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Weather Reporting System Using Internet Of Things

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Abstract - *Weather forecasting plays a pivotal role in various sectors, influencing decisions in agriculture, transportation, disaster management, and more. In this research paper, we propose a sophisticated online weather reporting system based on the Internet of Things (IoT) to forecast the atmosphere's state at specific locations and times. This system allows for the real-time detection, recording, and display of essential weather factors, such as temperature, humidity, rainfall, and moisture. The heart of the project is a real-time database that securely stores collected weather data in the cloud, making it easily accessible to the public. By analyzing the measured weather features specific to each location, we can assess the weather trend and gather crucial insights. Our proposed system executes predetermined operations based on current weather conditions and sensor readings. The data from sensors is efficiently displayed through the ESP8266's serial output, facilitating user interaction with the system. Through this research, we present a valuable contribution to weather forecasting and monitoring, supporting better decision-making processes across various sectors that rely on weather information.*

Keywords- IOT, ESP-01 ESP8266 , Weather station, Sensors, Smart Environment.

1.INTRODUCTION

In today's fast-paced and interconnected world, accurate and real-time weather forecasting is of paramount importance for various sectors ranging from agriculture and transportation to disaster management. The advent of cutting-edge technology has revolutionized the field of meteorology, enabling the tracking and dissemination of local weather data globally. This research paper presents a pioneering approach to monitor and share meteorological conditions worldwide through the innovative use of the Internet of Things (IoT). The Internet of Things is a groundbreaking concept that seamlessly connects a myriad of devices and sensors in a vast network, enabling them to communicate and exchange data. In this context, electronic devices, sensors, and even automotive electronics become essential components of the IoT ecosystem. Leveraging this technology, our proposed system employs a network of sensors to continuously monitor and regulate environmental factors such as temperature and relative humidity, providing real-time data accessible through a user-friendly website. Traditionally, weather forecasting relied heavily on human observations, mainly focused on changes in rainfall and sky conditions. However, the field has evolved significantly, with computer-based models now playing a pivotal role in predicting weather patterns. Our proposed IoT-based weather reporting system empowers users to access meteorological parameters online without relying on external weather forecasting services. The system effectively utilizes sensors for temperature, humidity, and rain measurement, providing continuous tracking of weather conditions and delivering real-time data reporting. Data collected by rain and temperature sensors is relayed to a microcontroller, which interprets and transmits it through a Wi-Fi connection to an online web server. In conclusion, this research paper introduces an innovative IoT-based weather reporting system that revolutionizes the way we monitor, forecast, and disseminate meteorological data. By combining cutting-edge technology with traditional forecasting methodologies, this system offers a reliable and user-friendly platform for accessing real-time weather information, ultimately contributing to informed decision-making across various domains.

A. Role of IOT in Weather Reporting System

Weather forecasting is an essential and practical skill that significantly impacts various aspects of human life. With the advent of the Internet of Things (IoT) concept, the field of meteorology has witnessed remarkable advancements, transforming the way meteorological characteristics are sensed, recorded, and utilized for real-time alerts, appliance adjustments, long-term analysis, and notifications. In the IoT-based weather reporting system, a range of specialized instruments and sensors are employed to capture and process critical weather data. These sensors are designed to monitor various aspects of weather and climate, such as temperature, humidity, wind speed, wetness, light intensity, UV radiation, and even airborne carbon monoxide levels. The collected data is then transmitted to the cloud, where it is further processed, analyzed, and presented to users in the form of graphical statistics. Furthermore, the vast amount of data collected over time by the IoT-based weather reporting system offers valuable insights for long-term weather analysis. This accumulated data can be utilized to study weather trends, climate patterns, and potential impacts of climate change on specific regions.

By facilitating in-depth analysis, this system contributes to the development of more accurate and reliable weather forecasting models, benefiting various sectors, including agriculture, transportation, tourism, and disaster management. In conclusion, the integration of IoT in weather reporting systems has revolutionized the way meteorological data is sensed, processed, and disseminated. Through the utilization of specialized sensors, cloud-based data storage, and user-friendly applications, this technology enables global access to real-time weather information, empowering individuals and communities to make informed decisions and respond effectively to weather changes.

B. Why is an IoT-based weather monitoring system necessary?

An IoT-based weather monitoring system is indispensable due to its ability to provide simple access from anywhere in the world to real-time local weather monitoring. Moreover, the system allows for both short- and long-term archiving of weather and environmental data, enabling researchers to study changes in weather patterns and gain insights into how locally produced climate change has impacted weather over time. This vast repository of historical weather data becomes a valuable resource for climate research and helps us comprehend the evolving climate and its potential implications. Additionally, the ease of deploying an IoT-based weather monitoring system for monitoring local atmospheric variables and microclimates is a significant advantage. This simplicity empowers various sectors, such as agriculture and disaster management, to harness accurate weather forecasting and prediction, facilitating proactive planning and resilience-building measures. Ultimately, an IoT-based weather monitoring system is necessary to foster global awareness, enhance preparedness, and ensure a sustainable future in the face of weather-related challenges.

2. LITERATURE REVIEW

The accurate prediction of rainfall is a pivotal challenge in meteorology, with potential implications for various sectors such as agriculture, water resource management, and disaster preparedness. Rainfall monitoring systems play a crucial role in collecting essential information about moisture and temperature, enabling the production of graphical rainfall maps based on current and past readings. Upon reviewing several papers in the field, it becomes apparent that none of them have addressed the specific combination of temperature and moisture parameters within an intertwined system that incorporates selectors for modifying these settings.

While there is one research paper that explores the incorporation of multiple environmental conditions, there remains a notable absence of citations related to the inclusion of selectors for customization. Thus, the main objective of this research is to develop a system that can effectively sense the key factors influencing rainfall formation and accurately predict rainfall with minimal errors, bridging the gap in existing literature.In conclusion, the literature review highlights the critical need for a rainfall prediction system that integrates temperature and moisture parameters with selectors for customization. By addressing this research gap, the proposed system aims to improve the accuracy of rainfall prediction, contributing to more effective water resource management, agriculture planning, and disaster preparedness. Moreover, historical soothsaying practices underscore the importance of advancing modern methods to ensure reliable and scientifically validated rainfall predictions, which can be vital for various applications and decision-making processes.

A. Related work

In the pursuit of creating an efficient and user-friendly IoT platform for weather monitoring, several relevant works have been undertaken, with a focus on integrating various sensors and microcontrollers. One such prominent development is the creation of the IoT platform ThingSpeak, which serves as a powerful tool for displaying detector data in real-time. The proposed research builds upon this foundation and delves into two primary sections: software development and hardware implementation. In the software development phase, the research encompasses critical aspects such as IoT coding, circuit schematic illustration, circuit simulation, and data accession. The objective is to ensure seamless communication between the sensors and microcontroller, facilitating the collection and analysis of data related to weather parameters, including temperature, moisture, rainfall, and air quality. On the other hand, the hardware implementation phase involves the creation of a prototype and circuit construction, aiming to establish a robust and functional weather monitoring system. The microcontroller chosen for this task is the ESP32, which will efficiently handle all the data generated by the sensors. To enhance user experience and accessibility, the system will be made available through the ThingSpeak channel, offering an online platform for users to check and monitor weather conditions in real-time. In conclusion, the related work highlights the efforts and advancements in IoT-based weather monitoring systems, with an emphasis on creating an integrated platform for displaying real-time weather data. The proposed research aims to build upon this foundation, encompassing both software development and hardware implementation, to create a robust and efficient weather monitoring system.

By employing multiple sensors and a sophisticated microcontroller, the system endeavors to provide comprehensive weather information to users through online platforms and a dedicated android app, enhancing its accessibility and usability.

B. Existing System

The existing weather monitoring systems typically involve an array of sophisticated sensors, satellite imagery, and data processing units, enabling comprehensive data collection across large geographic areas. These systems can monitor multiple weather parameters, including temperature, humidity, rainfall, wind speed, and air quality, among others. The collected data is often transmitted to central weather monitoring centers, where it is processed, analyzed, and disseminated to the public and relevant authorities for decision-making purposes. While these high-end devices serve critical roles in weather forecasting and disaster management on a large scale, their implementation for monitoring weather in a small region raises several challenges. Firstly, the initial setup and installation costs of such systems can be prohibitively high for smaller communities or organizations with limited resources. Secondly, the maintenance and operational expenses required to sustain the continuous functionality of these complex systems may not be economically viable for a small region. As a result, the need for an alternative and practical weather monitoring system for small regions becomes apparent. The proposed research aims to address this gap by developing an IoT-based weather monitoring system that is cost-effective, easy to deploy, and tailored to the specific needs of smaller regions.

C. Problem Definition

The problem addressed in this research paper pertains to the absence of a practical and cost-effective weather monitoring system tailored for small regions. While high-end devices for 24-hour weather monitoring are readily available, they are primarily designed and extensively used for recording weather conditions across vast areas, such as cities. However, implementing such systems for small regions becomes impractical due to the high maintenance costs and the extensive infrastructure required. The core of the system is the ESP8266 microcontroller, responsible for processing the sensor readings and saving them in a text file. This data can be further analyzed to generate weather forecasts and gain insights into weather patterns specific to the small region under consideration. In conclusion, the problem definition for this research paper revolves around the need for an innovative weather monitoring system tailored for small regions. By integrating essential weather sensors, utilizing the ESP8266 microcontroller, and providing real-time data visualization, the proposed system seeks to bridge the gap in weather monitoring capabilities for small communities.

The research aims to empower small regions with accurate and localized weather information, facilitating informed decision-making, and enhancing preparedness in the face of changing weather conditions.

D. Problem Explanation

The focus of this research paper is to address the significance and challenges of automatically acquiring data on humidity and ambient temperature in our immediate environment. These measured factors play a pivotal role in understanding and responding to varying weather conditions, which differ from one location to another. The research aims to design an intelligent and adaptive system that can effectively respond to current weather conditions and the real-time readings of humidity and temperature parameters. Specifically, the system is programmed to activate the heating system automatically when the temperature falls below the user-set values, ensuring a comfortable indoor environment. Conversely, when the temperature rises beyond the user-defined set values, signifying hot or humid conditions, the cooling system is triggered to maintain a comfortable and conducive atmosphere. The proposed solution aims to overcome the limitations of traditional weather monitoring systems, which often require manual adjustments and lack real-time adaptability. In conclusion, the problem explanation for this research paper centers around the need for an advanced weather monitoring system capable of automatically obtaining data on humidity and ambient temperature in real-time.

The research aims to develop an intelligent and adaptive system that can effectively regulate indoor environments based on changing weather conditions.

E. Limitations

- It is impossible to implement such a system in a tiny area.
- It's a web-based program.
- Such systems have a very high maintenance cost for a small region.

3. Proposed System

Our research proposes an innovative weather monitoring and analysis system that utilizes multiple sensors to measure various weather and environmental variables, such as temperature and humidity. The core of the system is the ESP8266 microcontroller, which processes the sensor readings and efficiently stores them in a Google Firebase database for further analysis. To provide users with real-time updates, the collected readings are also displayed on an on-board LCD screen for convenient viewing.

By evaluating these sensor readings, we can determine the weather features specific to any given location and monitor the weather trend over time. These measured factors, which vary from place to region, play a pivotal role in accurate weather forecasting. To aid in weather analysis, the system tracks and records these essential specifications over time, facilitating the creation of weather charts for specific regions.

These charts offer insights into past weather forecasts' performance, enhancing our understanding of regional weather patterns. The ESP8266's serial output enables real-time access to the readings read from the sensors, facilitating continuous monitoring and evaluation. Overall, our proposed system presents a robust and user-friendly approach to weather monitoring, analysis, and forecasting.

4. System Design

A. Overview of Functional Requirements

1. Temperature Sensing and Averaging: The system must include a temperature sensor (DHT11) to measure the environmental temperature accurately. The system will perform two consecutive temperature readings and calculate their average to ensure data accuracy.

2. Autonomous Temperature Regulation: The system should have the capability of autonomously regulating the temperature in the target region. If the measured temperature is lower than the desired level, the system will inject hot air into the area to moderate the temperature. Conversely, if the temperature exceeds the set threshold, the system will blow cold air to lower it.

3. Safety Measures: The system should include safety features to prevent any potential hazards related to temperature regulation. For instance, it should have temperature limits for hot air injection and cold air blowing to avoid extreme conditions.

By fulfilling these functional requirements, the proposed system will be able to effectively measure temperature, maintain temperature levels within the desired range, demonstrate the autonomous capabilities of its individual components, ensure user safety, and provide an intuitive user interface for seamless interaction. The successful implementation of these functionalities will contribute to the advancement of temperature regulation systems, potentially finding applications in various real-world scenarios.

B. Requirement Analysis

1. ESP8266 WIFI Wireless Module:

Figure 1: ESP8266 WIFI Wireless Module

The ESP 01 ESP8266 Serial WIFI Wireless Transceiver Module is a versatile and self-contained System-on-Chip (SOC) that comes with an integrated TCP/IP protocol stack, making it an ideal choice for enabling any microcontroller to connect to a Wi-Fi network. This module offers the unique capability of hosting an application on its own or delegating Wi-Fi networking tasks to another application processor, providing flexibility in system design. Equipped with a preprogrammed AT command set firmware, the ESP8266 module can be easily integrated with an Arduino device, granting it comparable Wi-Fi functionality to a Wi-Fi Shield right out of the box. One of the key advantages of the ESP8266 module is its affordability, making it a cost-effective solution for Wi-Fi connectivity.

2. DHT11 Temperature and Humidity Sensor:

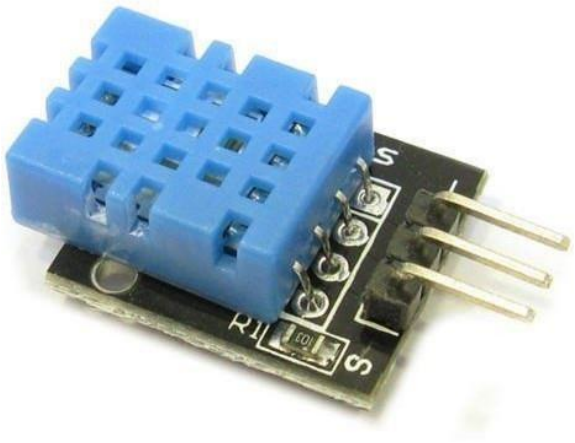

Figure 2: Temperature and Humidity Sensor

The DHT11 temperature and humidity sensor is a straightforward and cost-effective digital sensor and thermostat that accurately measures the surrounding air and delivers digital readings. Its simple design offers a single-wire serial interface, ensuring easy integration with microcontrollers and other digital devices. For temperature measurement, the DHT11 sensor exhibits reasonable accuracy, offering readings with a resolution of 1 degree Celsius. Additionally, the DHT11 sensor proves itself versatile by also providing humidity measurements.

It can accurately measure the relative humidity of the environment and present humidity readings with a resolution of 1% RH. This capability allows users to monitor and respond to changes in both temperature and humidity, making it valuable for environmental monitoring and control systems.

3. LCD-LIQUID CRYSTAL DISPLAY:

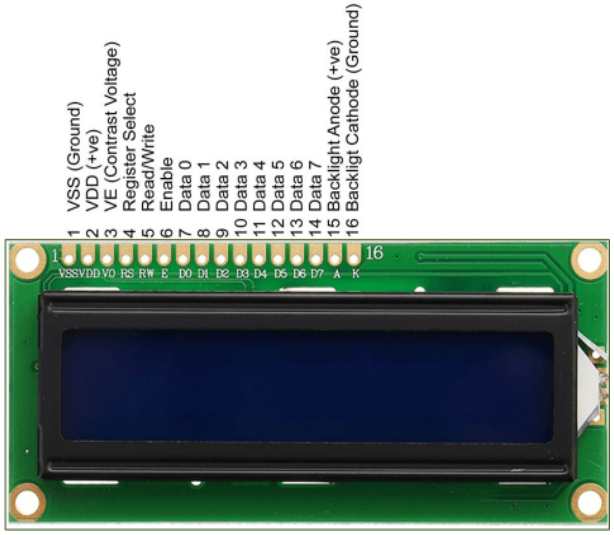

Figure 3: LCD-Liquid crystal Display

A Liquid Crystal Display (LCD) is a display device that utilizes liquid crystal technology to present visual information. In the realm of electronics-based real-world applications, a reliable medium or device is essential to showcase output values and messages. Among the widely used LCD modules, the 16x2 LCD Module stands out, capable of displaying 32 ASCII characters across two lines. This module provides an efficient solution for conveying information in a compact and organized manner. The integration of LCDs in electronics-based applications enhances user interfaces and aids in creating efficient and user-friendly systems.

4. I2C Serial Interface Board Module:

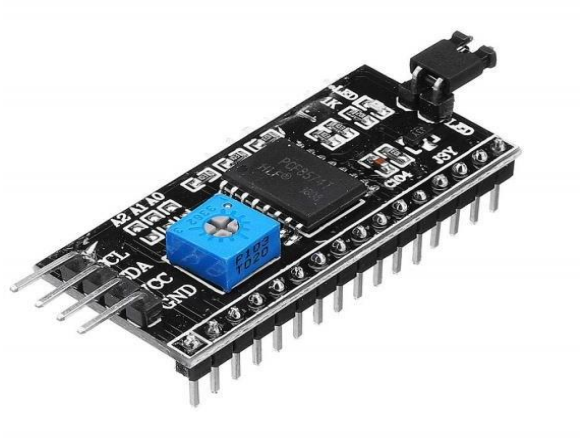

Figure 4: I2C Serial Interface Board Module

Although you can use a 204 LCD instead of 162 Liquid Crystal Display in our Arduino Board's I2C or 2- wire connection for this demonstration, for the 16x2 LCD's wiring. You may easily control an LCD with this I2C module by connecting two wires to your Arduino board's input SDA and the SCL. See the diagram above to determine which pin is the proper one to connect your I2C module to. Four pins are located on the module's left side; two of them are for voltage and ground and the other two are for the 12c (SDA/ and SCL). The board features a tripper pot to change the LCD's contrast, and the jumper on the opposite side of the board permits.

5. Breadboard:

Figure 5: Breadboard

Breadboards typically come in four different sizes. Portions, two of which are outer and two of which are inner.

In the interior parts, there are five rows of sockets that are electrically connected to one another. Normally, the breadboard's two outer parts are utilized only for power.

6. Jumper Wire (M&F) Module:

Figure 6: Jumper Wire

A jumper wire, also referred to as a muumuu, muumuu line, or DuPont line, is an electrical conductor, or a series of them in a string, featuring connectors or legs at each end, or sometimes left "tinned" without connectors. Its primary purpose is to establish connections between various points on a breadboard, prototype circuit, or test circuit, either internally or with other components or circuits, without the need for soldering. Individual jump cables are equipped with "end connectors," which can be easily inserted into designated slots on a breadboard, a circuit board's title connector, or a piece of test equipment, enabling convenient and quick setup of connections. Jumper wires play a fundamental role in simplifying the process of circuit prototyping, testing, and experimentation, facilitating swift reconfigurations and adjustments without the complexities of permanent connections.

C. Software Requirements

1. Arduino IDE Software:

The Arduino Integrated Development Environment (IDE), also known as the Arduino Software, is a comprehensive platform designed to facilitate writing and editing code for Arduino-based projects. It encompasses various essential components, including a textbook editor tailored for programming in the context of law, a communication area for seamless interaction with connected hardware, a textbook press for compiling and uploading code, and a user-friendly toolbar containing buttons for common functions. The Arduino IDE serves as a bridge between the user's computer and the Arduino board, enabling effortless program upload and real-time communication with the connected hardware.

2. Visual studio: Visual Studio Code:

Visual Studio Code (VS Code) is a versatile integrated development environment (IDE) developed by Microsoft, catering to developers across Windows, Linux, and macOS platforms.

Packed with an array of powerful features, VS Code offers comprehensive support for debugging, syntax highlighting, and intelligent code completion, streamlining the coding process and enhancing productivity. The IDE also boasts additional functionalities, including snippets, code refactoring tools, and seamless integration with Git for version control.

3. Notepad++:

Notepad++ is a widely used text editor and source code editor designed for Microsoft Windows users. One of its standout features is the tabbed editing functionality, which allows users to manage multiple open files efficiently within a single window. The project's name, "Notepad++," draws inspiration from the C increment operator, reflecting its commitment to enhancing productivity and providing a seamless editing experience.

4. Google Firebase:

Google Firebase is a versatile and comprehensive platform that caters to various application types, ranging from Android and iOS to Javascript, Node.js, Java, Unity, PHP, C++, and more. This all-encompassing service offers hosting solutions for different application types, ensuring seamless deployment and management across multiple platforms. Firebase provides real-time and NoSQL hosting capabilities for databases, content, and other essential services. Its real-time database allows for instant data synchronization, enabling users to access the latest information in real-time without delay.

5. DATA FLOW DIAGRAM

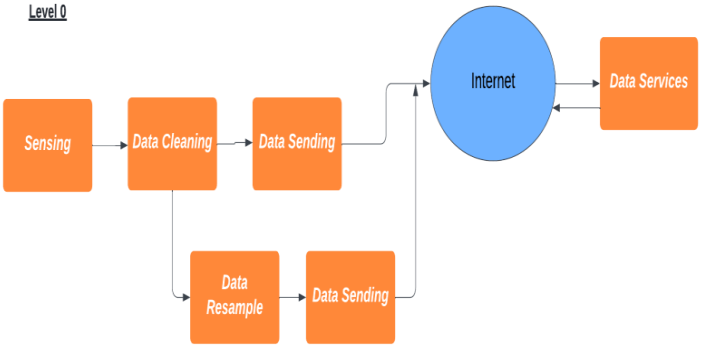

Figure 7: Data Flow Diagram Level 0

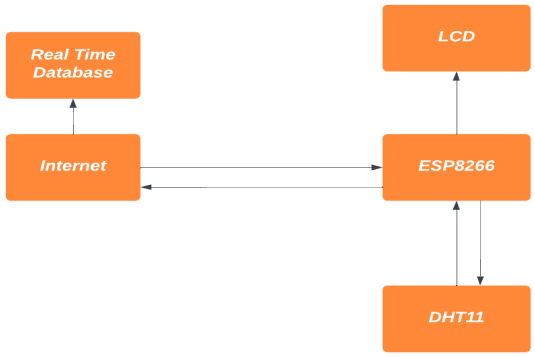

Figure 8: Data Flow Diagram Level 1

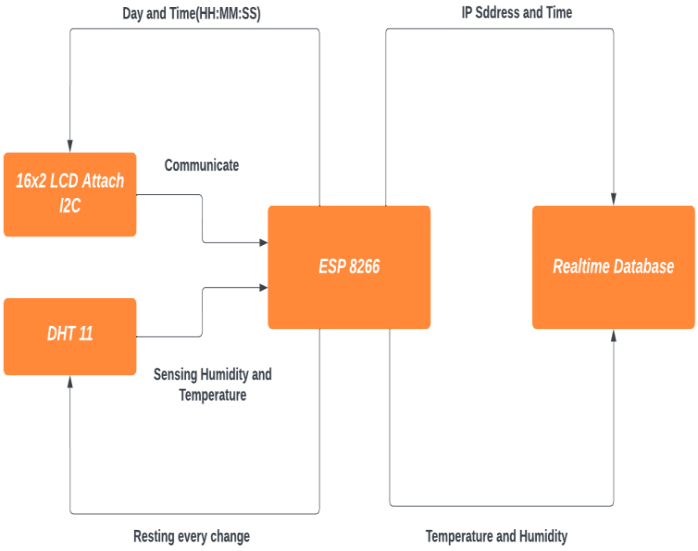

Figure 9: Data Flow Diagram Level 2

6. MODULES

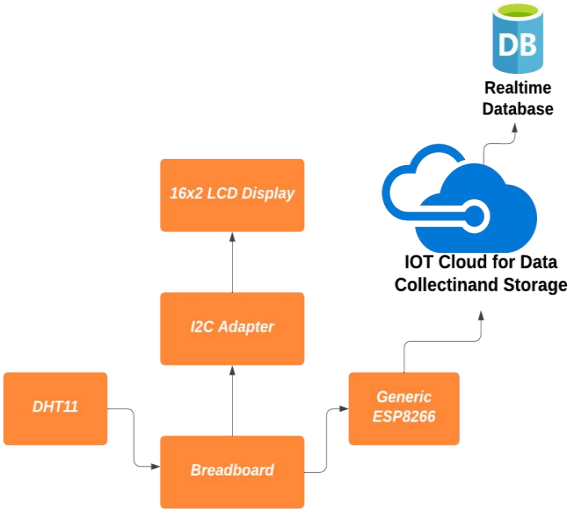

Figure 10: Modules

7. Outcome of Proposed System

The outcome of the proposed system is promising, as all the modules have been successfully developed, and the components have been seamlessly integrated. Rigorous testing of each module was conducted, and the results were favorable, ensuring the system's reliability and functionality. In a controlled environment, the sensor readings were accurately received and stored in files as intended. By conducting additional studies in more realistic weather conditions, the proposed system's performance and accuracy can be further validated and optimized. The insights gained from these studies will enhance the system's reliability and effectiveness, making it a valuable tool for real-world weather monitoring and forecasting applications.

8. RESULTS

Test case number	TC_o1
Test case name	Output verification 1
Description	This test case is done to verify if appropriate output is given by LCD
Input	Room temperature, humidity, day, Time(HH:MM:SS) is recorded
Expected output	Appropriate answer is found
Actual output	Appropriate answer is found
Remarks	Test Successful

Table 1: BTest Case No 1

Test case number	TC_o2
Test case name	Timing verification.
Description	This test case is done to verify if user is able to access the personal weather station only after session hours.
Input	Try to access the personal weather station before session hours.
Expected output	Able to open the personal weather station.
Actual output	Able to open the personal weather station.
Remarks	Test successful.

Table 2: Test Case No 2

Test case number	TC_o3
Test case name	Real Time Database
Description	This test case is done to verify if appropriate the data is collecting is same or different shown in LCD
Input	Room temperature, humidity, Day, time (HH:MM:SS) is recorded
Expected output	Appropriate answer is found
Actual output	Appropriate answer is found
Remarks	Test Successful

Table 3: Test Case No 3

Test case number	TC_o4
Test case name	ESP8266 node MCU
Description	This test case is done to verify if the pin are working properly or not
Input	DHT11, IC2 connected respective pin for esp8266
Expected output	Appropriate answer is found
Actual output	Appropriate answer is found
Remarks	Test Successful

Table 4: Test Case No 4

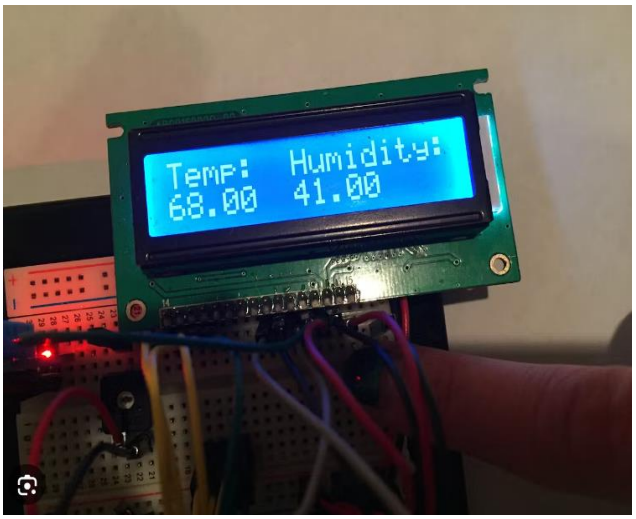

Figure 11: Outcome Of System

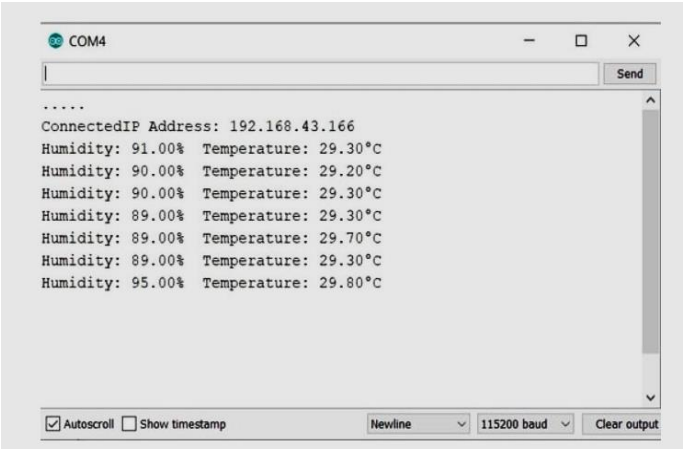

Figure 12: Serial Monitor showing Temperature and humidity reading

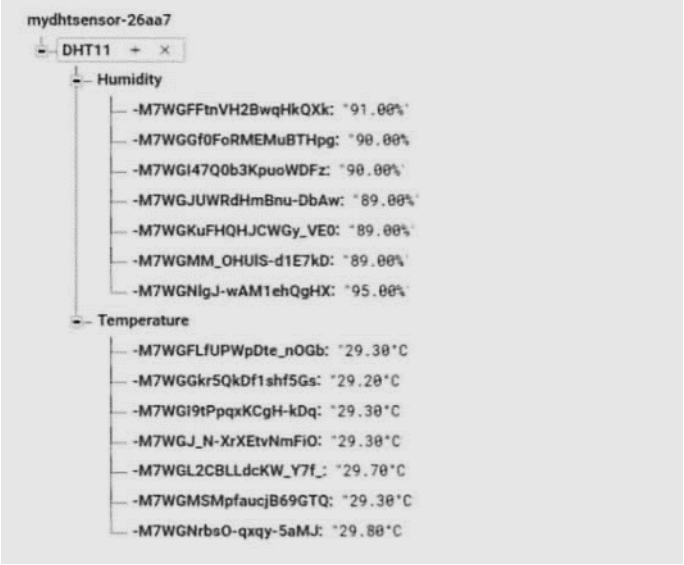

Figure 13: Outcome Of Real Time Database

9. CONCLUSION

In conclusion, the Climate Station project "Using Internet of Things" (IoT) has successfully achieved its objective of providing users with real-time access to weather data from any location. Leveraging the power of IoT, the system has proven to be an appropriate and effective solution, as supported by previous research and discussions. The project not only offers current weather data but also allows users to review historical information and interpret measurement trends, enabling informed decision-making.

The system's ability to provide real-time alerts to users empowers them to plan their activities and respond to changing weather conditions promptly, potentially preventing emergencies and mitigating risks. It serves as a valuable tool in the agricultural sector, revolutionizing farming practices and enhancing productivity worldwide.

The Climate Station project has demonstrated the potential of IoT in weather monitoring and its significant impact on agriculture and farmers globally.

As technology continues to evolve, this project serves as a stepping stone towards harnessing the power of real-time data for sustainable and efficient agricultural practices. With continuous improvements and advancements, the system holds the potential to play a crucial role in optimizing crop production, enhancing food security, and aiding farmers in adapting to the ever-changing climate.

10. ACKNOWLEDGEMENT

The author would like to thank Professor Sonali Ajankar for providing her guidance and valuable suggestions.

11. XI. FUTURE ENHANCEMENT

The following feature can improve the learning assistant project

- In the future, sensors for gas detector-based air quality analysis may be added.
- It is also possible to construct a web interface or service to provide data directly to an online platform
- The Arduino board's connectivity can be expanded much further.

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