Smart weather monitoring and real time alert system using IoT (December 2017)

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***Abstract*— In today's world, the weather has been a subject of universal concern, which plays an important role in human life. This has led to increase in importance of real-time alerting and weather monitoring. Hence, the collection of information about the temporal dynamics of weather changes is very important.**

The main aim of this project is to develop an effective weather monitoring system using ESP8266 (NodeMCU) module and wireless technologies. The root concept of this project is IoT (Internet of Things), which is an advanced and efficient way to connect the entire world of things in a network. The project deals with monitoring and detecting the environmental conditions like Light intensity, relative humidity and temperature with sensors and ESP8266 (NodeMCU) acts as a main electronic board which transmits data to Ubidots.com (cloud server). Further, this data is accessed through a designed Web page.

With the help of such technologies mentioned above, real-time weather monitoring & alert systems proves to be successful. The scope of improvements can be achieved with advancement in the current technologies in the coming years.

Keywords: Cloud, ESP8266, IoT, humidity, light, temperature, web page, weather.

I. INTRODUCTION

Weather is an important domain of this geographical globe. Changes in weather have been gaining importance over the years. Eye observation and guess forecasting were the original tools that had been used in the past to predict the weather. Only recently people started to understand the basics and elements that control the weather well enough to accurately predict how the weather is going to be, so that advanced planning and intelligent actions can be made based on it. Using sensors to measure different weather parameters is not a new idea. However, smart weather station based on wireless sensors has just come into existence only recently with the advance of wireless communication technology.

Nowadays, the need for weather monitoring devices that can be counted on for real-time alerting and reporting on the varying environmental conditions becomes increasingly essential. The need for better monitoring the critical parameters that will help in the understanding of the processes involved in climate change has driven the requirement to produce accurate, robust and reliable sensors and the associated instrumentation. The reason behind is to achieve a reliable measurement of these parameters outside the laboratory.

The proposed project has been developed to accommodate four sensors being responsible to measure four key weather parameters; temperature, pressure, humidity, and light. Temperature is always described as the key weather element of primary concern. Change in the air temperature is usually the main cause of many other weather changes. The air pressure is another important weather parameter that needs to be measured since it is highly correlated to other parameters of weather. The third weather element to be measured by the proposed system is relative humidity. Relative Humidity of water-vapor mixture is mainly dependent on temperature and absolute pressure of the mixture of interest. Another important element of weather is sunlight. For the Smart Weather Station, the method used to measure the sunlight is by determining the intensity of illumination (visual perception) for a specific wavelength of light on the surface of the particular sensing area.

This proposed project will develop a platform by which smart sensors for weather monitoring will be selected and interfaced to a central station. The overarching aim is to understand the parameters which are important for climate studies and to prepare it in industry globally. Smart Weather station project can be considered as a platform for further applications in future. This system can be expanded to accommodate more sensors and develop the area of potential applications for such a system.

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II. EXISTING SYSTEM MODEL

In today's world, by considering different environmental parameters many pollution monitoring systems are designed.

Existing system model uses Zig Bee based wireless sensor networks to monitor physical and environmental conditions with thousands of applications in different fields.

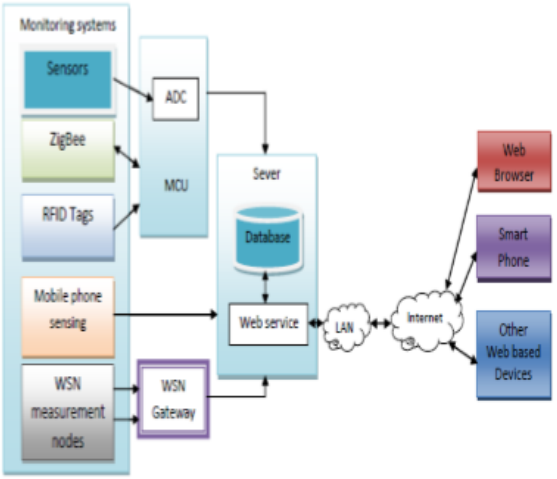


Fig. 1: Existing System Model

The sensor nodes directly communicated with the moving nodes deployed on the object of interest which avoided the use of complex routing algorithm but local computations are very minimal. Storing and retrieving data through electromagnetic transmission to an RF compatible integrated circuit is done by means of RFID systems. RFID systems consist of two main components: tags and readers. A tag has an identification (ID) number and a memory that stores additional data such as manufacturer, product type, and environmental factors such as temperature, humidity, etc. The reader is able to read and/or write data to tags via wireless transmissions.

Mobile phones or smart phones which are enabled with sensors are used for impact on social that includes how mobile technology has to be used for environmental protecting, sensing and to influence just-in-time information to make movements and actions environmental friendly.

A Wireless Sensor Network consists of many inexpensive wireless sensors, which are capable of collecting, storing, processing environmental data, and communicating with neighboring nodes. In the past, sensors were connected by wire lines. Wireless sensor network management model consists of end device, router, gateway node and management monitoring center. End device is responsible for collecting wireless sensor network data, and sending them to parent node, then data are sent to gateway node from parent node directly or by router. On receiving data from wireless sensor network, gateway node extracts data after analyzing and packaging them into Ethernet format data and sends them to the server.

A server is an instance of a computer program that accepts and responds to requests made by another program; known as a client. Servers are used to manage network resources. The services or information in the servers are provided through the Internet that are connected through LAN and made available for users via smart phones, web browser or other web browser devices to make the system more intelligent, adaptable and efficient.

III. PROPOSED MODEL

The proposed embedded device is for monitoring Temperature, Humidity, light intensity and in the atmosphere to make the environment intelligent or interactive with the objects through wireless communication. The proposed model is more adaptable and distributive in nature to monitor the environmental parameters.
The implemented system consists of ESP8266 as a main processing unit for the entire system and all the sensor and devices can be connected with the microcontroller. The sensors can be operated by the microcontroller to retrieve the data from them and it processes the analysis with the sensor data and updates it to the internet through Wi-Fi.

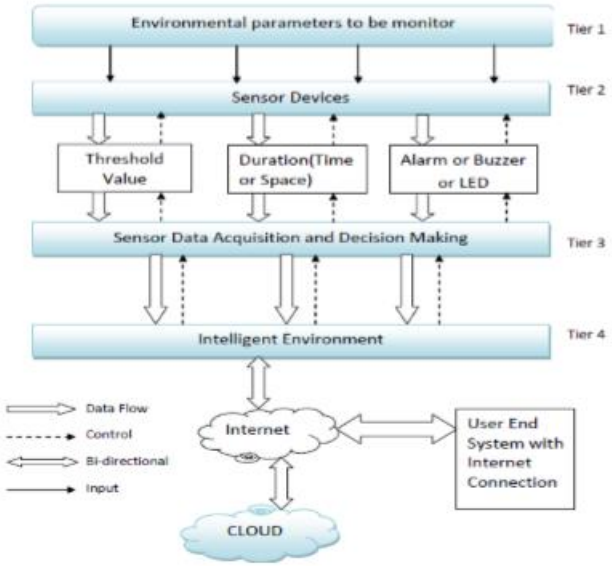


Fig.2: Proposed model

A. STAGES INVOLVED IN THE SYSTEM

1. *Sensing:*

Various parameters are measured with the help of appropriate sensors; GPS is interfaced with ESP8266 module for gathering location information whose values are transferred to cloud (ubidots).

2. *Data processing and transferring:*

I) ESP8266 module is Connected to internet through Wi-Fi module

II) Reading sensor values, uploading / transferring sensor values to web page for storing in database and for Real time remote monitoring.

III) Reading GPS (longitude and latitude) values and uploading onto web page and app to store in database for location monitoring

3. *Data Display (Options available on Web Server):*

I) Transferred data to database.
II) Continuous display of weather parameters on web page and app includes below.
Humidity
Temperature
Light intensity
Air pressure
Precipitation
III) Display of location details on web page and app:
Longitude value
Latitude value
Map of Location of the system on Google Maps
IV) Display of readings using graphs for prediction analysis.

4. *Power Supply:*

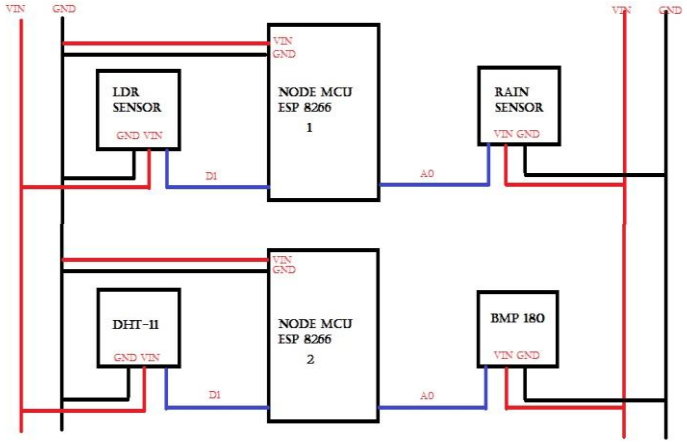
I) 5V as input to ESP8266.
II) Energy can be conserve by using solar panel.

IV. SYSTEM ARCHITECTURE

The implemented system consists of ESP8266 (NodeMCU) as the microcontroller as well as a Wi-fi module for the entire system, with all sensors and devices interfaced on it. The sensors are used to retrieve real-time data which is sent to the circuit board for processing/analysis. Through the internet services these data are sent to the cloud (ubidots) for visual and graphical representation. A designed web page can access data from the cloud. Using ubidots.com (IoT based platform) we have designed an alert system. Integrating ubidots & IFTTT an email or sms notification is sent on crossing the set threshold value of weather parameters.

A. ESP8266 (NodeMCU)

Here we used ESP8266 Wi-Fi module which is having TCP/IP protocol stack integrated on chip. So that it can provide any microcontroller to get connected with Wi-Fi network. ESP8266 is a pre-programmed 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.



B. Sensors:

The system consists of temperature, LDR, humidity, rain and CO sensor. These sensors will measure the primary environmental factors light intensity, temperature, air pressure and humidity. All this sensors will gives the analog voltage representing one particular weather factor. The microcontroller will transfer it to the cloud.

1. *DHT-11:*

DHT-11 is a low cost digital single wire integrated Humidity and temperature sensor. It uses restive humidity sensor and thermostat to measure surrounding air, and sends output value on data pin. DHT -11 Sensors is directly connected with pins of ESP8266. The measurement range of relative humidity and temperature are 20-90% of RH and 0-500C respectively.

2. *LDR (Light dependent Resistor):*

To measure intensity of light we have used LDR. LDR (Light Dependent Resistor) is variable resistor, the resistance of the LDR is inversely proportional to the light intensity, and it exhibits maximum resistance in the absence of light and minimum resistance in the presence of light. Resistive voltage divider circuit is used to measure the change of output voltage in terms of change in LDR resistance in accordance with the Light intensity. Output of this sensor in this project is digital to define between day and night.

3. *BMP180:*

High precision Digital pressure sensor, measurement range of pressure 300... 1100hpa (+9000m .500m relating to sea level), because of its ultra-low power, low voltage it is used in consumer electronics, PDAs, mobile phones, GPS navigation devices. BMP 180 is designed to be connected directly to the ESP8266 module. BMP 180 has 176-bit E2PROM. It is partitioned into 11 words of 16 bit each.

4. *Rain Sensor:*

The rain sensor module is an easy tool for rain detection. 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 though a potentiometer. The analog output is used in detection of drops in the amount of rainfall. Sensor is connected to 5V power supply.

C. Ubidots:

Ubidots is an IoT based platform used to store data in the cloud. This platform is easy to use and can be easily integrated with Arduino or ESP8266. Moreover, it has built-in dashboard features, so that it is possible to create interesting dashboard to show, using charts, the values sent from the board.

D. IFTTT:

IF This Then That, also known as IFTTT is a free web-based service to create chains of simple conditional statements, called applets. An applet is triggered by changes that occur within other web services such as Gmail, Facebook & Instagram. Services are the basic building blocks of IFTTT. Services can also describe actions controlled with certain API's, like SMS. Each service has a particular set of triggers and actions. Applets are predicates made from triggers and actions.

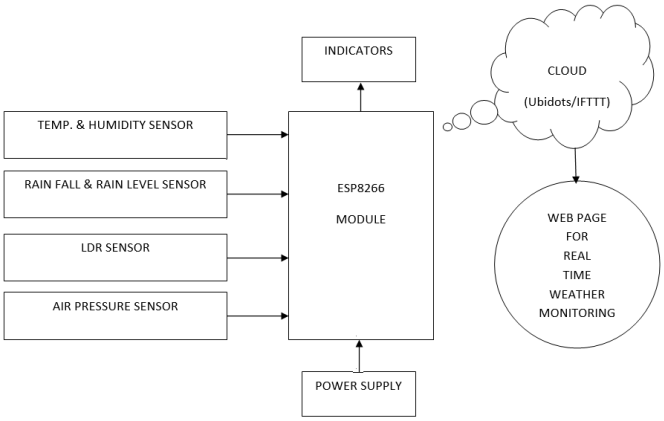
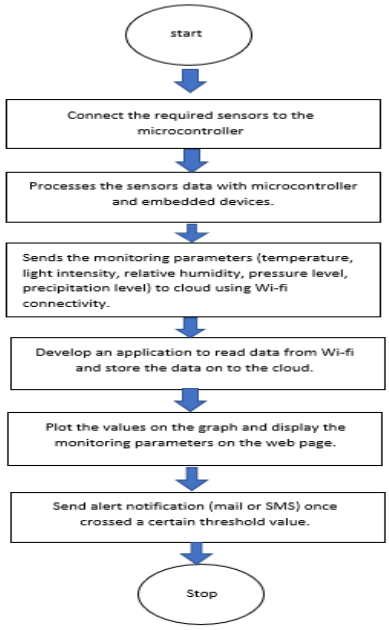


fig.3: system flowchart

V. IMPLEMENTATION

Based on the framework shown in figure 2, we have identified a suitable implementation model that consists of different sensor devices and other modules, their functionalities are shown in figure 3. In this implementation model we have used ESP8266 (NodeMCU) with its inbuilt Wi-fi connectivity, having sensors interfaced on the board. The ESP8266 has analog input pin (A0) and digital output pins (D0-D8). The in-built ADC and Wi-fi connectivity of the board helps us to connect the embedded devices to the internet. Sensors are connected to ESP8266 board for monitoring, ADC will convert the corresponding sensor reading to its digital value and from that value the corresponding environmental parameter will be evaluated.



The Wi-Fi connection has to be established to transfer sensors data to end user and also send it to the cloud storage for future usage.

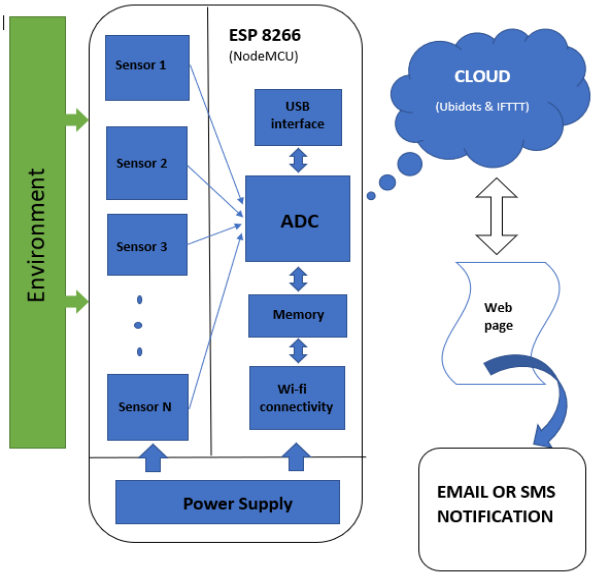


Fig 4: Schematic implementation model

All the sensor devices are connected to internet through Wi-Fi module. The data from the sensors are processed on the ESP8266 (NodeMCU) and sent to the cloud which is an integration of Ubidots and IFTTT. A designed web page will be able to access the data in the cloud as and when required. Depending on the threshold value set for each weather parameter, an alert notification which could be a mail or SMS will be sent for controlling purpose

VII. CONCLUSION

By keeping the embedded devices in the environment for monitoring enables self-protection (i.e., smart environment) to

the environment. To implement this need, deploy the sensor devices in the environment for collecting the data and analysis. By deploying the sensor devices in the environment, we can bring the environment into real life i.e. it can interact with other objects through the network. Then the collected data and analysis results will be available to the end user through the Wi-Fi (internet). The smart way to monitor environment and an efficient, low cost embedded system is presented with different models in this paper.
In the proposed architecture functions of different modules were discussed. The weather monitoring system with Internet of Things (IoT) concept experimentally tested for monitoring weather parameters. It also sent the sensor parameters to the cloud (ubidots & IFTTT). This data will be helpful for future analysis and it can be easily shared to other end users.
This model can be further expanded to monitor the developing cities and industrial zones from weather alerts. this model provides an efficient and low-cost solution for continuous monitoring of environment.

VIII. REFERENCE

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