

ORIGINAL RESEARCH

Development of a Wifi-based IoT Weather Monitoring System

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Abstract

Knowing the live environmental condition is one of the most important problems in the modern world since measuring the live environmental condition presents lots of challenges. This issue will be resolved by the suggested system because it tracks current weather conditions. It shall be ensured that the system successfully tracks the Gidan Kwano Region's live weather parameters. Using the Internet of Things, the suggested system will operate on a client-server architectural model. The architecture of the system is two-tiered. The suggested system has several sensors that will track the system's light intensity, humidity, and local temperature. This paper shows the data on the webserver and monitors the real-time weather data using the sensors. A webserver allows anyone to monitor the weather condition from anywhere without relying on any application or website. The sensor collected data and sent it to the node MCU controller. The Arduino IDE is used to upload the sensed data. The serial monitor serves as a gateway between the sensor and the cloud. The sensor pushes the data on a serial monitor, which monitors an IP address. The data is accessible to the public via the webserver. The proposed system measures the Gidan Kwano Region's weather conditions, and after obtaining data from the different sensors, it is discovered that the suggested model outperforms the conventional weather technique.

Keywords: Arduino IDE, HTTP display protocol, Sensor, Serial monitor, Weather monitoring

Introduction

Human life is greatly impacted by weather monitoring, so it is essential to collect data on the temporal dynamics of changing weather. By collecting and analyzing data on temperature, humidity, air pressure, airflow direction, velocity, and rainfall over a wide area, one can accurately assess the weather (Kang and Park, 2000). Previously, most weather monitoring systems relied on mechanical and electromechanical devices, which had poor error rates and permanence issues. In 2000, Kang and

Pack created sensors to measure the climate and surroundings inside buildings (Kang and Park, 2000). In 2005, it was discovered that integrating these sensors with a data collection system provided a more efficient method of keeping an eye on temperature, pressure, and relative humidity (Moghavvemi and Tan, 2005).

Every person's life involves a lot of weather monitoring. The state of the environment causes many issues in various industries, such as construction, agriculture, and more, but the quantified impact is most noticeable in the agriculture sector, which is crucial to Nigeria's economy and contributes more than 25% of its Gross Domestic Product (GDP), as everyone knows.

Internet of Things (IOT)'s clever language (Sharma et al., 2020; Verma and Prakash, 2020) suggests that using the fewest parameters feasible yields better results. In addition to utilizing more modern science and technology, it improves crops with less time, space, and water. One of the main problems with IOT networks is security (Verma and Prakash, 2020a; Srivastava and Prakash, 2020b). There are always methods to improve the security that is already in place, even though there are numerous different security approaches accessible. In agriculture, weather is the most expensive factor in the farming process, which involves multiple stages prior to yield.

As the years go by, the regional weather in Gidan Kwano varies seasonally. Gidan Kwano is located in the "Minna" region in mid-Nigeria. In this case, knowing the state of the weather is crucial before planting or harvesting the crops. Therefore, farmers would benefit from weather monitoring in this scenario with the use of a weather monitoring system (Sharma et al., 2020; Verma and Prakash, 2020).

The writers in (Huang et al., 2020) recommended a single automatic weather station that is both dependable and cheaply priced. According to the author of this work, better weather forecasting skills and building resilience against the adverse effects of weather report conditions rely heavily on the quality of meteorological data because the weather prediction system is facing an increasingly challenging task with each extreme weather event that negatively impacts property and human life.

The work claims that a lack of reliable weather observation has made it difficult for Uganda and many other developing countries to produce timely and accurate meteorological data. One of the factors driving up the expense of creating automated weather scenarios is the scarcity of weather monitoring. National weather services in the relevant nations are able to use the restricted funds. This proposed method involves the author first addressing the issues and then implementing the remedies. Based on a wireless sensor network, the author suggested an autonomous weather monitoring station.

The authors in Ladi et al. (2017) present a system that monitors the weather using IoT. In that work, the ambient parameter is obtained using sensors. The author uses an LDR sensor in addition to another sensor to scale numerous factors, such as temperature, pressure, humidity, and rain value. The dew point value is likewise determined by the system using the temperature prototype. Any location, including rooms and spaces, can have its value measured by the temperature sensor. The light intensity can be utilized as the author recommends with the aid of the LDR sensor. The SMS warning system, an additional weather monitoring tool used in the study by the authors, is activated when temperature, humidity, pressure, light intensity, and rain value above preset criteria. The author also includes an alerting system for tweets and emails. The writers in this system use several sensors and a node MCU 8266.

The authors of the journal paper, Susmitha and Sowmyabala, (2014), show how an OLED can be used to monitor the live weather and also identifies various fields where IoT innovation has led to new advancements for the system. The authors presented a brand-new, cutting-edge method that offers a weather evaluation in real time. All parties interested in weather monitoring, including regular workers, businesses, students, and farmers, gain greatly from it. The authors made it easier for farmers and businesses by developing a real-time weather monitoring system. The journal article's author used an OLED panel to show the current weather, and the suggested concept involved using an Arduino-powered WeMos D1 board with an ESP8266-EX microcontroller to retrieve the data from the cloud.

The ESP-8266EX microprocessor is the central component of the WeMos D1 Wi-Fi module, and the weather data will be displayed on the Thingspeak website after the connection has been established. The data is saved on the cloud and displayed by the system's OLED and cloud-speaker devices. The OLED and cloud-speaker devices of the system show the data. The author wants to be able to access real-time weather data on an OLED display.

A weather monitoring and prediction system was presented by the authors in Parashar et al. (2015) so that everyone may make plans for their daily lives. Every industry benefited from this endeavor, including business and agriculture. To track and forecast weather information, the author uses the first two stages of the weather management system. Finally, the author talks on the reliability of the proposed approach for weather monitoring. Furthermore, this model proposed a one-day weather forecast or prediction based on the training model. Lastly, the author presents a real-time weather monitoring and forecast system by demonstrating the application of bus information management in this system. Four essential components are embodied by the author: Information management, an interactive transportation hub, a machine learning prediction model, and a weather information platform

The authors of a research journal, Sabharwal et al. (2014) installed a system that monitors weather using IoT, and explained how weather patterns may be tracked, and environmental elements can be found. People may become more aware of climate change thanks to this program. It employs the swarm method to further improve accuracy, and it produces an output that is accurate and efficient. Thus, the authors want to build a weather monitoring system using IoT.

Popa and Iapa, (2011) explains how to construct a weather monitoring system with a WIFI module. Through a Wi-Fi connection, the weather monitoring device completes the procedure. The transmitting and receiving halves of the system are separated. The controller, multiple sensors, and the Wi-Fi module are all housed in the transmitting section. The receiving sector contains router, web

server, and other parts. The author explains the system's operation as follows: Temperature, humidity, pressure, and other environmental factors are measured by a multitude of sensors. The tipping bucket method is employed by the rain gauge sensor.

The authors of this study proposed and built a cheap hardware module that is based on the Arduino Uno Board. This board measures meteorological data, such as average temperature, sensor, atmosphere, wind direction, and speed. It then uses a Zigbee wireless link to transfer all this data to the GUI system installed on the laptop. One helpful stand-alone program is the Windows operating system's graphical user interface. It is used with the software LABVIEW. The current state is graphically displayed by the LABVIEW software, which also records data that is comprehensible by Microsoft Excel.

The study "An Intelligent weathering system using the internet of things," which was reported by the authors of paper (Yashawi et al., 2018), employed machine learning algorithms and IoT technology to measure climate factors and predict the next state. The author has a very effective and cost-effective method for managing the weather. The information is uploaded to the cloud, where it is viewable online by anybody with an internet connection. Temperature, humidity, and pressure all have a big impact on the system. can be employed in logistics or other systemic industries like agriculture. Weather monitoring and forecasting are essential for these businesses to expand. This study's design and execution made use of Internet of Things (IoT) technologies. The Internet of Things (IoT) is a clever and practical way to attach a sensor to the cloud, which keeps data in real time and connects everything in the world via a network. The item could be a sensor, electrical device, or component of the car's electronics system. Utilizing sensors, move data or information to a cloud platform and store it there.

This method makes use of a machine learning prediction technique. The method described by the author gathers data from discrete sensors—which are just code dumps into Nodemcu—using a node

MCU microcontroller. After that, the data is transferred to a specific cloud, where Things peak is utilized to provide the data in both application and online views. Every sensor has a nodeMCU connection. It sends the sensed data from the cloud, performs data analysis, and displays the outcome on the website's consequent view.

Paper, Sharma et al. (2020) presents the “Embedded weather station with Remote wireless control”. In this work, the authors elaborate on the importance of a weather monitoring system. The author provides an explanation of how the modern weather monitoring system functions. Knowing the weather is crucial before beginning any outdoor work. That work discusses a field where weather observation is crucial. Weather monitoring is done in a variety of methods in a wide range of industries, including industry, entertainment, military, and agriculture. One of the three options—a weather monitoring system—is explained. A static weather station was employed at first. The second one is based on the wireless sensor network, while the third one uses a smaller weather station. A weather station with sensors implanted for temperature, light, pressure, humidity, and other variables and a micro-controller based on the board is described by the study's author. SMS services on mobile phones limit the weather station's functionality.

The authors, Verma and Prakash (2020), envisioned the idea of weather monitoring using artificial intelligence. The authors claim that rather than using a binary decision approach, weather forecasting uses a statistical strategy. The authors plan to put in place a sophisticated weather forecasting system. due to the system's required tool, which logs and assesses the highest and lowest temperatures as well as the amount of precipitation that falls during a specific time of day. The available data, which is produced by machine learning algorithms, serves as the basis for the forecast. The analysis and prediction are based on linear regression, which creates a more accurate forecast for the weather the following day. More than 90% accuracy is attained by machine learning approaches. The data set can only be changed to appropriately reflect the results by the system that generates the best result. It works

effectively when there is a lot of data. A further consideration is that about 7% of the data must be forecasted. Weather conditions may be tracked and forecasted more accurately and efficiently with the help of this module.

The real-time accessible system is covered by the authors in Joseph (2019). The authors of this study established an IoT-based approach. The technology utilized in this study monitors a wide range of meteorological and climatic factors, including UV radiation, pressure, temperature, humidity, and even airborne carbon monoxide levels. It gathers data from a variety of sensors and publishes it to a webpage for people to view and interact with graphically. Anybody in the world can view the data if it is uploaded to the web server. A smartphone app that notifies an alert system to notify users of abrupt and severe weather changes is the main component of the concept. Not much extra power is used by the component. Moreover, a solar panel can power it as well. According to the author, this technology is more affordable and efficient when compared to other consumer-available options. The weather station, aviation, marine, meteorological, and other industries employ this kind of project.

The early systems' lack of stiffness, requirement for endurance, requirement for human contact, and resulting parallax problems were just a few of their shortcomings. Furthermore, the industry only used mechanical and electromechanical technologies. Therefore, to eliminate this disadvantage, a remote monitoring system is required.

Materials and Methods

This section outlines the design methodology for the weather monitoring system, covering system description, hardware design (component selection and interconnection, with NodeMCU as the central processing unit), and software design (data processing and communication with the IoT platform).

In this project, the hardware and software are used which makes it easy to implement. The authors gather and store climate data on the cloud using an alternative sensor. All the weather information is uploaded to the Android mobile application by the frequently used Internet of Things website -

www.thingspeak.com - after it has been retrieved from the cloud storage space using an API key. Rain sensors are devices that can identify drops of precipitation. Three sensors - TC thermistors and an integrated circuit at the back of the sensors - can be employed as humidity sensing components. The humidity component, which comprises two electrodes, is used to measure humidity. The controller in use is the Node MCU. The Node MCU is mostly utilized in Internet of Things projects. The Arduino IDE was used to program this. The programming language used for scripting is called LUA. The WiFi module ESP8266 is used by NodeMCU. Google developers utilize this Android STUDIO for development work. This program's objective is to expedite the processing procedure. Create a common application with Android Studio that displays data streaming from item space. This smartphone application makes it easy to monitor the weather.

The project uses an ESP32 microcontroller for processing sensor data, DHT11 and LDR sensors for temperature, humidity, and light measurement, a display unit (likely LCD) to show data, and a power unit. Figure 1 shows the block diagram of the system.

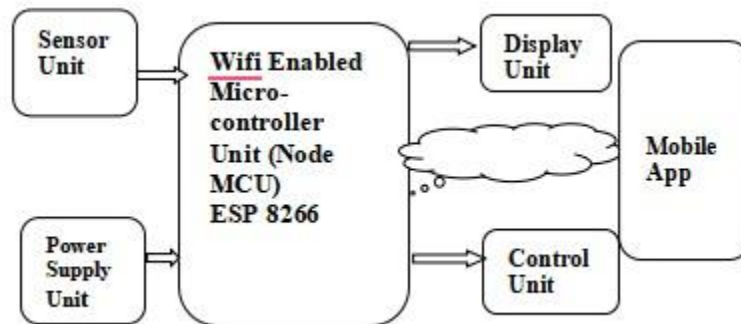


Figure 1: Block Diagram of The System.

This section emphasizes the importance of verification and testing throughout the process to ensure successful implementation (citations can be added here to specific electronics assembly guides).

The initial phase involved virtual testing using Proteus software. This computer-aided design (CAD) software allows for simulating the behavior of individual components within the system. This virtual

testing stage served a critical role in identifying and troubleshooting potential problems before moving on to physical assembly. By simulating the circuit, any design flaws or component incompatibilities could be addressed before investing time and materials in real-world construction.

The project's circuit design was first simulated using Proteus software. This virtual testing helped identify and troubleshoot any potential issues early on, avoiding problems during the build phase.

Figure 2 shows the Circuit diagram of the IoT Based Weather Monitoring System.

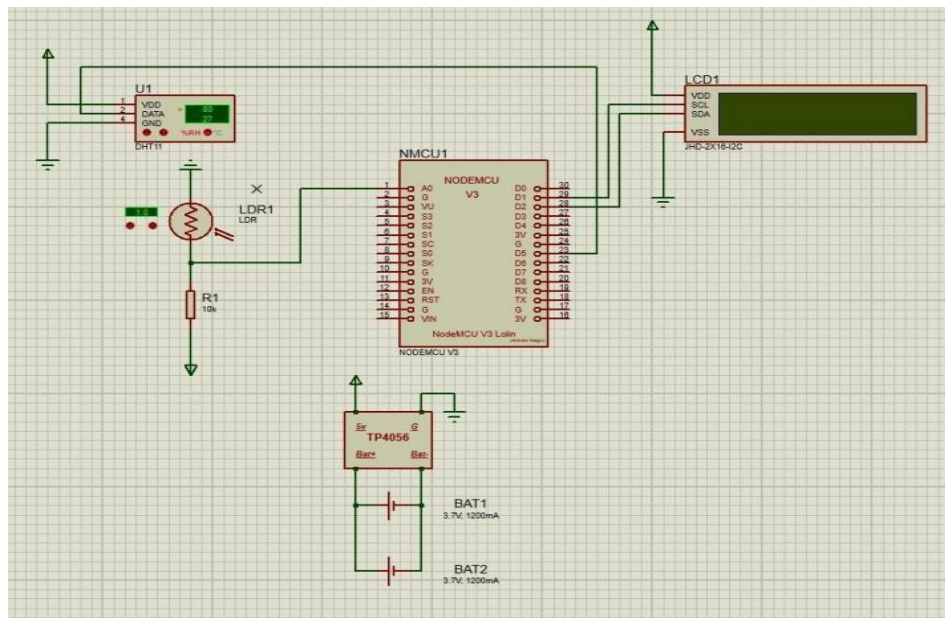


Figure 2: Circuit Diagram of the IoT Based Weather Monitoring System.

The components of the hardware units are:

1. NodeMCU (ESP8266) Wi-Fi Module

The NodeMCU module successfully communicated with the mobile app, transmitting sensor readings to the app's dashboard, allowing users to monitor weather conditions remotely.

2. **TP4056 Battery Charging**

The TP4056 module efficiently charged the connected lithium batteries in parallel

3. **Light Dependent Resistor (LDR)**

Light intensity levels were monitored over seven days at various times (morning, afternoon, and night).

4. **Power Supply Unit**

It comprises two lithium batteries and a TP4056 charging module. This module is made for charging rechargeable lithium batteries using the constant current/constantvoltage (CC/CV) charging method.

5. **Temperature and Humidity Sensor (DHT11)**

The DHT11 has three pin which are the VDD, GND and DATA. The VDD is the input voltage pin and it was connected to the power source. The GND was connected to ground and the DATA pin was connected to the digital pin 5 (D5) of the nodeMCU.

Software Coding

The software design code is done using Arduino IDE which operate on embedded C programming language as shown in Figure 3.



```
IoT_Monitoring_System | Arduino 1.8.19
File Edit Sketch Tools Help

IoT_Monitoring_System

//#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <SoftwareSerial.h>
#include <ESP8266WiFi.h> // hotspot
#include <ESP8266WiFiClient.h> // wifi
#include <DHT.h> // https://github.com/adafruit/DHT-sensor-library

#define DHTPIN 14 //DS pin where the dht11 is connected

DHT dht(DHTPIN, DHT11);

#ifdef ESP32
#pragma message(THIS EXAMPLE IS FOR ESP32 ONLY!)
#error Select ESP32 board.
#endif

const char* ssid = "IOT MONITORING";
const char* password = "1122334455";
String URL = "http://bot.rajtronixtech.com/iotmonitoring/bot.php?UID=idata="; //computer IP or the server domain
String getData, Link;
#include <WiFiClient.h>
WiFiClient wifiClient;
// I2C LCD setup
LiquidCrystal_I2C lcd(0x27, 16, 2);

// MQ2 gas sensor setup
int mq2DigitalPin = D6;

// LDR intensity
```

Figure 3: Snapshot of Arduino IDE.

Flow chart

The flow chart of the system is shown in Figure 4

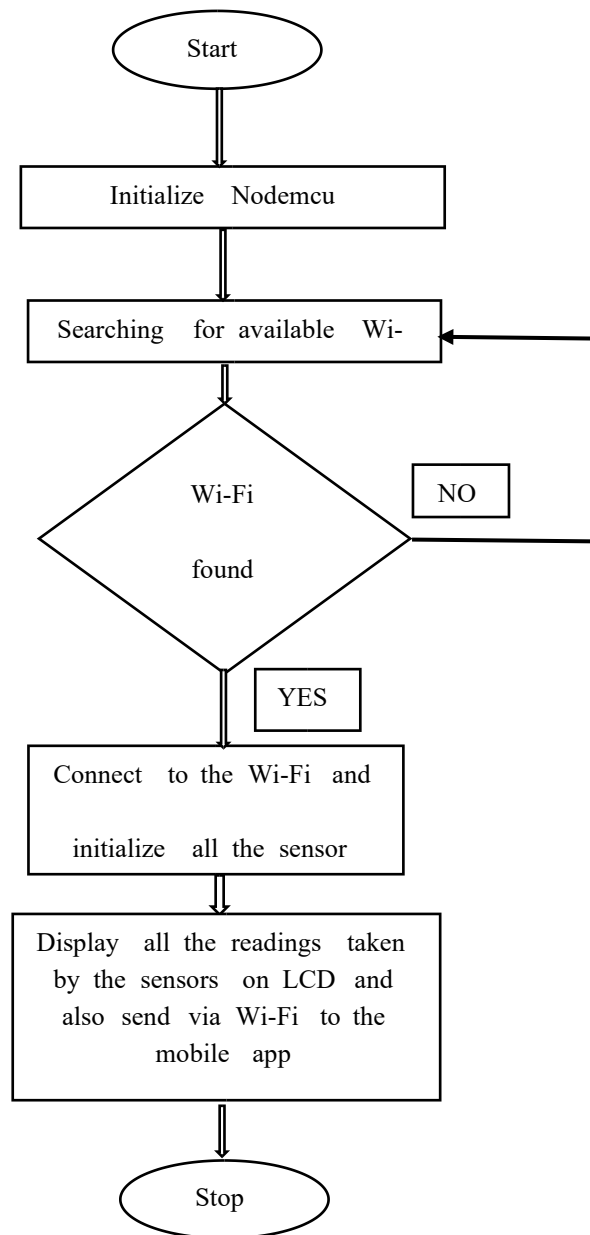


Figure 4: The Flow Chart

Following the virtual testing phase, the project progressed to the breadboarding stage. Breadboarding is common electronics prototyping technique that involves temporarily connecting components using a solderless breadboard. This temporary assembly method allowed for real-world testing of the

circuit's functionality and facilitated adjustments before permanent assembly. During this stage, researchers could confirm sensor readings, display behaviour, and overall system operation. Figure 5 shows the breadboard connections of all components.

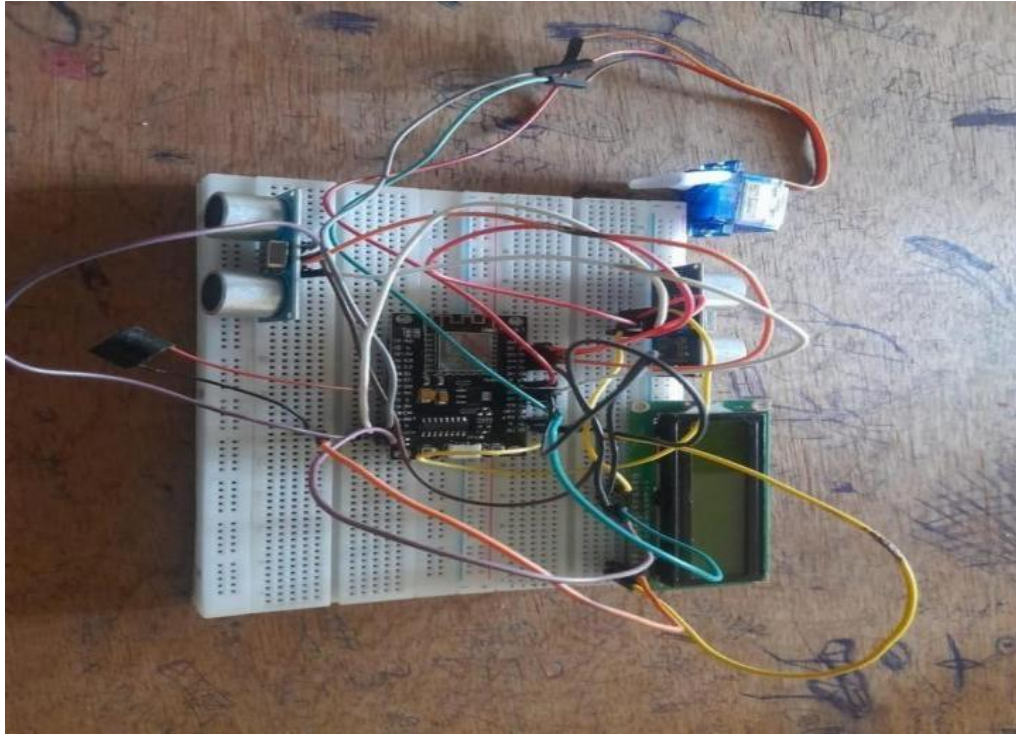


Figure 5: Breadboard connection of all component.

Once the breadboard prototype successfully demonstrated the desired functionality, the components were permanently soldered onto a Veroboard. A Veroboard, also known as a stripboard, is a versatile prototyping PCB (printed circuit board) that allows for permanent component mounting through soldering. Compared to the breadboard, the Veroboard offered a more compact and permanent design, making it suitable for the final weather monitoring system. The inclusion of male-to-male connectors on the Veroboard provided a clever and practical solution for future component replacement in case of malfunction. This design consideration ensured the system's longevity and maintainability. The interfaced components on Veroboard is shown in Figure 6.

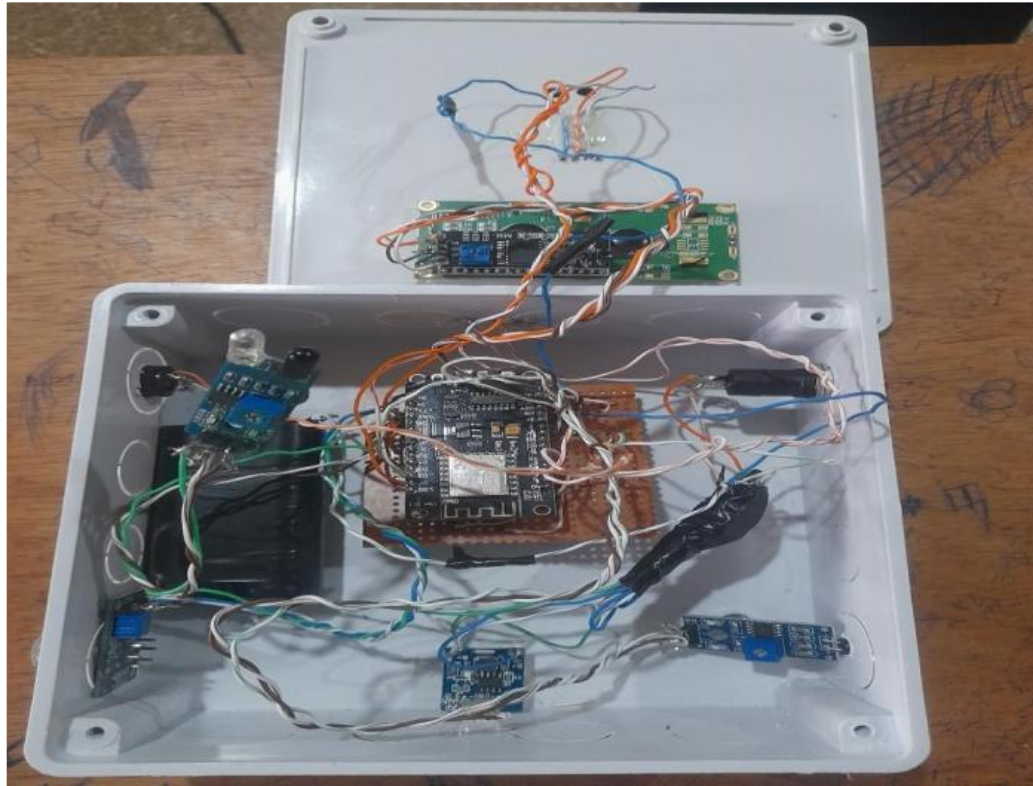


Figure 6: Interfaced components on Veroboard

Safety remained a top priority throughout the assembly process. The text emphasizes the importance of using appropriate tools for soldering, maintaining a proper soldering temperature to avoid damaging components, and double-checking for overvoltage or loose connections that could lead to malfunctions or safety hazards. By adhering to these safety precautions, the researchers ensured a reliable and functional final product.

Results

The results are categorized into two. The software implementation results and the hardware implementation result.

A. Software Implementation Result

A mobile application was developed to display sensor readings from the weather monitoring system. Figure 7 showcases the software interface of this mobile app, which provides security features for the system.



Figure 7: The mobile App interface

B. Hardware Implementation Results

Each hardware component was tested individually to ensure proper functionality. All components performed as expected, meeting the project's design requirements and demonstrating their effectiveness and reliability.

The node MCU (esp8266) Wi-Fi module worked as expected, establishing a steady connection with the mobile app and allowing for easy appliance control. Figure 8 shows the system's connectivity based on the available network

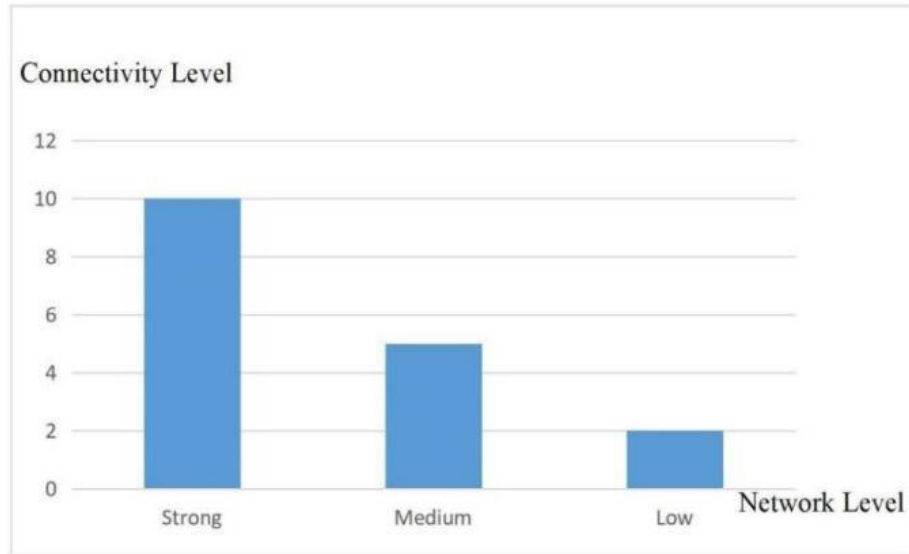


Figure 8: The system's connectivity based on the available network.

Figure 9 illustrates the voltage reading of the fully charged batteries.

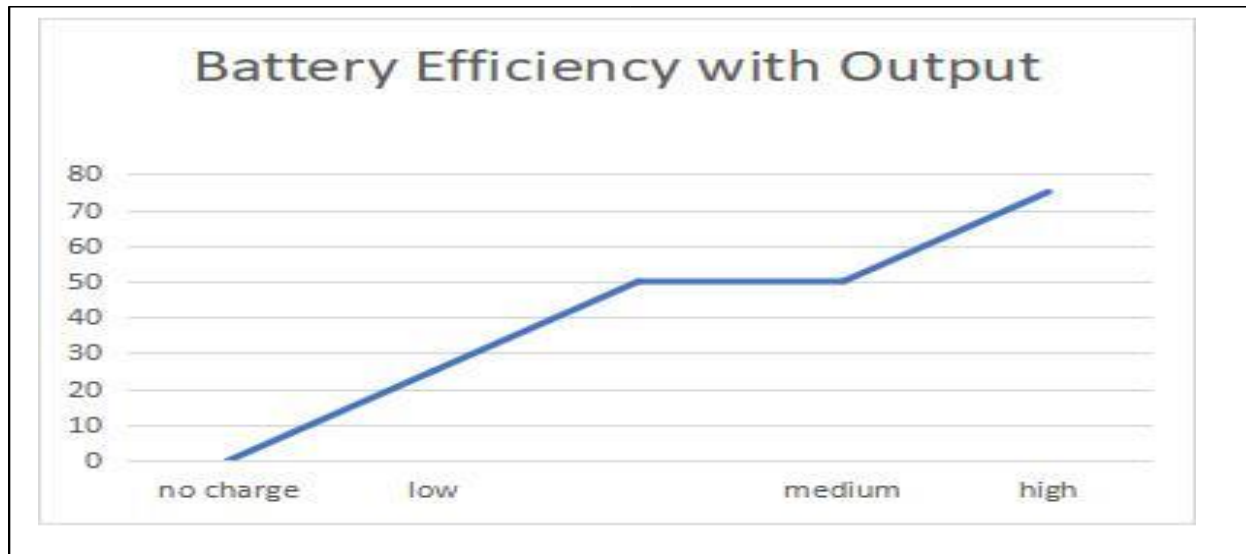


Figure 9: The voltage reading of the fully charged lithium batteries connected in parallel.

The readings in Figure 10 showed variation in natural illumination, with mornings averaging 6.79%, afternoons averaging 28.29%, and nights averaging 75.71%.

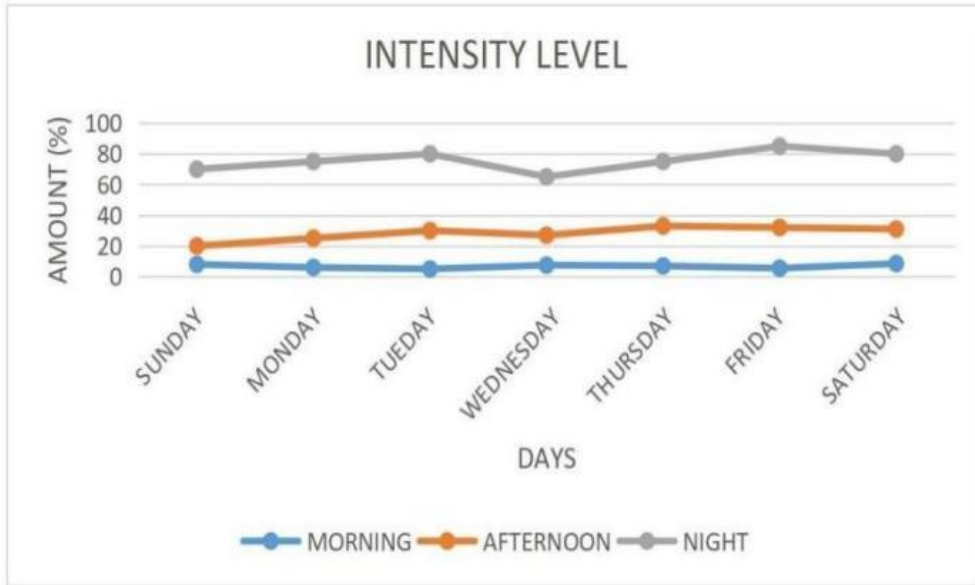


Figure 10: The intensity sensor Readings

Figure 11 depicts the average temperature readings, showing a cooler start in the mornings (78%), moderate warmth in the afternoons (30%), and cooler nights (18%) while Figure 12 illustrates the changes in humidity over the seven days.

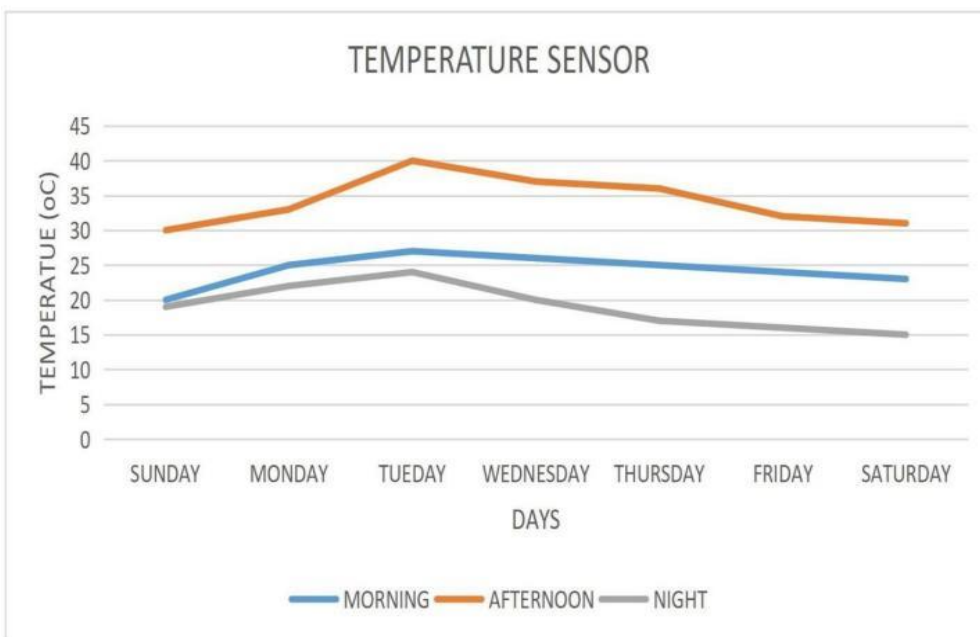


Figure 11: Temperature Sensor Reading

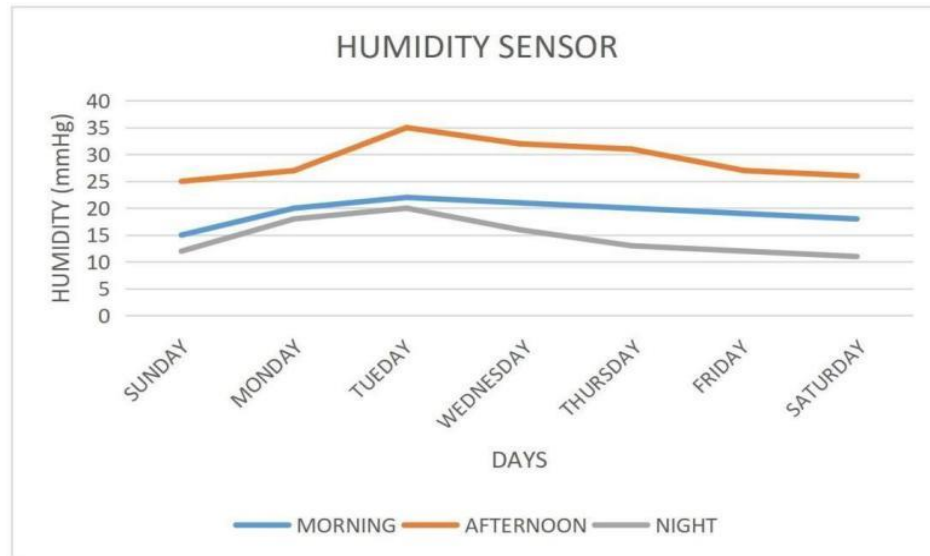


Figure 12: Humidity Sensor Reading

Discussion of Results

The system demonstrated good performance in terms of accuracy, connectivity, and response time. Sensor readings were displayed on the LCD and transmitted to the mobile app, highlighting its suitability for real-world applications.

When compared to existing projects in the department, the developed system offers a wide range of connectivity because the user can get notification both within the premises and remotely.

Conclusion

Self-protection (also known as a smart environment) is made possible for the environment by keeping the weather station there for observation. This research presents an intelligent approach to an effective, low-cost embedded system for environmental monitoring. Additionally, the sensor parameters can be sent to the cloud. This data will be helpful for future analysis and it can be easily shared to other users also. This model can be expanded to monitor the developing cities and industrial zones for pollution

monitoring. To protect the public health from pollution, this model provides an efficient and low-cost solution for continuous monitoring of environment. Devices in this proposed system that monitor weather parameters at the lowest possible cost. The client-side architecture paradigm is used by the suggested system to operate. Based on the client-side architecture model, the suggested system functions. The suggested method used several sensors to record different environmental data. The designed system uses fewer sensors than the current model. Our business model's primary goal is to lower the system's cost of operation. The suggested system captures data from numerous sensors and sends it to a webpage using the HTTP request protocol on a web server, allowing anyone to utilize it without restriction. Here, the proposed system performs working in the region of Gidan kwano. In this region, we have sensed the value of a single location i.e. GIDAN KWANO. Then the 38 values are being arranged in a tabular form with respect to their data, time and done analysis. The proposed model is not only collecting data but also making decisions on the basis of observed data. It is very helpful for farmers because it collects environmental data making an interpretation for farmers.

Author's contribution

Abdullahi, H. M and Usman, A. U. conceptualized the study. Innocent C. and Abdullahi, H. M. designed the study. Innocent C., Abdulkadir, O. A. and Abdullahi, H. M participated in fieldwork and data collection. Abdullahi, H. M. performed the data analysis; Anunuso, J. C. and Jack, K. E. interpreted the data. Innocent C. prepared the first draft of the manuscript, reviewed by Usman, A. U. and Zubair, S. All authors contributed to the development of the final manuscript and approved its submission.

Conflict of Interest

None

Ethics Approval and Informed Consent

Ethical approval for this study was obtained. All participants were duly informed of the objectives of the study and the protocol for sample collection. All participants signed an informed consent form were signed. Participation was voluntary.

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References

- Anandharajan, T. R., Abhishek, V. G., Hariharan, K. K, Vignajeth, R. & Jijendiran, K. (2016), Weather monitoring using Artificial Intelligence; 2016 *International conference on computational Intelligence and Networks*. pp. 106 - 111; DOI 10.1109/CINE.2016.26
- Huang, Z. Q., Chen, Y-C., & Wen, C-Y. (2020). Real- Time Weather Monitoring and Prediction Using City Buses and Machine Learning; *Sensors*, 20 (8), pp. 1 - 21; Accessed via: <https://doi.org/10.3390/s20185173>.
- Joseph, F. J. J. (2019), IoT Based Weather Monitoring System for Effective Analytics; *International Journal of Engineering and Advanced Technology*, Vol 8, Issue 4, pp 311-315, 2019. Accessed via: <https://www.ijeat.org/wp-content/uploads/papers/v8i4/D6100048419.pdf>
- Kang, J. & Park, S. (2000). Integrated comfort sensing system on indoor climate. *Sensors and Actuators*, 2000: 302-307.

Ladi, K., Manoj, A. V. S. & Deepak, G. V. N. (2017). IOT Based Weather Reporting System to Find Dynamic Climatic Parameters; *International Conference on Energy, Communication, Data Analytics and Soft Computing (ICECDS-2017)*. pp. 2509 - 2513

Moghavvemi, M. & Tan. S. (2005). A reliable and economically feasible remote sensing system for temperature and relative humidity measurement. *Sensors and Actuators*. 2005: 181-185

Parashar, T., Gahlot, S., Godbole, A. & Thakare, Y. B. (2015). Weather Monitoring System Using Wi-Fi”, 2015: pp. 78 - 96.

Popa, M. & Iapa, C. (2011), Embedded weather station with remote wireless control; *2011 19th Telecommunications Forum (TELFOR) Proceedings of Papers*, Belgrade, Serbia, 2011, pp. 297-300, doi: 10.1109/TELFOR.2011.6143549.

Prakash, S. & Verma, G. (2020). “Emerging Security Threats, Countermeasures, Issues and Future Aspects on Internet of Things (IoT): A systematic Literature Review”, *2nd International Conference on Future Learning Aspects of Mechanical Engineering (FLAME 2020)*, pp. 1 - 8.

Prakash, S. & Verma, G. (2020). “A comparative study based on different Energy saving mechanisms based on Green Internet of Things (GIoT)”, *8th IEEE International Conference on Reliability, Infocom Technology and Optimization (ICRITO-2020)*, IEEE Conference Record Number 48877, Amity University, Noida, India, Pid631, June 4-05, (2020). pp. 659 - 666

Rahut, Y., Afreen, R. & Kamini, D. (2018), Smart weather monitoring and real time alert system using IoT; *International Research Journal of Engineering and Technology (IRJET)*; Volume: 05 Issue: 10; pp. 848 - 854; Accessed via: <https://www.irjet.net/archives/V5/i10/IRJET-V5I10158.pdf>

Sabharwal, N., Rajesh, K., Thakur, A. & Sharma, J. (2014), A low- cost zigbee based automatic wireless weather station with Gui and web hosting facility; *Electronics and Communication*; pp. 1 - 58; Accessed via: <https://doi.org/10.13140/RG.2.2.15921.99686>.

Sharma, R., Prakash, S. & Roy, P. (2020). Methodology, Application and Challenges of WSN-IoT; *IEEE International Conference of Electrical and Electronics Engineering (ICE3-2020)*, jointly organized by Madan Mohan Malaviya University of Technology Gorakhpur and North Dakota State University, Fargo, USA; pp. 502 - 507.

Srivastava, S. & Prakash, S., (2020). “An Analysis of various IOT Security Techniques: A Review”, *8th IEEE International Conference on Reliability, Infocom Technology and Optimization (ICRITO-2020)*, IEEE Conference Record Number 48877, Amity University, Noida, India; pp. 355 - 362

Susmitha, P. & Sowya Bala, G. (2014), Design and Implementation of Weather Monitoring and Controlling System, *International Journal of Computer Applications*. 97, 3 (July 2014), pp. 19-22; DOI: 10.5120/16987-7089