IJAREEIE

e-ISSN: 2278-8875
p-ISSN: 2320-3765

International Journal of Advanced Research

in Electrical, Electronics and Instrumentation Engineering

Volume 13, Issue 5, May 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.317

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.317|| A Monthly Peer Reviewed & Referred Journal |

||Volume 13, Issue 5, May 2024||

|DOI:10.15662/IJAREEIE.2024.1305007|

IoT Based Electronic Device Microclimate Monitoring: A Case Study of Temperature and Humidity Analysis at a Specific Location

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ABSTRACT: The way we track and evaluate environmental conditions has completely changed with the introduction of Internet of Things (IoT) technologies. We provide a thorough investigation of the use of Internet of Things-based electronic devices for microclimate monitoring in this research article, with an emphasis on temperature and humidity analysis at a particular site. Insights into the design, development, and implementation of IoT-enabled sensors and devices for real-time data collection and analysis are the main goals of the project.

KEYWORDS: Microclimate, Sensors, Communication Modules, Centralized data processing unit, Statistical Analysis, Data Visualization

I. INTRODUCTION

The methods for gathering and analyzing data have been completely transformed by the use of Internet of Things (IoT) technology in environmental monitoring. This study investigates the use of Internet of Things (IoT)-based electronic devices for microclimate monitoring, emphasizing the analysis of temperature and humidity at a specified site. Microclimates are atmospheric conditions that are exclusive to a certain area.

1.1 Overview of microclimate monitoring via IoT:

The swift progress in technology has opened up new avenues for creative solutions across a range of industries, including environmental monitoring. Of these developments, the rise of Internet of Things (IoT) technology is notable for revolutionizing conventional approaches to data gathering and processing. Real-time monitoring is made possible by IoT technology, which makes it easier to install linked sensors and devices.

1.2 Importance of Data analysis of Temperature and Humidity by Readings of Device:

Analysis of temperature and humidity is important because microclimates defined as localized air conditions that are different from those in the surrounding areas are important for many elements of both natural ecosystems and human existence. Acquiring knowledge about and keeping an eye on microclimates, which include temperature and humidity, is crucial for many uses, including urban planning, agriculture, and environmental preservation

1.3 Importance of the particular site selected for the case study:

This research's selected site functions as a case study to illustrate the viability and efficacy of the suggested Internet of Things (IoT)-based electronic device system. The research intends to shed light on microclimate dynamics, spot trends, and give useful information for decision-making processes by concentrating on a particular area.

II. METHODOLOGY

The research paper "IoT Based Electronic Device Microclimate Monitoring: A Case Study of Temperature and Humidity Analysis at a Specific Location" employs a comprehensive methodology that makes use of the Arduino Uno microcontroller, DHT11 sensor, I2C communication protocol, 16x2 LCD display, breadboard, and jumper wires.

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First of all, the DHT11 sensor was chosen since it is easy to use and reasonably priced for sensing temperature and humidity. The I2C communication standard will be used to connect it to the Arduino Uno microcontroller, enabling effective data flow. In addition, the Arduino Uno will be interfaced with a 16x2 LCD display to see temperature and humidity information in real time. All of these parts will be put together on a breadboard, which will provide a small and handy setup for testing. The required connections between the components on the breadboard will be made easier with the help of jumper wires.

Procedures for testing and calibration will be carried out to guarantee the precision and functionality of the hardware configuration. In order to confirm data collecting capability, communication between the DHT11 sensor and Arduino Uno will be tested. The sensor will be calibrated using known temperature and humidity values. In order to verify appropriate communication and display capability, the connections to the LCD display will also be examined.

After the hardware configuration has been verified, it will be installed at the precise site selected for the microclimate monitoring case study. Care will be taken to guarantee that the site offers appropriate environmental conditions for investigation and is representative of the target area.

The Arduino Uno will be used for data collecting and logging. It has been configured to continuously read the temperature and humidity values from the DHT11 sensor. Periodically, the gathered data will be timestamped and logged for temporal analysis. Instantaneous feedback on microclimate conditions will be provided by the LCD panel's simultaneous presentation of real-time temperature and humidity information.

Using the proper software tools, data gathering, analysis, and visualization will be carried out. The mean, median, and standard deviation of descriptive statistics can be used to summarize the changes in humidity and temperature over time. To show trends and patterns in the gathered data, data visualization tools like line plots and histograms will be used.

The temperature and humidity readings from the DHT11 sensor will be compared with reference measurements from calibrated devices in order to validate the results that were obtained. The comparison of observed microclimate dynamics with current knowledge and theoretical frameworks will serve as a reference for interpreting the results.

Lastly, a thorough study paper that complies with academic norms and procedures will present the research findings. The approach, results, consequences, and suggestions for further research will all be covered in this publication. The results will be shared with pertinent environmental science and Internet of Things technology stakeholders, through peer-reviewed journal publication, and through academic conferences.

III. DESIGN AND INSTALLATION OF INTERNET OF THINGS (IOT) DEVICES

3.1 DHT11

The IoT-based microclimate monitoring system described in our research article heavily relies on the DHT11 sensor. The DHT11 sensor was chosen for our research because of its precision in measuring temperature and humidity, as well as its affordability and ease of use. Because of its single-wire protocol, this sensor makes integrating it with the Arduino Uno microcontroller easier. To guarantee accurate readings, calibration processes are used to offset any intrinsic errors in the sensor's output. By means of uninterrupted observation, the DHT11 sensor furnishes up-to-date information on temperature and relative humidity, thereby facilitating precise and dependable analysis of microclimate dynamics. It may be deployed in a variety of environmental conditions thanks to its small size and simple interface, which helps us achieve our objective of performing a case study on microclimate analysis at a particular

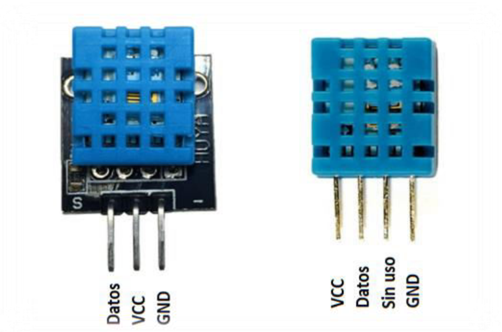

Fig 5.1 DHT11 Sensor

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3.2. I2C and LCD 16x2 Display:

Our Internet of Things-based microclimate monitoring system relies heavily on the LCD 16x2 display and the I2C (Inter-Integrated Circuit) connection protocol. Using just two wires—SDA (data) and SCL (clock)—the I2C protocol enables effective bidirectional communication between the Arduino Uno microcontroller and peripherals, like the LCD display. By doing this, the wiring configuration becomes less complicated, and the Arduino Uno's GPIO pins are freed up for other uses.

Due to its simplicity, cost, and ease of integration, the LCD 16x2 display is a popular option for real-time data visualization. Its dimensions—16 characters per row and two rows—give rise to its moniker. The liquid crystal display (LCD) technology used in the display produces legible and clear text output. Usually, the 16x2 display has the liquid crystal display (LCD) technology used in the display produces legible and clear text output. Usually equipped with an HD44780 controller, the 16x2 display can be used with an Arduino Uno or a variety of other microcontrollers.

A tiny I2C module, such the PCF8574, is frequently used to interface the LCD 16x2 display with the Arduino Uno via the I2C protocol. By converting I2C signals into commands that the LCD display can understand, this module serves as an interface between the Arduino Uno and the LCD display.

There are various benefits that the 16x2 I2C LCD display provides for our microclimate monitoring system. First of all, it gives consumers instant feedback by visualizing temperature and humidity values in real time. Furthermore, It can be used in a variety of settings because to its small size and low power consumption. Furthermore, the I2C communication protocol guarantees effective data transfer with little wire, which lowers the hardware setup's total complexity.

To sum up, our IoT-based microclimate monitoring system relies heavily on the I2C protocol and the LCD 16x2 display to provide effective communication and real-time data visualization. The seamless operation made possible by their integration with the Arduino Uno allows us to efficiently monitor and analyze the microclimate conditions at our particular site of interest.

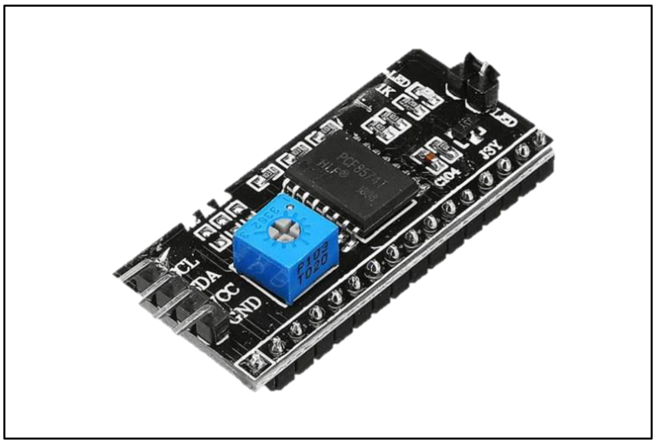

Fig 5.2 I2C (Inter-Intergrated Circuit)

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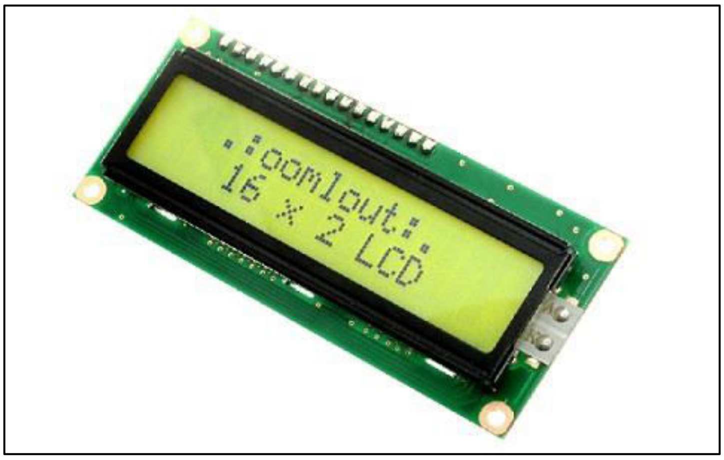

Fig 5.2 LCD 16x2 (Liquid-Crystal Display)

3.3 Jumper wires and a breadboard:

1.The hardware components are assembled and arranged using a breadboard as a platform.
2.It offers an easy-to-use configuration for attaching the Arduino Uno, LCD display, and DHT11 sensor.
3.To provide electrical connections between the components, jumper wires are used, which allows for greater flexibility and simpler prototyping.
4.Jumper wires must be placed and routed carefully to keep a hardware setup tidy and orderly and reduce the possibility of short circuits or signal interference.

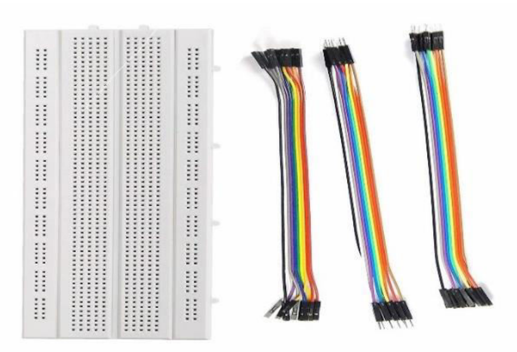

Fig 5.3 Jumper wires and a breadboard

3.4 Ardunio UNO :

Among the Arduino series of microcontroller boards, the Uno is one of the most widely used models. Because of its price, simplicity, and adaptability, it's commonly utilized in educational settings, hobbyist projects, and even certain business applications. Here's a thorough rundown:

Description:

Microcontroller: The ATmega328P, a low-power CMOS 8-bit microcontroller built on the AVR improved RISC (Reduced Instruction Set Computer) architecture, is the microcontroller platform upon which the Arduino Uno is built. It runs at a 16 MHz clock speed.
Pins for Input and Output: The Uno has fourteen pins for input and output, six of which are PWM (Pulse Width Modulation) outputs. Six analog input pins are also included. Users can interact with different actuators, sensors, and other electrical parts via these pins. USB by connecting it to a computer using a USB connection.

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Interface:
The programming and power supply of the Uno may be conveniently accomplishedFor USB connectivity, it makes use of the ATmega16U2 or ATmega8U2 microprocessor.
Power Source:
An external power source or a USB connection can be used to power the board.Although it can handlevoltages as low a s 6 volts and as high as 20 volts, the suggested input voltage range is 7 to 12 volts.The microprocessor and other parts a re supplied with a steady 5V supply by an integrated voltage regulator.
Programming:
The Arduino Integrated Development Environment (IDE), which is built on the Processing programming language, ma y be used to program the Arduino Uno. It offers an easy-to-use interface for code writers to write, compile, and publish code to the board The programming language is basically a condensed form of C/C++ plus a few libraries and functions exclusive to Arduino. The Uno runs on a 5 volt operating voltage. It can, however, also interface with 3.3V components.
Memory:
The ATmega328P microcontroller contains two KB of SRAM, one KB of EEPROM, and 32 KB of flash memory to store the software (of which 0.5 KB is utilized for the bootloader).
Bootloader: A bootloader is a little software that is pre-installed on the Uno and activates when the board is switched on or reset. Without the help of an outside programmer, users may upload new drawings, or programs, to the board.
Uses include:
Prototyping: Because of its quick development capabilities and ease of use, Arduino Uno is often utilized for electrical project prototyping.
DIY electronics is a popular pastime among enthusiasts who use it to build robots, home automation systems, and other gadgets.
Education: The Arduino Uno is a popular teaching tool used by educational institutions to introduce students to the fundamentals of programming and electronics.
IoT (Internet of Things): Uno may be used in IoT projects to link sensors and actuators to the internet by adding shields, which are extra circuit boards that can be inserted into the Arduino.

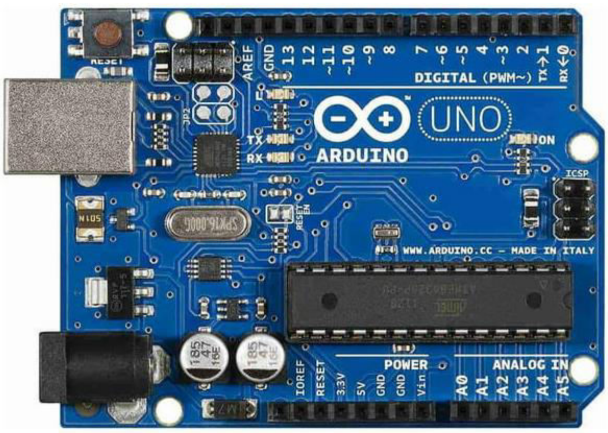

Fig.5.4 Ardunio UNO Board

3.4 Hardware Setup & Integration Process :

Our study article, "IoT Based Electronic Device Microclimate Monitoring: A Case Study of Temperature and Humidity Analysis at a Specific Location," heavily relies on the hardware setup and integration. The methodical procedure for putting together and integrating the electronic parts required for microclimate monitoring is outlined in this section.

The hardware setup is mostly concerned with choosing and setting up the parts that are necessary for our Internet of Things system. The Arduino Uno microcontroller is connected to the DHT11 sensor, which was selected due of its precise temperature and humidity measurement capabilities. In order to ensure correct signal routing and compatibility, the sensor's output is connected to particular digital pins on the Arduino Uno. Furthermore, the Arduino Uno is interfaced with the I2C LCD 16x2 display, allowing for the real-time observation of temperature and

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humidity information.
The connection design of the display is set up to use the I2C communication protocol for communication, which maximizes data transfer efficiency while requiring the least amount ofwiring.

As part of the integration process, the parts are meticulously arranged on a breadboard to create a neat and orderly structure that is ideal for efficient prototyping and experimentation. In order to ensure smooth operation and communication, jumper wires are essential for making electrical connections between the parts. In order to facilitate troubleshooting and future hardware setup updates, careful documentation of wiring schematics and pin assignments is essential during this phase.

In order to guarantee the IoT gadget operates steadily, power supply considerations are essential. The Arduino Uno and its attached components are normally either by an external power source or a USB connection that is connected to a computer.
In order to guarantee the IoT gadget operates steadily, power supply considerations are essential. The Arduino Uno and its attached components are normally either by an external power source or a USB connection that is connected to a computer. To keep the device from overheating or experiencing voltage fluctuations, as well as to provide continuous monitoring, it is imperative to monitor and optimize power consumption.

Strict testing protocols further strengthen the hardware integration and setup. The DHT11 sensor is calibrated in order to compensate for any intrinsic imperfections and guarantee reliable readings. The sensor and Arduino Uno's communication is confirmed, and the data collecting functionality is put through a thorough testing process to guarantee stability and dependability. Carefully inspecting the connections to the LCD display ensures correct communication and display operation. All things considered, the core of our Internet of Things microclimate monitoring system is the hardware configuration and integration procedure. By carefully choosing, arranging, and testing electronic components, we create a reliable and effective framework for tracking humidity and temperature at our particular point of interest. This all-encompassing strategy establishes the foundation for significant data collection and analysis while guaranteeing the precision, dependability, and efficacy of our microclimate monitoring system.

IV. SCHEMATIC CIRCUIT DIAGRAM

Fig. displays the microcontroller board and the schematic circuit. Using an eco-friendly cardboard for the main body frame instead of Perspex increases the efficiency and efficacy of the sensor. While keeping in mind the stiffness and quality of the prototype, the size is lowered to save production costs and the amount of space needed to put it. Prototypes of various kinds have been tested to meet client needs.Final Prototype shown in Fig.

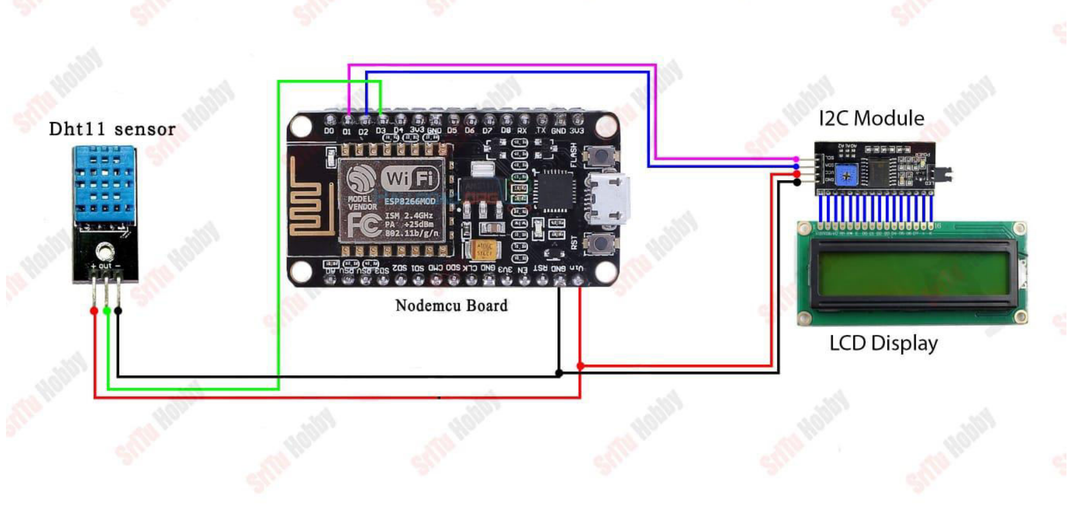

Fig 4.0 (a) The Schematic Diagram

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V. CONCLUSION

In conclusion, our study has shown that an Arduino Uno, DHT11 sensor, LCD 16x2 display with I2C interface, jumper wires, and breadboard components may all be successfully used to create an Internet of Things-based electronic device for microclimate monitoring. We are able to gather and analyze temperature and humidity data at a particular place by carefully configuring hardware and creating software. The device's capacity to record hourly changes in humidity and temperature during the day and night offers important insights into the dynamics of microclimates and surrounding circumstances. This case study highlights how IoT technology may be used practically in environmental monitoring, providing practitioners and academics with an economical and effective way to investigate and control microclimate fluctuations. In the future, this device's capabilities might be further refined and expanded, and improvements in IoT technology could further improve our comprehension of microclimate phenomena and support environmentally friendly management method

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