas concentrations anywhere from 20 to 2000 ppm.It make detection by method of cycle high and low temperature, and detect CO at low temperature.It is widely used in domestic CO gas leakage alarm, industrial CO gas alarm and portable CO gas detector The gas sensitive material used in MQ-9 gas sensor is SnO2, which is of lower electrical conductivity in clean air. It detects carbon monoxide with low temperature (heated by 1.5V) through high-low temperature cycles. The electrical conductivity of the sensor increases with the increase of the carbon monoxide concentration in the air. The change of electrical conductivity can be

converted to the output signal corresponding to that of the gas concentration by using a simple circuit. The sensitivity of MQ-9 gas sensor to carbon monoxide is quite high, so it can be used to detect various gas containing carbon monoxide. It is a low-cost sensor suitable for a variety of applications.

Fig.6 MQ 9 Sensor

5. EXPERIMENTAL RESULTS

The Experimental equipment shown in Fig.7 helps in the acquisition of the data for the various parameters of the environment in which the system is installed.

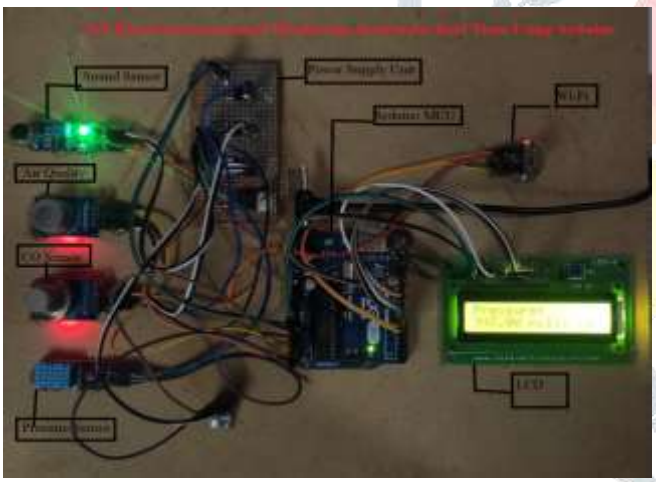

Fig.7 Experimental Setup

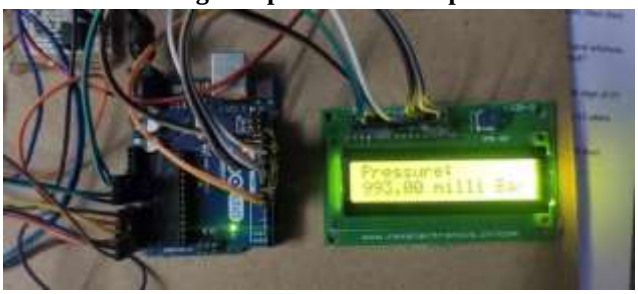

Fig.8 LCD Showing the Pressure Value

Fig.9 LCD Showing the Air Quality Value

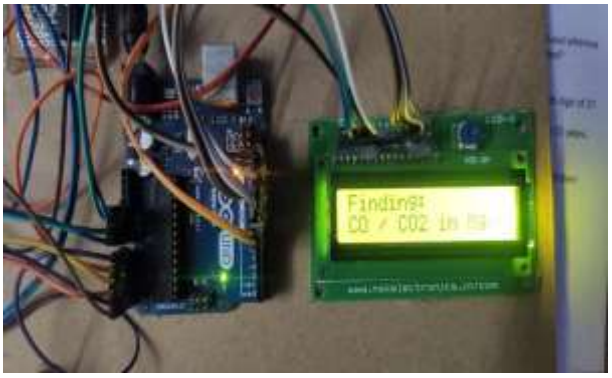

Fig.10 LCD Showing the Finding CO Value in the Air

Fig.11 LCD Showing the CO Value in the Air

Fig.12 LCD Showing the sending Environmental Values in the Air to IoT

6. CONCLUSION

This paper defines an environmental monitoring system for real-time monitoring of temperature and humidity of the surrounding environment. The data which is collected or sensed is passed to cloud by wi-fi where we can see data and graphical analysis. An Android application is developed for the client who can monitor the environment of the area where the hardware is placed an executed using a smartphone. The designed application is used as basic home automation system where the observed values of temperature and humidity can be used to operate some action and control the devices through the mobile application. Thus designing of this system is an important step in understanding the IoT application development and implementation and works as a foundation for many useful innovations in this direction.

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