IoT Based Lightning Prediction System and Measurement of Different Weather Parameters

N. Sarala, M. Lakshmipathy, S.Nandha Kishore

Abstract: *The lighting strike is a huge electrical discharge between the environment and earth bound object. A lightning can warm the encompassing air to 50,000 degree Fahrenheit and can contain up to 300Kv of vitality. Besides individuals do bite the dust from lightning strikes. It additionally prompts memory misfortune, serious cerebral pain, victory eardrums, steady muscle jerks and extreme nerve harm. As of now vajrapaat application has been created so as to tweak provincially to give advance cautions about helping and strikes to the general population. Which works with PDAs which just give data about strikes and does exclude any climate parameters? When lightning strike occurs the system provides advance alerts about lighting and strikes to the people by website and alert SMS to rescue the people. Whereas this system provides weather parameters like temperature, pressure, humidity, wind speed and direction, and PH value of the rain water through LCD Display and that information has been uploaded to IoT platform. That information can be accessed from anywhere by accessing the cloud.*

Index Terms: Embedded System, Raspberry Pi, Wi-Fi, Temperature, Humidity, Soil Moisture, Rainfall.

I. INTRODUCTION

Changes of atmosphere and climate conditions have been watched for quite a long time. Watching the climate parameters varieties is fundamental to decide the environment changes. There had been dependably a gigantic significance of atmosphere affecting on human life which had propelled to the advancement of entire logical territories on the atmosphere and climate perception. Starting there was basic and erroneous instruments utilized, which were insufficient for simple perusing and putting away of estimated parameters. These days, there are many mechanized observatories and climate determining systems everywhere throughout the world gathering the environmental parameters ceaselessly for a few or different applications which demonstrates the significance of the climate on the everyday life. Aside from government and non-government associations the climate estimated information can likewise be utilized for the fields like horticulture, transportation, development and so forth. Separated for the logical and business applications, climate determining frameworks can be utilized for educational purposes. The information of the deliberate parameters are not valuable on the off chance that they are not transmitted quick and exact way to the clients. In this way, transmitted and handling the deliberate information is a significant part of the advanced climate figure. Transmission of the deliberate information should be possible by various methods: Wi-Fi interface, GSM/GPRS connect, satellite connection immediate, wired connection, and so on. Climate anticipating must be dependable and exact, paying little heed to its application. Additionally, it needs to give straightforward access to all the deliberate parameters. The nature of sensors and exactness of estimations may fluctuate, and the area of climate guaging station can decide the precision and unwavering quality of the climate information accumulation. All in all client maker is constrained to the choices given by the. Regardless of whether a slight change in parameter checking or information handling is watched, the business gadgets ended up inapplicable. For some specific applications it is required to have adaptable and configurable arrangements. Also that the business gadgets could be unreasonably costly for certain applications purposes. This paper manages the climate anticipating model framework produced for specific purposes. Utilizing moderately cheap parts, the improvement of a model framework for estimating air temperature, air stickiness, light-force, precipitation and soil dampness is accomplished, which could be an economical module utilized in the rural land for the climate checking and anticipating the information to the server which could be seen and utilized for the periodical factual investigation of the climate information.
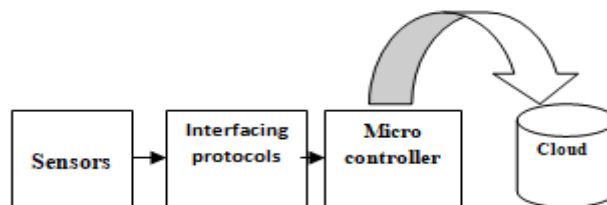
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Fig. 1: Block level representation

1. AQI and Health Implications

Reading air quality index value also an important factor as the man-made machines are releasing several hundred tons of Carbon Monoxide and Carbon Dioxide in to the atmosphere.

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Especially in metropolitan cities like New Delhi, Mumbai and Bangalore releases tons of Carbon monoxide in to atmosphere by vehicles and Industry equipment's.

The air quality index must be maintained below 50 for safe breathing and livelihood for man and animal. But this keeps on changing and sometimes it crosses above 150 making it hazardous for breathing.

2. Lightning Strike

Another important factor that may cause serious collateral damage and serious life threats are Lightning strike. Lightning is a sudden electro static discharge that forms and strikes during a thunder storm. The charging process of the Lightning occurrence is still being unknown and yet in study process. There is a general agreement on basics of electrifications. The main charging point is at the center of the storm cloud and air is moving upwards all the way from ground layer of Earth. The rapid movement of air produces mixture of cooled cloud droplets or ice crystals. These are Positively charged and moves towards upper level of the cloud and at the down level of the cloud remaining residue of the air particles which are hot enough settles down as soft hail or grapple which are negatively charged.

II. OBJECTIVES OF THE PROJECT

The main objectives of the this paper is

- To design a system this gathers weather information from different sensors.

- To develop an IOT based system which provides alerts to the people before 40min and within the range of 40kms

III. IMPLEMENTATION OF THE PROJECT

A. Project Description

Currently proposed arrangement of climate observing framework will screen different climate parameters like temperature, atmospheric pressure, humidity, Air Quality for all these measurements different kinds of sensors are connected to a generic PCB circuit. As venture depending on "Raspberry Pi", it goes about as a microcomputer and perform different capacities proficiently, all the climate sensors are associated or interfaced with the raspberry pi. Every parameter gathered by these connected sensors which will send information to the MCU module & to store the data on SD card of raspberry pi module. At that point it yields on LCD display. The data gathered from Raspberry pi is stored and respective graphs are plotted to analyze further study. This system covers a radius of 40Kms and predicts the approximate location of thunder strike and alerts the people around the effective areas.
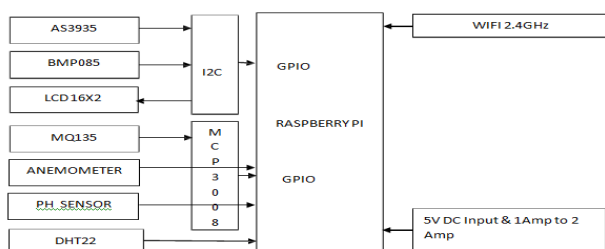

Fig.2: Block diagram

B. Work Flow

In the measurement of the environment variables in the current trend. The IoT solution provides far better and easy installation and maintainability. Using IoT devices the work flow remains as simple as possible. Once the hardware components are intact the system has to be guided to get the data and form a format to upload to the cloud server. The work flow or Algorithm of the lightning prediction & Detection system with measurement of environment variables are as shown as follows
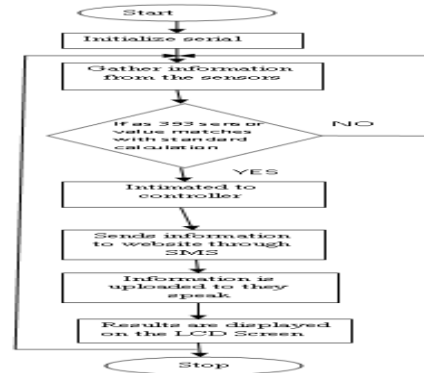

Fig. 3: Work Flow

As shown in above work flow the system starts and boots necessary modules and turns up the interface. Then it starts searching for any available network in the first place. It checks for any known network having SSID and password. Once the system is connected to internet then it starts reading for sensor data one by one as it has I2C interface. Serial input of data happens from sensor to MCU. Once MCU acquires required input from the sensor according to the user reference the formatting of the data begins. It aligns to the given data requirement and keeps it ready for the cloud API access. Once the data starts uploading to Cloud the connection remains Alive and continuously feeds the server for the cloud. At this point a Secondary Task begins in the background. This task governs only for AS3935 sensor. A background thread keeps on monitoring the Lightning activity. If any detection triggers then the system calculates the distance to the storm and alerts the users in the particular area.

C. Hardware and Software

i. Raspberry Pi Micro controller

Fig. 4: Raspberry pi

Raspberry pi zero is the latest updated MCU built on an ARM cortex processor which is a 32 Bit and run on higher language. This costs less than any Arduino boards in the market. This board has the inbuilt Wi-Fi and Bluetooth connectivity and apart from that it has to own connectivity over higher components with GPIO of 40 Pins and has ability to process the to connect to any display system and can able to synthesize high quality video rendering with audio processing. This system was named as Raspberry Pi Zero v1.3. This is an expansion of BCM43143 Wi-Fi chip more or less its equivalent to Raspberry Pi 3 and has lesser RAM for up to 512MB for process. This has vast number of application due to its inter connection capability like low power Bluetooth which can be able to connect to any smart device instantaneously and with basic read app can get the data from the MCU.

ii. DHT11

Fig. 5: DHT11 Sensor

The DHT 11 /22 is a basic sensor built as a thermistor combined over two different metals. This thermistor once the current passed over the metal phase the current is induced in the coil. This then tends to conduct over the metal surface.

Each DHT11 sensor are adjusted at Lab level to give an accurate output by matching the impedance at the end terminal. The voltage has to be passed in the range of 3.3v to 5v. The digital pin at 3 gives a differential voltage of the temperature parameter and humidity with a time delay over the MCU clock. This was tested over a long range transmission over a submissive wire where the value is retained as it passes over a distance in a medium. This is successfully read by the MCU.

- Operating Voltage 3.3v to 5v
- Low cost and easy to connect
- During conversion needs maximum 2.4mA of current
- Accurate for 0-100% of humidity
- Good for operation under -40 Deg to 80 Deg Celsius
- 4 pins for I2C connections.

iii. BMP085 Sensor

Fig. 6: BMP085 sensor

High precision Digital pressure sensor, measurement range of pressure 300 to 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.

iv. AS3935 Sensor

Fig. 7: AS3935 sensor

The sensor was produced by AMS Company in Australia. This is working under the principle of Franklin. Hence the name Franklin Lightning Sensor. The sensor utilizes an inbuilt algorithm to work while detecting a lighting strike and followed by elimination of any man made disturbances.

This has the inbuilt algorithm to save up to 15 strike to average or mean the values for more accurate.

v. Air Quality Sensor

Fig.8: MQ135 sensor

This sensor module is a Gas analyzing sensor which is analog. This sensor works like a thermistor over which the selected metals might react with Carbon Monoxide or any other Carbon gas. In clean air this gives out minimal voltage difference. Whereas while the concentration of the carbon gas is increased the sensor will have a bigger voltage drops and the difference will state the voltage difference.

Vi. A pH meter

A pH meter is a logical instrument that estimates the hydrogen-particle action in water-based arrangements, showing its acidity or alkalinity communicated as pH. The pH meter estimates the distinction in electrical potential between a pH anode and a reference cathode, thus the pH meter is in some cases alluded to as a "potentiometric pH meter". The distinction in electrical potential identifies with the corrosiveness or pH of the arrangement. The pH meter is utilized in numerous applications going from lab experimentation to quality control.

Fig. 9: pH Sensor

Vii. ANEMOMETER

An **anemometer** is a device used for measuring wind speed, and is also a common weather station instrument. The term is derived from the Greek word anemos, which means wind, and is used to describe any wind speed instrument used in meteorology.

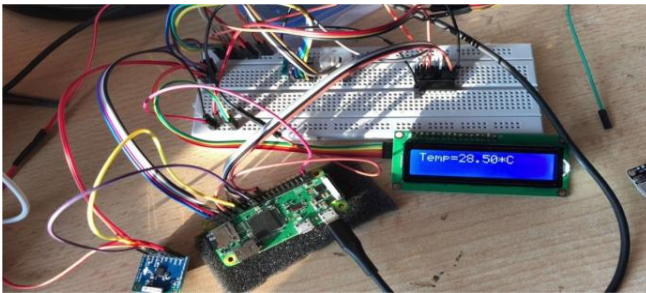**Fig. 10: Anemometer**

V. EXPERIMENTAL RESULTS

Fig. 11: Output of DHT22 on LCD 16X2

Fig. 12: Output of As3935 on LCD 16X2

D.   *Test Results of AS3935 sensor*

When the electromagnetic waves approaches the system, it compares energy with standard energy and identifies it has a lightning signal. When we observed the result it has shown that the strike is likely to hit 40kms from our current location within 40min.
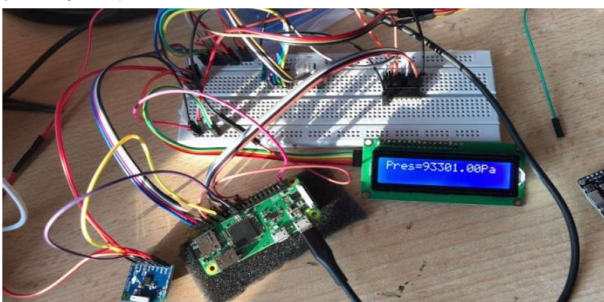

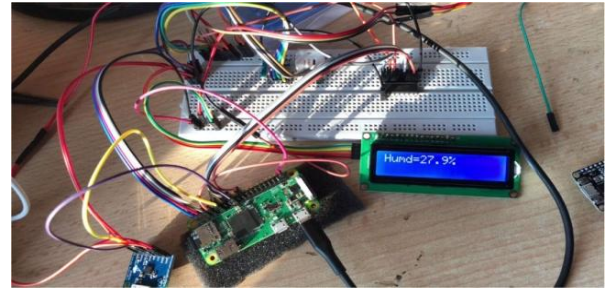**Fig. 13: Output of BMP085 (Pressure) on LCD 16X2**

Fig. 14: output of BMP085 (Humidity) on LCD 16X2

The BMP085sensor measures temp in °c, pressure in PA (Pascal's) as shown in above figures. The pressure displayed in the fig 13 is low because the normal atmospheric pressure is 101.325kpascals. The temperature displayed in fig 14 is less the normal temperature i.e. 37°c specifying it as a winter season.
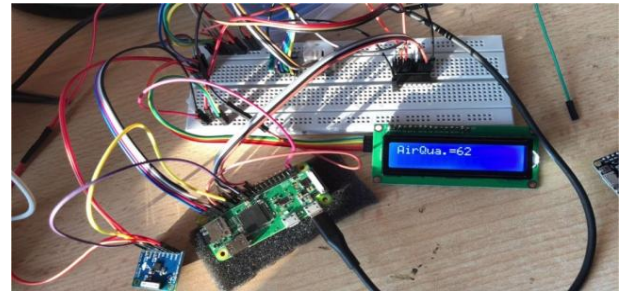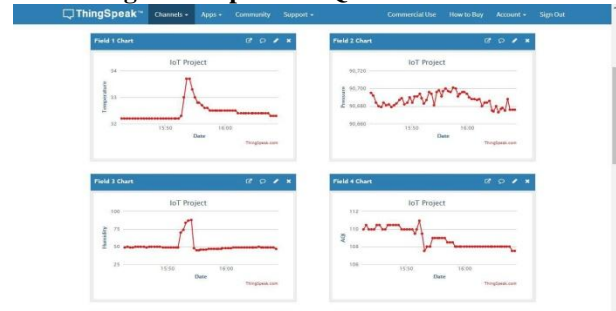

Fig. 15: output of MQ135 on LCD 16X2

Fig. 16: Temperature, pressure, Humidity and AQI values are uploaded to Thing speak

The graphs shown above displays the temperature showing that the before the lightning strike the temperature becomes five times hotter than the normal temperature and even after the strike the temperature around becomes more hot because strike discharges about 20kv.
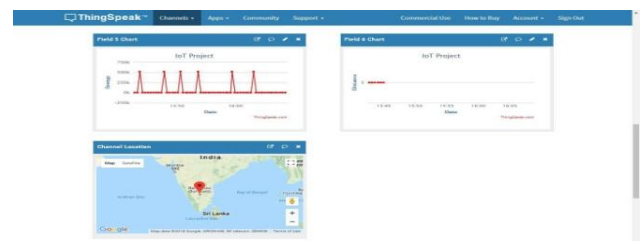

Fig. 17: Energy, Estimated distance and Sensor Location values are uploaded to Thing speak
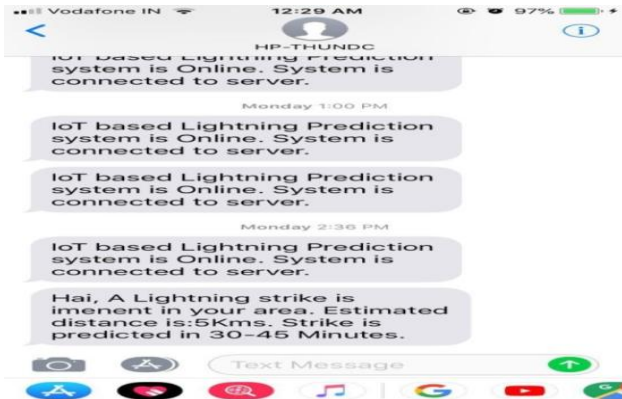
Fig. 18: Lightning Alert message/SMS sent from API Cloud

E. *Anemometer Results*

If wind prevails from a single direction, the top of your house (or a hill) may be the best place. Up to 30 % gains in wind speed are appeared in the underneath picture where red forms speak to most noteworthy breeze speeds near 7 m/s when the predominant breeze speed is 4 m/s. Wind quickens as it streams past most strong items' allest/amplest focuses (the highest point of a slope, edge of a precipice, rooftop line) as appeared in the underneath computational liquid elements (CFD) reenactment picture.

Article's shape, introduction and wind bearing are basic to amplifying wind speed gains. On the other side, if a breeze turbine is put in the wake (wind shadow) of an item, misfortunes, turbine commotion and vibration can result and will abbreviate your turbines lifetime and influence yield altogether. The anemometer when tried on EDC lab, it was situated in the focal point of the room. The breeze speed close to the divider contrasts from the inside. The vulnerability of the reference wound speed was a most extreme at low wind speeds. The greatest vulnerability is ±0.5m/s for wind speed under 1m/s. the speed is determined by

$$Wind\ speed = Cup\ RPM \times 0.0447$$

F. *PH Sensor Results*

When the PH value of battery acid was measured it was found that PH=1. Similarly when measured with water it was found PH=7.

Fig.19: Results of PH Sensor

VI. CONCLUSION

The project deals with designing a simple, highly efficient, cost effective and easy to operate Real time weather monitoring system using Raspberry pi to monitor various weather parameters of the desired location and transmit it to webpage created for remote monitoring & to LCD for local monitoring. Even Real time prior Thunder/Lightning prediction system detected successfully.

Future Scope

The following are the future scope of the proposed system:

● Early detection of earthquakes and tsunamis can be done by monitoring seismic activity using sensors without the need to visit the unreachable or unsafe site. This can help in early and effective disaster management operations.

● Combustion gases and pre-emptive fire conditions can be detected to define alert zones. Similarly, forest fires can be detected at an early stage even though human presence is very less in dense forests.

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