Weighing Type Rain Gauge with Weather Monitoring System

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Abstract **–Weather is a state of the atmosphere that it is cold or hot, dry or wet, stormy or quiet and cloudy or clear. Generally weather defines the day-to-day temperature and precipitation activity. Meanwhile climate is a term that is the average atmospheric conditions over a period of time. Weather is assumed to mean the earth's weather when used without qualification. Observing the weather circumstances manually is difficult. But the system proposed in my paper is an advanced solution for measuring rainfall in a specified area and monitoring the weather conditions at a particular place and make the information visible anywhere in the world. This system contains three sensors to measure weather conditions such as temperature, humidity, atmospheric pressure, altitude, light intensity. And also this system contains Load cell to calculate the rain fall magnitude. All the sensors and load cell connected with Arduino board. This microcontroller is used to get all the sensor values and Using Ethernet shield we can send all the sensor values to the web server. Thingspeak server is used to store all the sensor values in the online. We can download XL sheet from Thingspeak website that will hold all the sensor values. Thingspeak server automatically plot graph for all the sensor values with respect to time.**

Keywords**--Arduino, Weighing type rain gauge, Load cell, Ethernet shield, Sensors, Thingspeak server.**

I. INTRODUCTION

In the present time many innovations and technologies are found to measuring, monitoring and controlling various activities. Now these technologies are efficient one for human needs. Many things affect the environmental conditions. Weather conditions affected by many living and non-living things. Some human activities such as destroying forest by cutting down the trees, which is affect the weather conditions. Because of this now a days temperature is increased, pressure and altitude also gets affected. Because of sudden heavy rain and heavy storm flood will be possible. So we need a system to compare the rain fall magnitude with in a specific time in a specific area. Because of calculating the rain fall magnitude we will come know about the flooding and also we do the flood forecasting. By comparing all the weather condition details we can control the affected weather. Therefore we need a system to measure and compare all the values time by time.

Weighing type rain gauge with weather monitoring system is used to measure all the weather conditions and measuring the rain fall magnitude with in a specific area. This embedded system is used to control the activities already we speak before. The key objective of this system is used to measure all the weather conditions such as temperature, humidity, atmospheric pressure, altitude, light intensity and rain fall magnitude with in a specific area. Load cell is used to measure the weight of the water which is collected in the bucket. And then the weight value is get by Arduino by using HX711 load cell amplifier which is communicate with Arduino. DHT11 sensor is used to measure the temperature and relative humidity. BMP180 sensor is used to measure atmospheric pressure and altitude. LDR sensor is used to measure the light intensity. After getting all the sensor values, these are send to the web server. So we use Ethernet shield which is look like Arduino, is communicate with the webserver through internet. So by using this we can send all the sensor values to the webserver. RJ45 is an Ethernet cable used to connect Ethernet shield to computer's WiFi network by sharing the WiFi network. In this project we using Thingspeak server. It is an online web server used to all the values getting by sensors. Thingspeak server webpage automatically plot the graph for all the sensor values. By this graph also we can compare the sensor values with respect to time. And automatically all the sensor values are stored in a XL sheet and also we can see that.

This system is based IoT technology. IoT means Internet of Things. It connects entire world at one place. All the objects like physical devices, buildings, sensors and actuators can be connected and to share the data obtained in various locations for analyzing that data for some applications like traffic signaling, health care management, etc. IoT offers a wide range of connectivity with various properties of applications for obtaining a complete connection between a machine-to-machine interactions. It gives opportunity to connect physical world with computer-based systems. IoT improves efficiency, accuracy, economic benefits along with reduced manpower. IoT frameworks helping in the interaction between "things". In addition, supports for more complex structures like distributed computing and development of distributed applications.

II. LITERATURE SURVEY

The survey firstly done on typical technologies to implement a classic sensor connection. The main scope of this project is to consume less power and give high performance to users. So that's why we are using Arduino board. Connecting Arduino with sensors will give better performance. Arduino is an open

source electronic board. It is a typical microcontroller, for input modules such as sensors that sense the values and transfer these values to Arduino in order to take some decision[1]. It takes less power consuming that is 7-12V [2].

Next studies goes on selecting sensors. Sensors also having less power consuming and give better performance to users. That's why we are using DHT11 sensor for measuring temperature and relative humidity, BMP180 for measuring atmospheric pressure and altitude, LDR for measuring light intensity[2].In [3] proposed IoT based data logger system for weather monitoring system using wireless networks. In this project, he uses LPC2148 microcontroller. In this project, he proposed the importance of weather in introduction part. Using WiFi module he send the sensor values to the web.In [3] they proposed "Internet of Things (IOT) Based Weather Monitoring system". He using ESP866 WiFi module for sending date form sensors to "Thingspeak server". From here I know about the thinkspeak server and how to send the data to thinkspeak server and how to retrieve the data from thinkspeak server. They put the plotted graph for the sensor values. In [8] they proposed "IoT-based Temperature and Humidity Monitoring System for Agriculture". In this project they using Raspberry pi and Python language. They also use Thingspeak server. Hera also I take some knowledge about thinkspeak server.

Next studies goes on "weighing type rain gauge".Using load cell to get an exact weight of the water which is collected in the container. In [9] they proposed Tipping bucket method for measure rain fall depth. When the bucket gets full then it tips the other bucket in position. In weighing type rain gauge method, the weight of the water which is collected in the bucket will be measure by using load cell.

Next studies goes on how to send the data to the server. Ethernet shield is used to send the sensor data to web server. In [10] they explained about how to use Ethernet shield and how to communicate with internet by using Ethernet shield. And also they told about RJ45 cable which is used to connect the Ethernet shield with PC.

Next studies goes on the web server. Here I am using Thingspeak online webserver to store all the sensor data. In [5] and [8] also the author use Thingspeak server for store the sensor data. This website is automatically generate graph by using the data with respect to time and automatically store all the values in the XL sheet. We can view all the sensor data by download that XL sheet. Then this website generate read and write key for sending data to and retrieving data from this server. Using JSON function in JavaScript is used to read the values from this server.

III. DESIGN

A. System Architecture

Arduino Uno development board which has an ATmega328P microcontroller is used. It has 14 digital pins, 6 analog pins, a power jack, and USB connection, reset button, etc. It operates on very low current 40-50 mA and voltage is between 0-5 V. It can be powered by using the USB port or through an external power source connected to the power jack. Load cell which is measure which communicate with the Arduino by using HX711 load cell amplifier. Load cell having 4 wires and that is connected with HX711 accordingly and HX711 connected with Arduino. DHT11 is the sensor used to measure temperature and humidity. This sensor have 3 pins VCC, INPUT and GND. These 3 are connected accordingly with Arduino. BMP180 pressure sensor have 4 pins to connect with the microcontroller, which is VCC, GND, SCL, and SDA. LDR light intensity sensor have 3 pins to connect with Arduino, which is VCC, DO, and GND. Finally Ethernet shield which is look like Arduino board. So we can connect Ethernet shield upon the Arduino board.

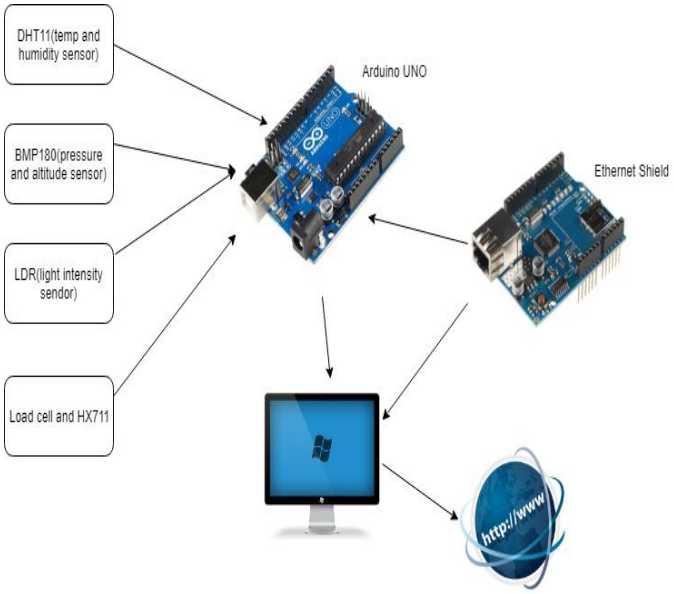


Fig.1. System Architecture.

B. Module Description

Weighing type rain gauge is a critical part in my project. We can measure the weight of water, which is gathered in the bucket. The weight is measure by load cell, which is associated with and configured by Arduino. Load cell is a transducer that modifies force into a computable outcome. HX711 it is a load cell intensifier takes 5 cables from the load cell. Those pins are marked with hues; RED, BLK, WHT, GRN, and YLW. These hues speak to the shading coding of load cells, where red, black, green and white cables originate from the strain gauge on the load cell and yellow is a non-compulsory ground cable that isn't bowed up to the strain gauge yet is there to ground any little outside EMI (electromagnetic impedance). Now and then rather than a yellow cable, there is a more extended black shading cable, foil, or free wires to shield the flag wires to decrease EMI. At that point this course of action is associated with Arduino. Then we have a career like setup on the load cell. We have to

keep the bucket on the career. Then the weight of the water which is collected in the bucket is measured by load cell. And then the weight will send to Arduino by HX711 load cell amplifier. Then by using some calculations weight of the water will be converted to depth of the water and this value is sent to the web server by using Ethernet shield.

Furthermore, here another essential part is we have to send all the sensor esteems to web server [12]. For this function, I am using Ethernet Shield. It is associated on the Arduino board and it additionally look like Arduino board. The Arduino Ethernet shield is used to associate Arduino board to the internet with the help of RJ-45 cable. To interface Ethernet cable to the PC's WiFi network we do take after the following steps,

1. Open “network and sharing center”
2. Right click on our laptop’s WiFi then go to properties and click on sharing.
3. Then click the check button “Allow other network users to connect through this computer’s Internet connection”.
4. Set the “Home network connection (This is the network which is sharing our WiFi)”.

Now our laptop' network is sharable and it is imparted to Ethernet. At that point associate the Ethernet Shield with PC by utilizing RJ-45 cable. In the event that it is superbly associated LEDs which are in the Ethernet shield are turned on likewise. Presently Ethernet Shield additionally getting to the Internet by utilizing Laptop's WiFi. The sensor information is getting by Ethernet shield and that will send to the "Thingspeak server" through Ethernet cable. In thinkspeak server, I am making my own channel to store the sensor information whatever I am utilizing. In Thingspeak server our sensor esteems are kept up as diagram and that sensor esteems are put away in one XL arrange record with Id and qualities. Fundamentally Thingspeak server get the qualities frame Arduino in at regular intervals. So this webpage revived for at regular intervals consequently. From that server I will get the sensor values by using JavaScript $.getJSON() function. JSON, JavaScript Object Notation, is a lightweight contrasting option to XML format for sending or accepting information. JSON has a place with a subset of the object exacting notation of JavaScript. JSON is an accumulation comprising of sets of name/value. Since these structures are in any programming language, we can state that the exchange of information using JSON is free of the programming language used. This has been one of the keys to its developing prevalence if effortlessness is looked for. JSON frequently used to send information from a server to the webpage. For sending values to thinkspeak server and getting values from thinkspeak server, we require Internet. Accordingly, we keep up our system associated with Internet.

C. UML Use Case Diagram

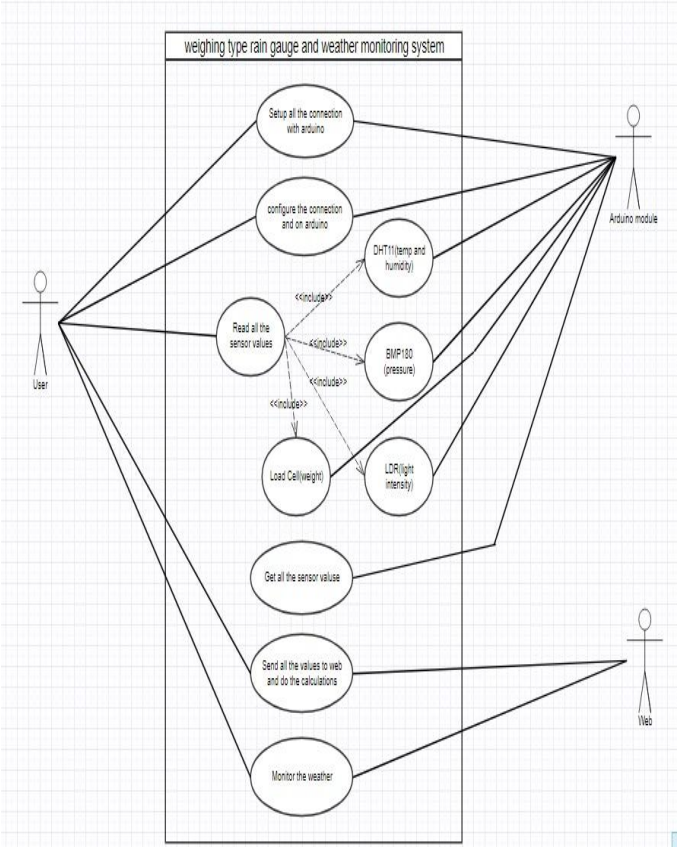
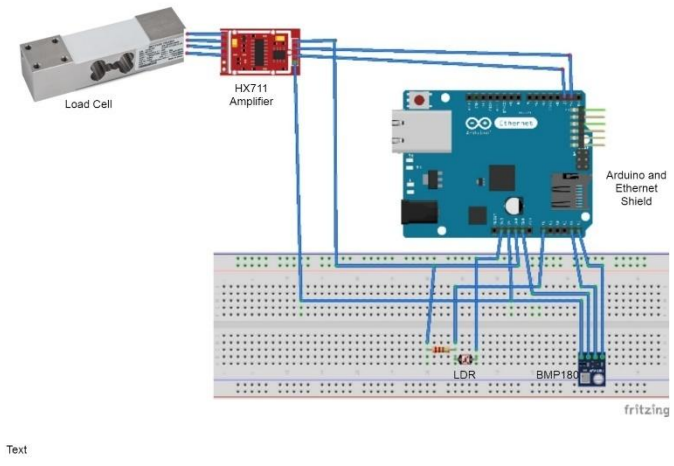


Fig.2.Use case diagram

IV. IMPLEMENTATION



Text

Fig.3.Circuit diagram

Here Arduino board and Ethernet shield are attached together. Because both the boards look same. Ethernet shield is connected with the laptop by using RJ-45 Ethernet cable. BMP 180 sensor is connected to the Arduino board by using 4 pins and the 4 pins are VIN, GND, SCL and SDA. VIN is

connected with 5 volt pin of Arduino. GND is connected with GND of Arduino. SCL is connected with pin A5 of Arduino. SDA is connected with A4 of Arduino. Now BMP 180 is configured with Arduino. We are adding BMP.h library file in Arduino IDE. We are calculating the pressure which is given on the BMP by using readPressure() function. And the altitude is calculated by readAltitude(pressure value) function. LDR sensor module is connected with Arduino by using 3 pins. And the pins are D0, GND and VCC. VCC is connected with 3 volt pin of Arduino. D0 is connected with A0 pin of Arduino. And GND is connected with GND. We can calculate the light intensity from the LDR module by using analogRead(A0) function. DHT11 sensor is connected to the Arduino board by using 3 pins. The pins are+, OUT, -. + is connected with 5V or 3V of Arduino board. – is connected with GND of Arduino board. OUT is connected with pin A0 of Arduino board. We include DHT11.h library file in the Arduino IDE. Now we can find the temperature by using readTemperature() function and find the humidity by using readHumidity() function.

Load cell has 4 screw holes, by using these holes we make a carrier setup. Load cell is connected to the Arduino board by using HX711 load cell amplifier. Load cell has 4 cables which are differentiated by colors. That 4 cables are Red, Black, Yellow, Green and White. Red cable is connected to E+ of HX711. Black cable to E-, Green cable to A- and White cable is connected to A+ of HX711. Now this HX711 is connected with Arduino board. GND of HX711 is connected to GND of Arduino. DT of HX711 is connected with pin 3 of Arduino. SCK is connected with pin 2 of Arduino. VCC is connected with 5V pin of Arduino. One arrow is placed on load cell which is looking down. This shows the direction of force on the load cell. We can any object's weight by using load cell. Here we measure the weight of the rain water which is collected in the bucket. From the weight value, we can easily calculate the depth of the water. The following formula is used to calculate the depth of the rain water.

$$W_w = \rho_w \times V_w \qquad (1)$$

Where, W_w is Wight of the rain water in Kg. ρ_w is density of water which is $1000 kg/m^3$ and V_w is volume of water.

$$V_w = A \times D_w \qquad (2)$$

Where, A is cross sectional area of the bucket in m^2 and D_w is depth of rainwater.

From (1) and (2)

$$D_w(cm) = \frac{W_w}{A \times \rho_w} \times 100 \qquad (3)$$

After reading all the values the values will send to the thingspeak server. For that purpose we need to create our own new channel in thingspeak.com by giving all the necessary parameters. After finishing this we get read and write keys. By using these keys we can send data to and retrieve data from the thingspeak server. And then the values are read from the thingspeak server and shown in the webpage.

V. RESULTS AND DISCUSSION

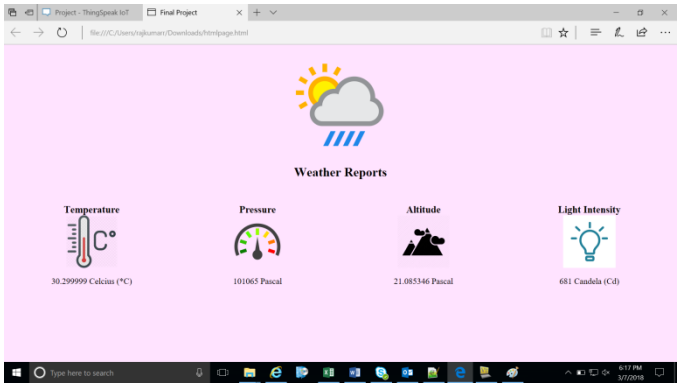


Fig.4.Webpage for weather system

This is the webpage for weather monitoring system. This system showing the weather parameters temperature, pressure, Altitude and light intensity. We need Internet to open this webpage. Because this project contains online server. This system show the weather changes in every 15 seconds. Because this page refreshed every 15 seconds. Thingspeak server also plot graph for every 15 seconds.

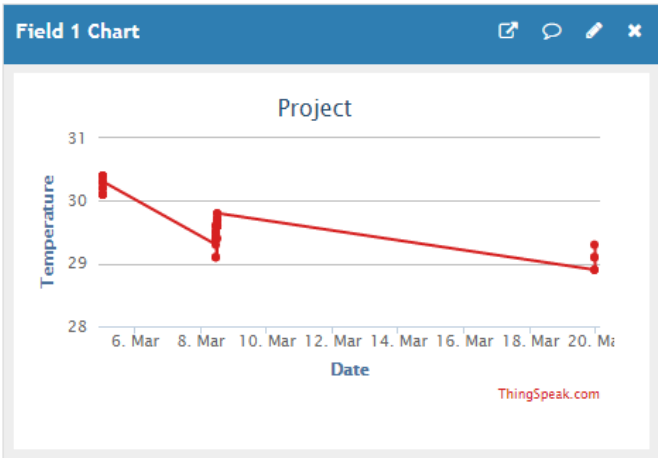


Fig. 5 Thingspeak graph for temperature

The curve showed in Fig.5 is a temperature curve for given period of time. Y axis holds the temperature values and X axis holds the time values. Here 31.5 ^{o}C is the highest value of temperature. The values which will get by Arduino updated in every 15 seconds.

VI. CONCLUSION

This paper establish a small and low cost system for weather monitoring system with rain fall measurement. It checked for more variation of inputs. Subsequently the weather parameters are measured and shown in a webpage. This system will mainly helpful for Transportation system, Airways and Agriculture. Because we know the weather parameters by using this system. And also this system will helpful to flood forecasting. This system embed with rain water measurement. Some future works also discussed here. We can add tipping bucket in this system. Whenever a bucket gets full it tips and

another bucket come to the place. So by this way the manpower will be reduced. And this system can work anywhere.

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