Real Time Weather Monitoring System Using IoT

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Abstract—*With the development in microcontroller technology, easily availability of internet and cloud computing it is now possible to connect physical objects to Internet, it makes data available universal. The Internet of Things (IOT) defines the inter-connection of devices and people, through the traditional internet and social networks, for various day-to-day applications like healthcare systems, weather monitoring, irrigation field, smart cities, and smart lifestyle. This paper suggests a low-cost weather monitoring system which recovers the weather condition of any location from the cloud database management system and displays the output on the display*

Keywords—Internet of Things, Remote Weather Monitoring,
sensor network,ARM board,ARM software,cloud computing

I Introduction

The importance of weather monitoring is important in many applications. The weather conditions are required to be monitored and maintain the healthy growth of crops and also ensure the safe working environment in industries. Due to technological growth, the process of reading the environmental parameters became easier compared to the earlier days. The sensors are the electronic devices used to measure the physical and environmental parameters. By using these sensors for the monitoring weather conditions, the results will be precise and the complete system will be faster and less power consuming. The system proposed in this paper describes the flow of the weather monitoring station. The system monitors the weather conditions and updates the information to the web page using cloud. 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. The system consists of temperature sensor, Co2 sensor, Humidity sensor, light dependent resistor (LDR) and wind speed Sensor (Anemometer). The standard ethernet communication standard was chosen in system by analyzing the requirements of the application, that the weather conditions should be monitored and updated. In this application, we have to make the weather condition of a particular place can be informative anywhere. The general platform is used for good results in a broad class of IoT environmental monitoring applications. However, in most of IoT applications may have stringent requirements like a very low-cost system, large number of nodes in system, low maintenance, long unattended service time, ease of deployment. These requirements will make these generic platforms less suited. This paper presents the application requirements, the examination of possible solutions, and the realistic realization of a full-custom, reusable of the WSN platform which is proper for use in long-term IoT environmental monitoring system. For a reliable design, the main application requires low cost, fast-deployment of large number of sensors, and reliability are considered at all design levels. A variety of trades-offs between platform features and specifications are recognized, analyzed. And these all are used to guide the design decisions. The development methodology presented can be reused for platform design for other domain applications. Also, the platform requirements of flexibility and reusability for a broad range of related applications were considered from the start. A real-time application for this domain application was selected and used as reference all through the design process. Finally, the experimental results show that the platform implementation satisfies the specifications

II.PROPOSED MODEL

Proposed Model

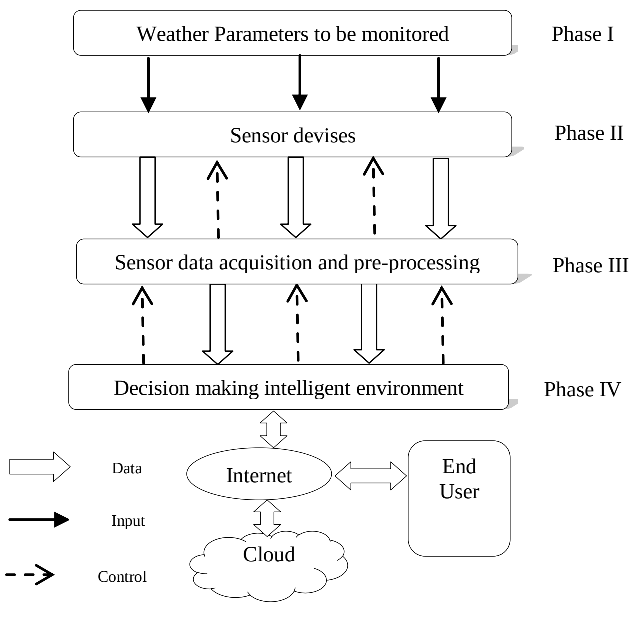


Fig 1: Proposed model

The proposed embedded device is used for monitoring Temperature, Humidity, Wind speed, light intensity, and CO levels in the atmosphere to make the environment intelligent. The projected model is shown in figure 1 which is more flexible and distributive in nature to monitor the environmental parameters. The projected architecture is discussed in a 4- Stage model with the functions of each individual module developed for monitoring all the weather parameters. The projected model consists of total 4 stages. which is revealed in figure 1. Here, the stage 1 provides information about the parameters under the region which is to be monitored, Stage 2 deals with the sensor devices with suitable characteristics, features and each of these sensor devices are operated and controlled based on their sensitivity together with the range of sensor. In between stage 2 and stage 3 necessary sensing and controlling actions will be taken depending upon the conditions, like fixing the threshold value, periodicity of sensing etc. Based on the data analysis performed in between stage 2 and stage 3 and also from previous experiences the parameter threshold values during critical situations or normal working conditions are determined. Stage 3 describes about the data acquisition from sensor devices and also includes the decision making. Which specify the condition that a data is representing which parameter? In the proposed model stage 4 deals with the intelligent environment. In this stage sensed data will be processed, stored in the cloud and also it will show a tendency of the sensed parameters with respect to the specified values. The end users can browse the data using mobile phones, PCs etc.

III. SYSTEM ARCHITECTURE

BLOCK DIAGRAM:

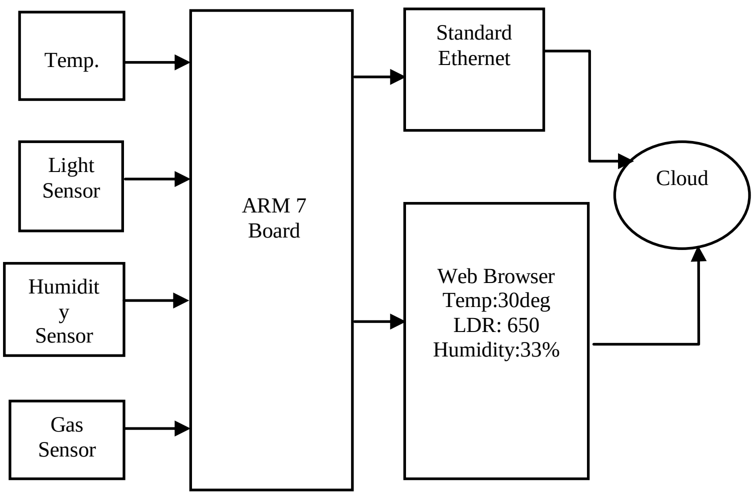


Fig 2. System block diagram

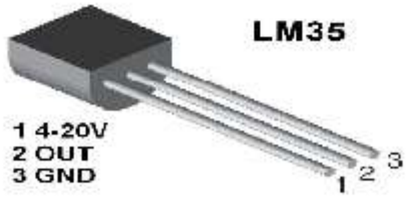
The system consists of a microcontroller (LPC2148) as main processing unit for the whole system and all the sensor and devices can be connected with the microcontroller. The sensors can be functioned by the microcontroller to recover the data from them and it processes the analysis with sensors data and updates it to the internet through Standard ethernet (LAN) connected to it.

ARM 7 BOARD:

Fig: 3 ARM 7 Board

The LPC2148 microcontrollers are based on a 32/16-bit ARM7TDMI-S CPU. The microcontroller supports real-time emulation and embedded trace. These microcontrollers have high speed flash memory which is ranging from 32 kB to 512 kB. A 128-bit wide memory interface and accelerator architecture allow a 32-bit code execution. For critical codes, the optional 16-bit Thumb mode will reduce the code by more than 30 % with minimal performance penalty. LPC2148 is ideal for applications because of their tiny size and low power consumption. A serial communications interfaces ranging from a USB 2.0 Full Speed device, multiple UARTS, SPI, SSP to I2Cs and on-chip SRAM of 8 kB up to 40 kB. This will make the system extremely well suited for a communication gateways, voice recognition, protocol converters, soft modems, and low-end imaging; which provides both high processing power and large buffer size. A LPC2148 also consisting of 32-bit timers, 10-bit DAC, single or dual 10-bit ADC(s), PWM channels and 45 fast GPIO lines.

Temperature Sensor



The LM35 is sensor which is used for measuring temperature with an electrical output proportional to the temperature. If the measured temperature will be observed as high then the fan will turn on automatically or vice versa. The LM35 Temperature Sensor is shown in Fig.3. The scale factor is 0.01V/oC. The LM35 sensor does not need any external calibration or trimming. It will maintain an accuracy of +/- 0.4oC at room temperature

CO Sensor

The Carbon Monoxide (CO) sensor is appropriate for sensing CO concentrations in the environment. The MQ-7 detects CO-gas concentrations from 20 to 2000 ppm. These sensors have a fast response time and high sensitivity. The sensor's output is an analog resistance. The drive circuit is extremely simple; you only need to do is power the heater coil with 5V and add a load resistance. Finally connect the output to an ADC.

LDR Light-Dependent Resistor

An LDR is a component which has resistance and the resistance changes with the light intensity that falls on the component. A light-dependent resistor (LDR) is a light-controlled variable resistor. The resistance of the component reduces with increasing incident light intensity means it exhibits photo-conductivity. An LDR can be useful in light-sensitive detector circuits, and light- and dark-activated switching circuits. An LDR is made up of the high resistance semiconductor material. In the dark, an LDR can have a resistance as high as a few mega ohms (MΩ) and in the light, an LDR can have a resistance as low as a few hundred ohms. If light incident on an LDR exceed a certain frequency limit then the photons immersed by the semiconductor gives bound electrons sufficient energy to jump into the conduction band.

Anemometer Sensor

An anemometer is a device used for measuring wind speed and is a common weather station instrument. This well-made anemometer is designed to sit outside and measure wind speed with ease. To use, connect the black wire to power and signal ground, the brown wire to 7-24VDC (we used 9V with success) and measure the analog voltage on the blue wire. The voltage will range from 0.4V (0 m/s wind) up to 2.0V (for 32.4m/s wind speed). That's it! The sensor is rugged, and easy to mount. The cable can easily disconnect with a few twists and has a weatherproof connector.

IV. **COMPUTATIONAL ANALYSIS ON ENVIRONMENTAL PARAMETERS**

Introduction:

In this chapter we will see the different types of method used for prediction of weather, from the data collected by the sensors deployed in the environment and also the data is stored on cloud. There are mainly two types of prediction methods.

1.Averaging Method
2.Sliding Window Method

1. AVERAGING METHOD

Large sets of temperature data are available as time series of daily minimum and maximum temperatures. the data from observations taken at several times regularly during the day. The widely used average of the maximum and minimum temperature gives a poor estimate of the actual mean daily temperature 2 m above ground level, $\overline{T}$, as given by

$$\overline{T} = \frac{1}{24\ \text{h}} \int_{24\ \text{h}} T\ \mathrm{d}t,$$

where T is the temperature and 24 h indicates the length of the day. The estimate is more accurate if it averages over more temperature readings per day taken at regular intervals. a few averaging methods based on temperatures observed at different times during the day giving 'a value that will differ very little from that of the mean.

The average of the daily extreme temperatures $T^i_{\text{avg}} = (T^i_{\min} + T^i_{\max})/2.$

2. SLIDING WINDOW METHOD

The technique is imposed on the data set and the error has been reduced. The range of trends of the previous year is determined experimentally as climate changes can be rapid or gradual in nature.

[a b c d e f g h]

[a b c]
 [b c d]
  [c d e]
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     [f g h

Neural network technique is used for performing the time series prediction Fig. 3 gives the basic architecture.

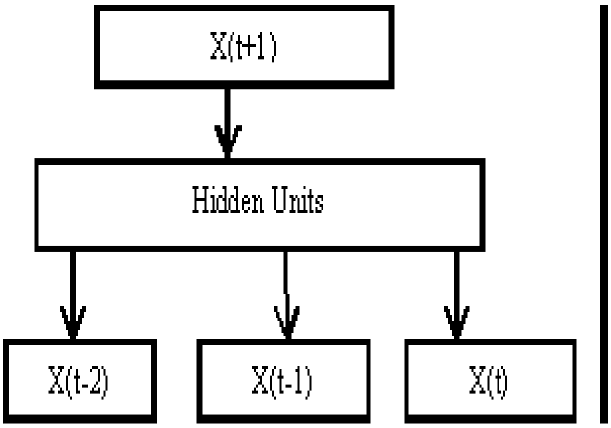

Fig. 4. Time Series Prediction Using Sliding Window Algorithm

This method is often called sliding window technique as the N-tuple input slides over the full training set which is mathematically known as the moving average and is calculated progressively as an average of N number data values over a certain period. It is represented as d_t, d_{t-1}, ..., d_0, where d_t is present and d_0, is the first data value, the moving average with a sliding window is given.

In two steps:

1. Generate an enumeration with the data itself and teach mode data collection.
2. Filter this list to find consecutive details as per window size.

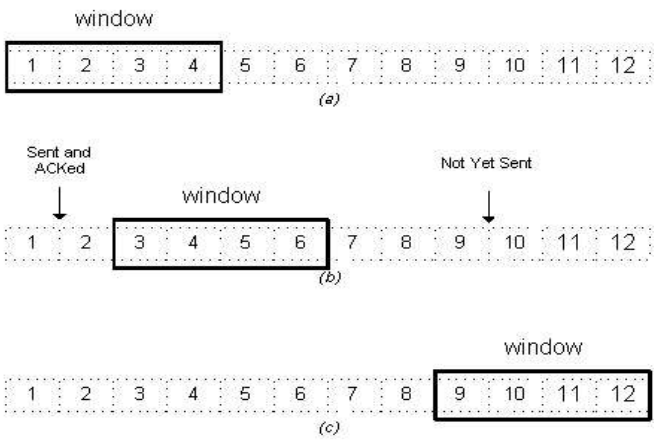

Fig.5.1 & 5.2. Sliding Window Mechanism

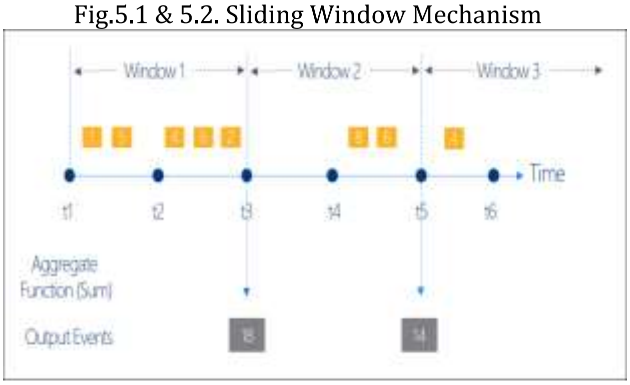

Fig.5.2

There is always a slightly variation in weather conditions which may depend upon the last seven days or so variation. Here variation refers to difference between previous day parameter and present day's parameter. Also, there exists a dependency between the weather conditions persisting in current week in consideration and those of previous years. In this work a methodology is being proposed that could mathematically model these two types of dependency and utilize them to predict the future's weather conditions. To predict the day's weather conditions this work will take into account the conditions prevailing in previous week, that is, in last seven days which are assumed to be known. Also, the weather condition of seven previous days and seven upcoming days for previous year is taken into consideration. For instance, if the weather condition of 16 june 2018 is to be predicted then we will take into consideration the conditions from 09 June 2018 to 15 june 2018 and conditions from 09 June to 22 june 2017 for previous years. Now the current year's variation throughout the week is being matched with those of previous years by making use of sliding window. The best-matched window is selected to make the prediction. The reason for applying sliding window matching is that the weather conditions prevailing in a year may not lie or fall on exactly the same date as they might have existed in previous years. That is why seven previous days and seven ongoing days are being considered. Sliding window is quite good technique to capture the variation that could match the current year's variation.

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. In this implementation model we used ARM 7 board with standard ethernet for storing the data in cloud. the data can be transferred through IP that connects the embedded device to internet. Sensors are connected to ARM 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.

Flowchart:

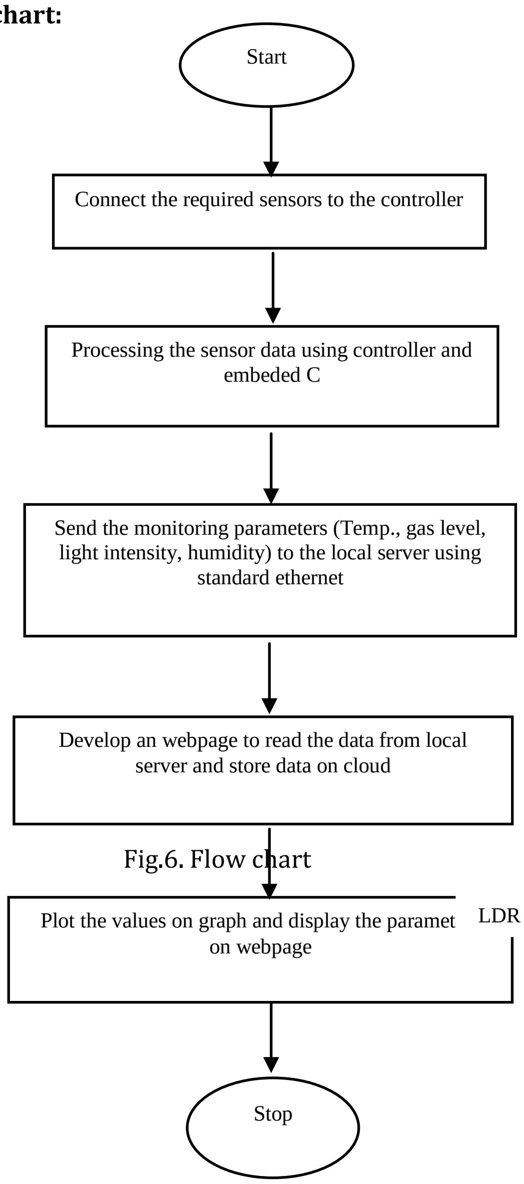

Fig.6. Flow chart

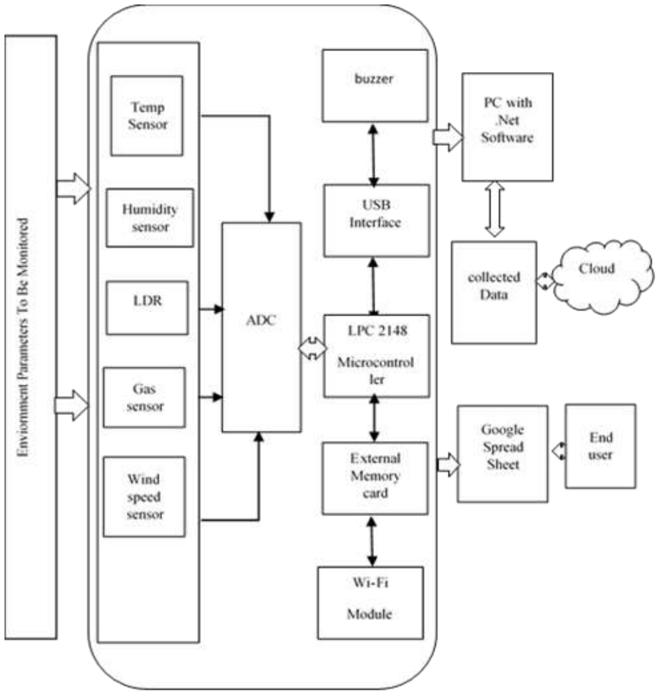

Fig.7. Schematic diagram of implementation model

An embedded system designed for environmental monitoring and its components are shown in figure 7. The embedded device is placed in particular area for testing purpose. The sound sensor detects sound intensity levels in that area and Carbon Monoxide (CO) sensor MQ-7 will record the air quality in that region, if the threshold limit is crossed the corresponding controlling action will be taken (like issuing message alarm or buzzer or LED blink). All the sensor devices are connected to internet through LAN.

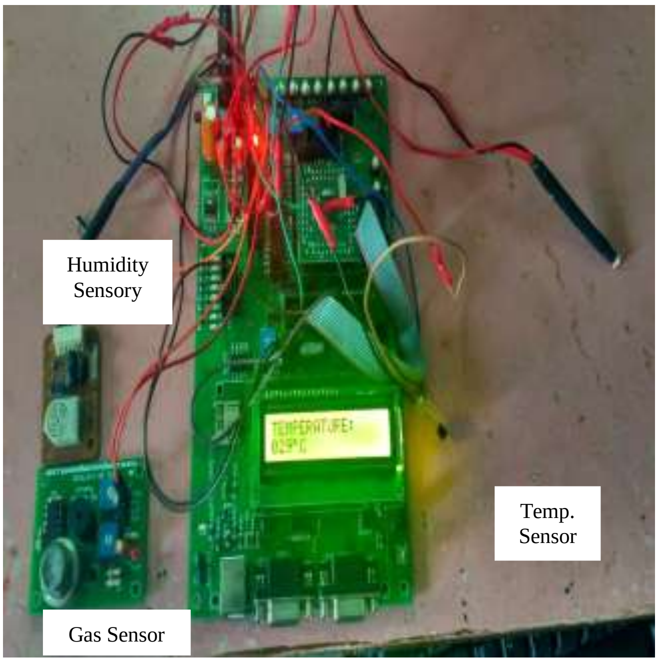

Fig. 8: Environment monitoring embedded system with its components

Figure 8 shows the embedded system with its components for reading and to store the parameters in cloud. After successful completion of sensing, the data will be processed and stored in database for future reference.

VI. SIMULATION RESULTS

After sensing the data from different sensor devices, which are placed in particular area of interest. The sensed data will be automatically sent to the web server, when a proper connection is established with sever device.

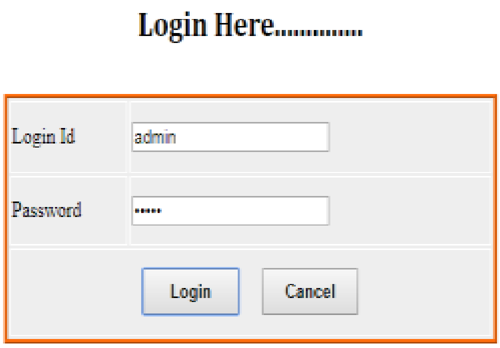

Fig.9.1. web server login page

Fig.69.2. web server data page

The figure 9.1 & 9.2 shows the web server page which will allow us to monitor and control the system. By entering IP address of server which is placed for monitoring we will get the corresponding web page. The web page gives the information about the intensity of sound and the CO level variations in that particular region, where the embedded monitoring system is placed.

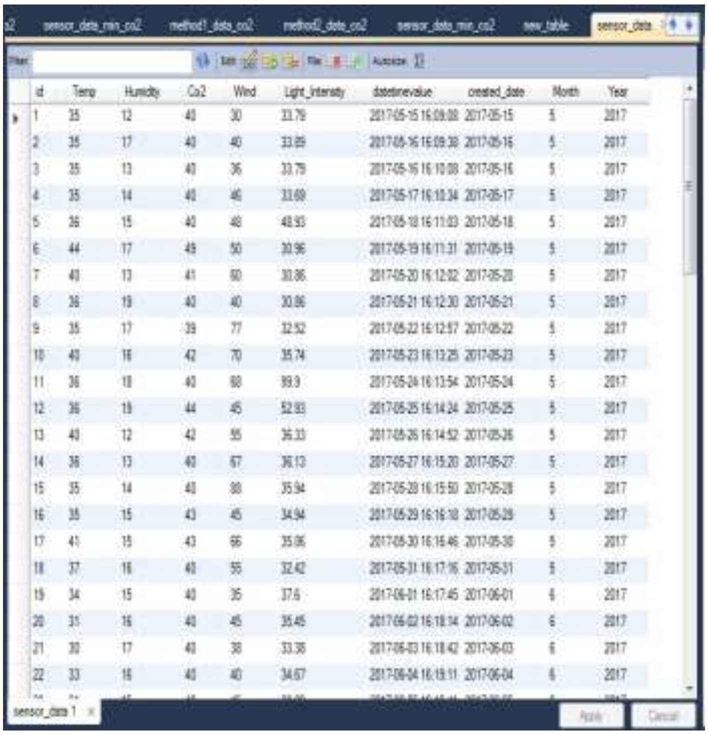

Fig. 10: Cloud storage (Data Sheet) for sensors data

The sensed data will be stored in cloud the data stored in cloud can be used for the analysis of the parameter and continuous monitoring purpose. The figure 7 shows the all the weather parameters at regular time intervals. All the above information will be stored in the cloud, so that we can provide weather data in a particular area at any point of time.

Fig.11(a)

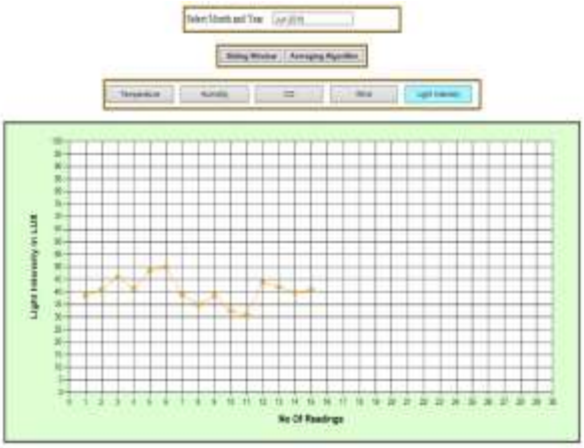

Fig.11(b)

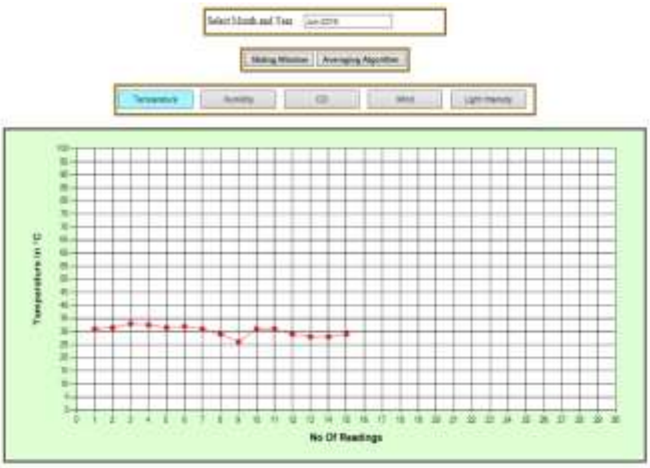

Fig.11(c)

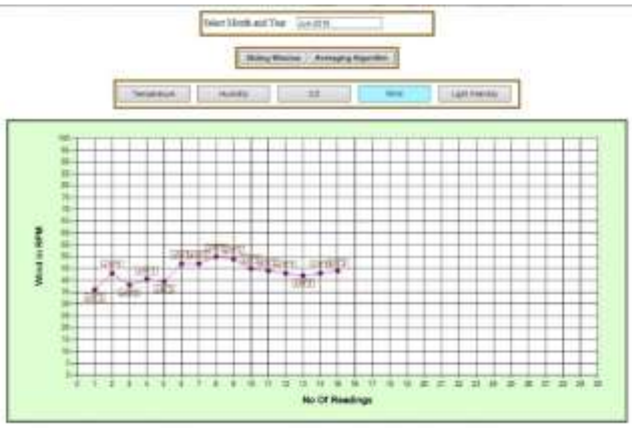

Fig.11(d)

The graph in figure 11 (a) shows the Humidity levels during day time at regular time intervals. The graph 11 (b) shows the Light intensity levels. The graph 11(c) shows the average Temperature level during entire day. Depending on the average value, threshold value will be decided. The graph 11(d) shows the Wind speed level of entire day.

CONCLUSION

The research and implementation of a system for monitoring the environmental parameters using IoT scenario is accomplished. To implement this we need to deploy the sensor devices in the environment for collecting the data and analysis. By deploying sensor devices in the environment, it can interact with other objects through the network. the collected data and analysis results will be available to the end user. In the proposed architecture functions of different modules were discussed. The environment monitoring system with Internet of Things (IoT) concept experimentally tested for monitoring all the necessary parameters and also the parameters sent to the cloud. 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 for pollution monitoring. To protect the public health from pollution, the system provides a low power solution for establishing a weather station. The system is tested in an indoor environment and successfully updated the weather conditions from sensor data.

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