IOT BASED WEATHER STATION

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Abstract

The system proposed is an advanced solution for monitoring and is a display of weather conditions of a particular place. The device senses various parameters like temperature, humidity, barometric pressure, light intensity, rain value, PM 2.5, PM 10 and altitude in the surrounding atmosphere. The brain of the prototype is the esp8266 based Wi-Fi module NodeMcu (12E). All the sensors are connected to the NodeMcu. The acquired data can be displayed in two ways identified as in the direct database system and periodic graphical data read in an open source app called ThingSpeak. The system measures and logs data in either ThingSpeak or on the database making it wireless.

Key Words: *Internet of Things (IOT), Light Dependent Resistor (LDR), Wireless Fidelity (Wi-Fi), Proteus IDE, Graphical user interface (GUI)*

1. INTRODUCTION

The weather predictions and observations have been of great importance to mankind from as early as 650 BC (Ukhurebor et al., 2017). After the invention of weather instruments, people were able to standardize the units while predicting weather. Weather stations were built. Personal weather stations provided the user with the weather conditions and its parameters like temperature, humidity, light intensity, precipitation, wind direction, wind speed, pressure and altitude. In order to maintain safe working environments for labourers, growth in healthy crops and safe travelling. weather conditions were needed to be monitored. (Sai Ram & Gupta, 2016) presented a paper on IOT based Data Logger System for weather monitoring using Wireless sensor networks that uses wireless communication technology and Internet of Things (IoT) for collecting weather conditions at a particular place. The collected weather data is directed to the internet web page so that the user can access the web page from anywhere in the world. For interfacing the sensors, LPC2145 microcontroller has been used to run systems with low power consumption. Keil uVision IDE and Flash Magic software tools were used for running the programming platforms. With advancement in technology, broadcasting weather conditions through mobile phones is more convincing than checking through television. (Chawla et al., 2015) presented a Bluetooth based Weather Station that measures temperature and humidity whose sensor is interfaced to an Arduino Uno board. (Muck & Homam, 2018) has proposed a weather station using Raspberry Pi 3 as the getaway between the sensors and IOT platform. The data were being stored using Google CloudSQL and displayed via Google Data Studio. Also, a weather data app was created using Android Studio. The IOT (Internet of Things) based weather station can be described as a device, which provides weather information of a specific location. For instance, it gives insights about the surrounding temperature, environmental pressure, humidity, rain, wind speed and its direction, light intensity and particulate matter (Patel & Patel, 2016). The weather station uses sensors to detect and measure various parameters. The measured data are stored in the system or on a database which can be accessed remotely from any computer if they are connected to the internet.

This paper focuses on a weather station designed using esp8266 based Wi-Fi module NodeMcu (12E) as the main brain of the system. It contains DHT11 as a sensor to measure temperature and humidity. SDS011 to measure Particulate material in the atmosphere around CST. It can measure pm2.5 and pm10. Also, LDR and BMP180 are placed in the station to check the light intensity and pressure of the place respectively. It also focuses on developing mySQL database to direct and store the data collected from the sensors and to display the periodic graphical data in ThingSpeak database.

2. DESIGN METHODOLOGY

There are three phases to achieve the proposed system:

2.1 Phase I: Implementing designed circuits

The circuit connection required for each sensor is implemented on breadboard and tested simultaneously. The components are then interfaced with Arduino MEGA to measure the desired environmental parameters whose sensed data needs to be directed and stored.

2.2 Phase II: Transmission of sensed data to the database

The transmission of the sensed parameters to a storage unit like a database is assisted by a Wi-Fi module. The Wi-Fi module uses wireless fidelity to direct data from the microcontroller to any computer connected to the internet.

2.3 Phase III: Data storage

The transmitted data are collected and stored on My SQL database and the results are displayed through ThingSpeak, an open source IOT application.

3. CONCEPTUAL BLOCK DIAGRAM

The designed system is broadly categorized into a data collection and data storage center based on the functionality of the components being used (Kodali & Mandal, n.d.). Fig 1 illustrates the conceptual block diagrams used in the designed architecture. The system will consist of different sensors to sense data of different environmental parameters. This information will be collected by a microcontroller, Arduino MEGA and will be sent to external servers or database using a Wi-Fi module known as esp8266 integrated to a NodeMCU.

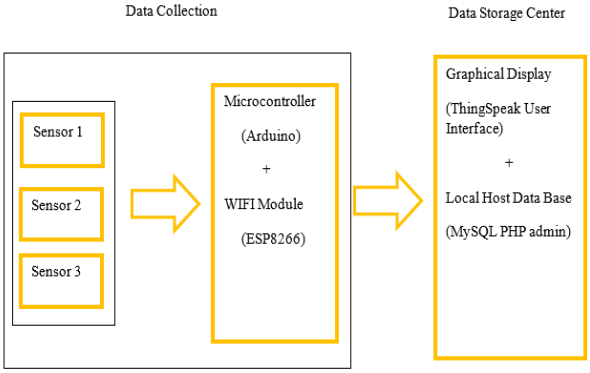


Fig 1 Conceptual block diagram of the system

Figure 2 depicts the complete hardware schematic of the designed project. The system contains all the necessary sensors to get a complete weather data of a particular place. The raw digital data from the sensors are fed to the Arduino/Wi-Fi module NodeMCU. The collected data from this sensor along with the date and time is displayed in the ThingSpeak GUI system and is stored in mySQL database for future analysis. If a person wants to check weather parameters, this system can be placed in that particular location and can be viewed in ThingSpeak. The designed system can be used to study the weather pattern of a location, to forecast weather based on the data collected and plan activities farming, national events and sports accordingly.

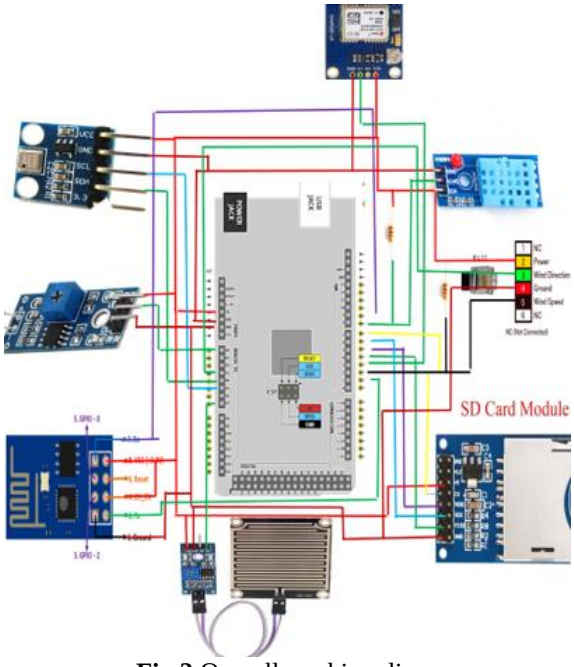


Fig 2 Overall working diagram

The power source for the system is supplied by an 5v output adapter. The adapter is designed using a step-down transformer and a bridge rectifier circuit. The main voltage supply is 220v AC which is stepped down to 12v AC with the use of a transformer. The 12v AC then converted to direct current by the bridge rectifier circuit. A capacitor is connected to the output which acts as a high pass filter. LM7805 Voltage regulator is used to bring down the 12v DC to +5v.

4. FABRICATION

At first the components were tested individually and integrated together. The final measurement was done by collecting data from 3 days after completion of the project.

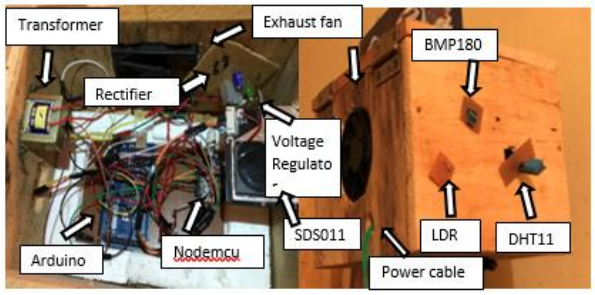


Fig 2 Prototype circuit diagram

The prototype hardware is portable as shown in the photograph with the dimension of 5*5*5 cm unit, weight 2.5kg and powered by 220V AC directly connected to any house socket, stepped down to 5V. It stands on top of a 2m tall metal stand. Weather monitoring system is a simple system with all basic data collection of any location. The prototype is implemented smoothly for almost two weeks. The circuit components are placed in the thermocol, which is made in the shape of the components. It consists of one exhaust fan to cool down the internal components from overheating. The external part of the system is made of wood.

5. DATA STORAGE

A data table is developed in local host mySQL using XAMPP server to store the weather variables. After every 5 minutes the system is programmed to save data into mySQL. XAMPP is an abbreviation for cross-platform, Apache, mySQL, PHP and Perl, and it allows the user to build WordPress sites offline, on a local web server on the computer. The localhost phpMyAdmin is used for its feature to host databases in a personal computer with its inbuilt security system and its ease to set up and run. However, the data stored and saved in local mySQL storage is accessible by administrator with username and password.

CST NodeMCU

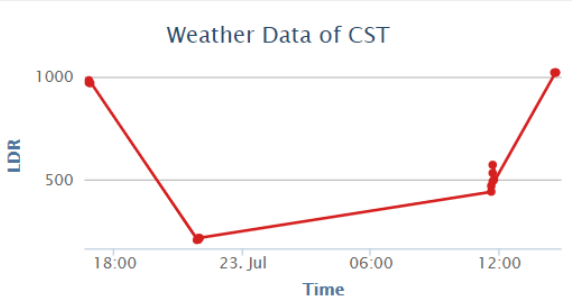
No	LDR Value	Temp Value	Humi Value	Pressure Value
192	974	27.3	95	953
194	986	27.2	95	953
196	977	27.3	95	953
198	206	27.8	95	956
200	208	27.9	95	956
201	208	0	0	956
202	216	28.1	95	956
203	221	28.1	95	956
204	216	28.1	95	956
205	470	27.8	95	957
206	492	27.8	95	957
207	533	27.9	95	957
208	573	27.7	95	957
209	1024	27.9	95	956
210	1024	27.8	95	956
211	1024	27.8	95	956
212	1024	27.9	95	956
213	488	27.9	95	957
214	530	27.9	95	957
215	521	28	95	957
216	552	28.1	95	957
218	607	28.1	95	959
219	561	28.1	95	959
220	630	28.2	95	959
221	549	28.2	95	959
222	514	14.1	187.8	959

SP8266 MySQL Database

Altitude Value	PM10 Value	PM25 Value	Date	Time
512	66.6	34.5	2020-07-22	17:24:48
512	55.3	41.7	2020-07-22	17:26:53
512	39.8	33.1	2020-07-22	17:29:00
486	73.3	32.5	2020-07-22	22:28:28
487	55.6	30	2020-07-22	22:30:32
487	54.2	29.6	2020-07-22	22:31:37
487	53.7	29	2020-07-22	22:32:42
486	48.4	26.1	2020-07-22	22:33:47
486	53.5	28	2020-07-22	22:34:49
480	350.4	321.1	2020-07-23	12:16:29
480	65	59.9	2020-07-23	12:17:30
481	51	47.1	2020-07-23	12:18:33
481	73.9	68.7	2020-07-23	12:19:38
492	28.7	6.9	2020-07-23	15:13:53
491	13.3	5.6	2020-07-23	15:14:55
491	8.2	4.2	2020-07-23	15:15:57
492	5.8	4.1	2020-07-23	15:17:00
481	34.2	9.5	2020-07-23	19:45:58
481	25.2	8.4	2020-07-23	19:47:00
481	13.6	6.6	2020-07-23	19:48:03
481	19.8	8.1	2020-07-23	19:48:41
465	28.8	8.3	2020-07-23	22:19:42
465	13.3	8.1	2020-07-23	22:20:45
465	16	7.2	2020-07-23	22:21:47
465	14.7	6.6	2020-07-23	22:22:49
465	16.6	7.8	2020-07-23	22:23:51

Fig 4 Weather variable table in a phpMyAdmin

The data collected from the sensors were also presented using graphs in Thing Speak as shown below. Thingspeak is an IoT analytic platform. It allows us to visualize and analyze live data streams in the clouds (Joe & Joseph, 2019). It helps in monitoring and analysis of weather conditions which is accessed by both administrator and user through web page.



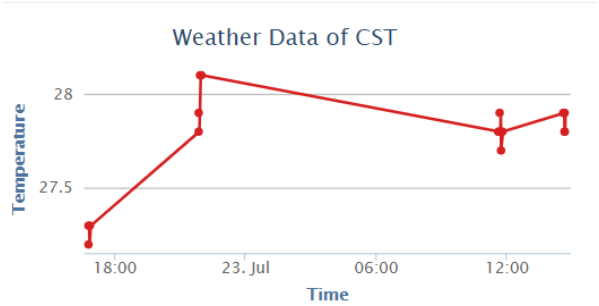


Fig 5 Graphical data of a temperature (DHT11) in ThingSpeak

DHT11 is also tested indoors. The sensors can read both Temperature and Humidity. The output given is stable and its signal output is digital. The temperature reading is given in degree Celsius and the humidity as Percentage. The test result is observed both in the serial monitor and Thingspeak. At last the result was compared to the reading that we obtained from our mobile phone.

Fig 6 Graphical data of a LDR

The figure above shows the reading of LDR in normal room light and at its highest when subjected to flash light (maximum point).

6. DATA ANALYSIS

The system has collected data of various parameters in different situations. All the data is recorded in MySQL database. The data is collected from normal room, an open field/environment and in an air-conditioned room. From the data, the system was stable in both normal room as well as in open environment but was not stable in air-conditioned room as shown in figure below.

253	992	26.5	95	960	451
254	682	24.8	92	958	472
255	782	0	0	958	472
256	790	-13	174	958	473
257	744	0	0	958	472
258	788	-12.9	174	958	472
259	944	25.4	93	958	472
260	945	25.5	94	958	473
261	873	0	0	958	473
262	885	25.6	95	958	473
263	886	25.8	95	958	473
264	600	12.4	174	959	458
265	607	0	0	959	459
266	646	25	91	959	458
267	641	25.1	91	959	459
268	702	-12.9	173	959	458
269	709	25.2	90	959	458
270	760	25.1	90	959	458
271	858	26.1	95	957	477
272	885	0	0	957	476
273	819	26	95	957	476
274	843	26.1	95	957	477
275	960	13.1	187.8	957	476
276	894	13.1	187.8	957	477
277	836	26.3	95	957	477

Fig 7 Data collected from air-conditioned room

6.1 CHALLENGES

Though there are many benefits from this IoT based weather station project, there are some challenges faced. In order to supply constant continuous power to the system, the 5 volts DC power supply is designed and used here. While designing and making this 5 volts DC power supply there were challenges like not getting the desired components and its values (the desired capacitor value and long electrical wire). Again, faced challenges in soldering and fabrication of it. It could not supply exactly 5 volts DC power supply, but it supplies between 4.23 to 4.9 volts. Unlike other sensors in this IoT based weather station project, the DHT 11 sensor shows sudden error sometimes. In the middle of displaying correct Temperature and Humidity values, it suddenly displays high random value of Temperature and Humidity value. Similarly, to the soldering and fabrication of 5 volts DC power supply, there were also major challenges in soldering and fabrication of the overall system. Like DHT 11 sensor and BMP180 sensor have the common pin connection in Wi-Fi module ESP8266 and it was impossible to connect both the pins to the Wi-Fi module ESP8266 in the same pin. Later an alternative way was found where DHT 11 sensor pin can be connected to the Wi-Fi model 26 ESP8266 pin. Nevertheless, there were challenges in soldering and fabrication as mentioned earlier. That is, each pin needs to connect to its exact or respective pin on other components perfectly. Otherwise the system fails to display the correct results. Since DHT 11 or Temperature sensor needs to be placed at the certain from the ground for the accurate result. Then stand for this weather station needs to be made according to the requirement and desirable of the sensors and weather station box.

7. CONCLUSION

The IOT based weather station serves as a reliable system for measuring the environmental parameters like temperature, humidity, pressure, altitude, pm2.5, pm10 and light intensity. The measured values using the designed system were checked against the information displayed online like temperature and humidity so cross check that the measured values had no errors. The system was found to be measuring the correct data. These parameters are important for the welfare of the people living in that area. The collected data can also be used to analyze and forecast weather. This proposed system can be further extended in measuring wind speed and wind direction which were omitted due to budget constraints.

8. REFERENCE

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