Weather Station

Report for Mini Project/Electronic Design Workshop (EC-681)

B. Tech in Electronics and Communication Engineering

B. P. Poddar Institute of Management & Technology

Under

Maulana Abul Kalam Azad University of Technology

Under the supervision of

Ms. Ankita Indu and Mr. Mostafa Seikh

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CERTIFICATE

This is to certify that the project work, entitled "Weather Station" submitted by Ruparna Saha, Shivam Kumar Biswas, Vikas Vishwakarma and Rohit Kumar Sharma have been prepared according to the regulation of the degree B. Tech in Electronics & Communication Engineering of the Maulana Abul Kalam Azad University of Technology, West Bengal. The candidate(s) have partially fulfilled the requirements for the submission of the project work.

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(Dr. Ivy Majumdar) (Ms. Ankita Indu and Mr. Mostafa Seikh)

Dept. of Electronics & Comm. Engg. Dept. of Electronics & Comm. Engg

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ABSTRACT:

The Arduino temperature and humidity monitor is an efficient device designed to gather real-time environmental data using sensors such as the DHT11. This versatile tool displays results on an LCD screen or transmits them wirelessly to another device, making it adaptable to various needs. Its affordability and straightforward setup process make it an ideal choice for a range of applications including home environments, agricultural settings, industrial operations, and weather tracking.

One of the standout features of this monitor is its compact size and low power consumption, which are perfect for long-term usage without frequent maintenance. Moreover, its modular design allows for customization with additional sensors or enhanced connectivity options, providing users with the flexibility to tailor it to their specific requirements.

In essence, this Arduino-based monitor is an indispensable tool for consistently tracking and managing environmental conditions. It offers a practical and reliable solution for anyone needing accurate data on temperature and humidity, whether for personal use, professional applications, or scientific research. Its adaptability and ease of customization further enhance its value, making it a versatile choice for a wide array of environmental monitoring needs.

ACKNOWLEDGEMENTS

It is a great pleasure for me/us to express our earnest and great appreciation to Mr. Mostafa Seikh and Ms. Ankita Indu, my project guide. We are very much grateful to him for her kind guidance, encouragement, valuable suggestions, innovative ideas, and supervision throughout this project work, without which the completion of the project work would have been difficult one.

We would like to express our thanks to the Head of the Department, Dr. Ivy Majumdar for her active support.

We also express our sincere thanks to all the teachers of the department for their precious help, encouragement, kind cooperation and suggestions throughout the development of the project work.

We would like to express my/our gratitude to the library staff and laboratory staff for providing us with a congenial working environment.

1.

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Date: _____ **_____**

(Full Signature of the Student(s)

B. Tech in Electronics & Comm. Engg.

Department of Electronics & Comm. Engg.

B P Poddar Institute of Management and Technology

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TITLE :

To implement a system for sensing and processing Temperature and Humidity data using ESP8266.

OBJECTIVE:

1. Provide easy access to real-time environmental data.
2. Offer a cost-effective solution for monitoring indoor and outdoor conditions.
3. Develop a user-friendly interface for accessing and visualizing collected data.

DEPARTMENTAL MISSION:

1. Imparting innovative educational programs through laboratory and project-based teaching-learning processes to meet the growing challenges of industry and research.
2. Providing an inspiring and conducive learning environment to prepare skilled and competent engineers and entrepreneurs for the sustainable development of society.
3. Creating a knowledge center of advanced technologies committed to societal growth using environment-friendly technologies.

DEPARTMENTAL VISION :

To emerge as a premier department for studies in Electronics and Communication Engineering.

Program Outcomes (POs)

1. **Engineering knowledge**: Apply knowledge of engineering fundamentals, mathematics, science, and environmental monitoring technologies to develop and optimize a weather station.
2. **Problem analysis**: Identify, formulate, review, and analyze environmental data to address complex problems related to weather patterns and air quality.

3. **Design/development of solutions**: Design and develop a comprehensive weather station that meets specific needs for monitoring temperature, humidity, and air quality, with consideration for user convenience and safety.
4. **Conduct investigations of complex problems**: Utilize research-based knowledge and methods, including the design of experiments, data analysis, and interpretation, to draw valid conclusions about environmental conditions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering tools, such as sensors and software, to predict and model environmental conditions accurately.
6. **The engineer and society**: Understand and demonstrate the impact of engineering solutions on society by promoting environmental awareness and public health through accurate weather and air quality monitoring.
7. **Environment and sustainability**: Recognize the importance of sustainable practices and demonstrate knowledge of how engineering solutions can mitigate environmental impact and promote sustainability.
8. **Ethics**: Apply ethical principles and commit to professional responsibilities and norms in the development and use of environmental monitoring technologies.
9. **Individual and teamwork**: Function effectively as an individual and as a member or leader in diverse and multidisciplinary teams, particularly in projects focused on environmental monitoring and data analysis.
10. **Communication**: Communicate effectively on complex environmental monitoring activities, including the ability to write comprehensive reports, design documentation, and make presentations, ensuring clear instructions and information dissemination.
11. **Project management and finance**: Demonstrate knowledge and understanding of engineering and management principles by applying them to manage environmental monitoring projects and resources effectively.
12. **Practical learning**: Recognize the need for, and engage in, independent and practical learning to stay abreast of technological advancements in environmental monitoring and data analysis.

Program Specific Outcomes (PSO)

1) Students will acquire knowledge in environmental monitoring technologies, including the design and implementation of weather stations, and the analysis of temperature, humidity, and air quality data.
2) Students will be equipped to succeed in various competitive examinations and pursue successful careers or further studies in environmental engineering, data science, and related fields, contributing to research and practical applications in environmental monitoring.

PO& PSO MAPPING:

PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO 1
2	2	**2**	**1**	**3**	1	**2**	1	**3**	**3**	**2**	**2**	1

JUSTIFICATIONS OF MAPPING:

PO/PSO MAPPED	LEVEL OF MAPPING	JUSTIFICATION
PO1	2	Apply engineering knowledge, environmental science principles, and technological innovations to develop and enhance weather stations.
PO2	2	Identify, analyze, and interpret data from weather stations to address complex environmental problems that impact daily life.
PO3	2	Design and develop weather stations that cater to specific user needs while considering public convenience and minimizing environmental impact.
PO4	1	Utilize research methodologies, including experimental design and data analysis, to draw accurate conclusions about weather patterns and air quality.
PO5	3	Create and apply modern engineering tools and technologies to ensure efficient, accurate, and real-time environmental monitoring with weather stations.
PO6	1	Understand and demonstrate the societal benefits of engineering solutions by promoting public health and environmental awareness through reliable weather and air quality monitoring.
PO7	2	Demonstrate a commitment to sustainable development by designing eco-friendly and energy-efficient weather stations that reduce environmental footprints.
PO8	1	Apply ethical principles and ensure professional responsibility in the development, deployment, and use of weather stations, focusing on accurate data reporting and integrity.
PO9	3	Function effectively both as an individual and as a team leader in multidisciplinary teams to design, develop, and implement comprehensive weather monitoring solutions.
PO10	3	Communicate effectively with a wide range of stakeholders about weather station technologies and findings, producing clear and detailed reports, design documentation, and presentations.

PO11	2	Demonstrate project management skills by applying engineering and management principles to oversee the design, development, and deployment of weather stations, including budgeting and resource allocation.
PO12	2	Recognize the importance of lifelong learning and continuously update your knowledge with the latest technological advancements in environmental monitoring and data analysis to improve weather station functionality.
PSO1	1	Acquire comprehensive knowledge and technical skills in designing and implementing weather stations, focusing on precise measurement and analysis of temperature, humidity, and air quality.

ACTIVITY CHART:

JOB	15th -30th January	1st -30th February	1st -30th March	1st-15th April	16th-30stApril	1st-15th May	16th-25th May
Literature Review	←						
0th Review		←					
Problem definition and requirement analysis			←				
Midterm report and presentation				←			
Design and Implementation					←		
Optimization and Results						←	
Report writing and project presentation							←

Chapter 1

INTRODUCTION:

Weather impacts our lives every day, dictating what we wear, how we plan our activities, and even influencing our moods. It encompasses the atmospheric conditions at a specific moment and place, shaped by an intricate interplay of factors such as air pressure, wind patterns, precipitation, sunlight, temperature, and humidity levels. Among these elements, temperature and humidity stand out as key players in short-term weather forecasting.

Temperature reflects the amount of heat in the air, affecting everything from plant growth to human comfort levels. Humidity, on the other hand, measures the moisture content in the air, influencing how we perceive temperature and contributing to phenomena like fog and dew. Together, these two variables provide valuable insights into imminent weather conditions.

Being informed about upcoming weather conditions allows us to make informed decisions, whether it's planning outdoor activities, adjusting travel schedules, or preparing for extreme weather events. It enables us to safeguard our well-being and minimize potential risks associated with adverse weather conditions.

Moreover, advances in technology have made weather forecasting more accessible than ever, with mobile apps and online platforms providing real-time updates and alerts. This democratization of weather information enables individuals to stay informed and prepared, fostering a culture of resilience in the face of environmental variability.

Ultimately, by paying attention to weather forecasts and heeding the advice of experts, we can enhance our readiness to confront whatever nature throws our way.

Chapter 2

THEORY

The Weather Station represents a significant advancement in environmental monitoring technology. Its main goal is to provide an easy-to-use solution for individuals, households, and small businesses. The focus is on monitoring temperature and humidity changes, helping users make informed decisions about comfort, energy efficiency, and overall environmental conditions [1]. The station's design allows for measuring both indoor and outdoor parameters, giving users a complete view of their surroundings.

At the heart of the station are high-quality components included in the kit, supported by their libraries and datasheets [2]. This ensures precise data recording and analysis, helping users recognize weather patterns and trends. The system uses sensors like the DHT11 or DHT22, known for their reliability and accuracy in detecting temperature and humidity. The data collected by these sensors is processed and displayed on an LCD screen or sent wirelessly to a connected device, ensuring real-time access to environmental information.

One enhancement could be adding a PM2.5 sensor to the existing setup. This would allow the station to monitor air pollution levels [3]. PM2.5 refers to particulate matter that is less than 2.5 micrometers in diameter, which can penetrate deep into the lungs and even enter the bloodstream, posing serious health risks. By incorporating this sensor, the weather station could provide vital information about air quality, alerting users to dangerous pollution levels and enabling them to take preventive measures.

With this upgrade, users would get a more complete understanding of their environment, helping them take steps to reduce health risks from poor air quality. For instance, they could use the information to decide when to stay indoors, use air purifiers, or implement other measures to improve indoor air quality. Additionally, the integration of the PM2.5 sensor could be paired with other sensors, such as those detecting carbon monoxide or volatile organic compounds (VOCs), to create a comprehensive indoor air quality monitoring system.

Adding advanced features like this not only improves the station's functionality but also supports goals of promoting environmental awareness and sustainability. By understanding environmental factors better, users can adopt practices that protect their health and the planet. For example, they could use the data to optimize heating and cooling systems, reducing energy consumption and lowering carbon footprints. The station can also serve educational purposes, teaching users about the impact of environmental conditions on health and the importance of sustainable living practices.

Moreover, the weather station's compact size and low power consumption make it suitable for long-term use in various settings. It can be deployed in homes, offices, greenhouses, and outdoor environments, providing continuous monitoring without requiring frequent maintenance. The system can also be expanded with additional sensors or connectivity options, such as integrating with smart home systems or IoT networks, to enhance its capabilities further.

Chapter 3

PROPOSED SYSTEM

The diagram represents the interfacing of an ESP8266 D1 Mini microcontroller with two DHT11 temperature and humidity sensors and an OLED display. The ESP8266 D1 Mini is a compact and versatile microcontroller with built-in Wi-Fi capabilities, designed to interface with various peripheral devices such as sensors and displays. The DHT11 sensors are digital sensors that measure both temperature and humidity, and this setup includes two of them to capture environmental data from different locations. The OLED display is a graphical module used to visualize data, such as temperature and humidity readings, in a clear and concise manner.

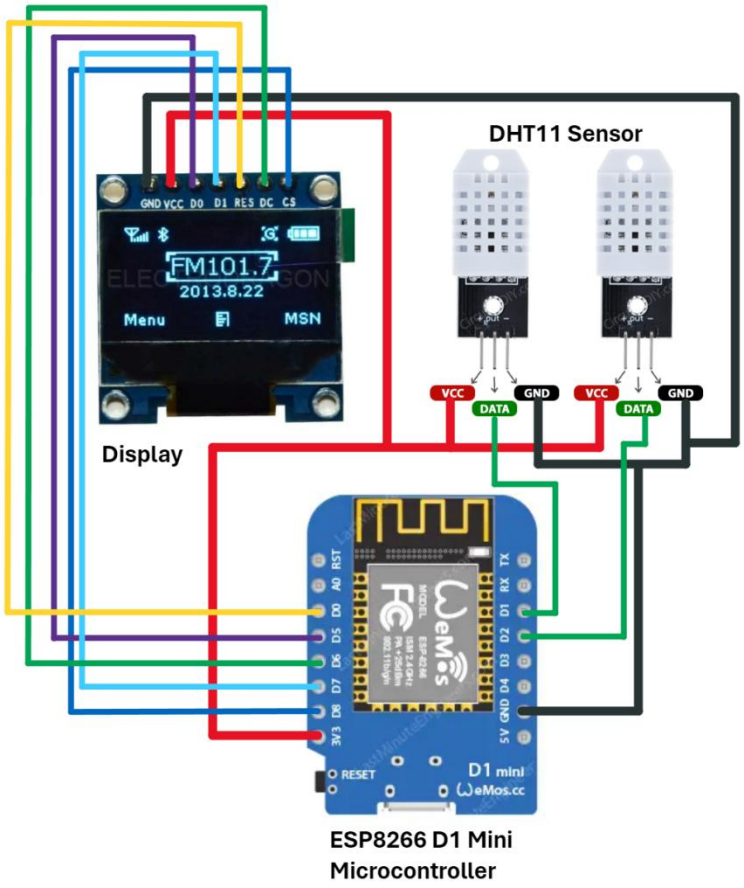


Fig.1. System Interface Diagram

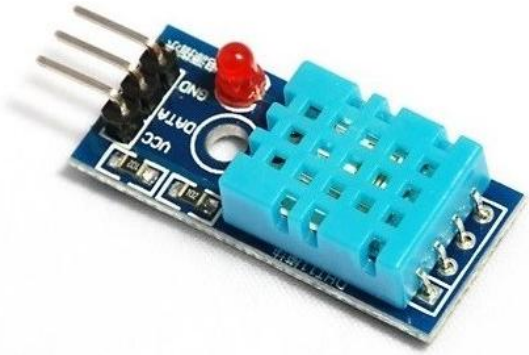
In terms of connections, the ground (GND) pin of the OLED display is connected to the ground (G) pin of the ESP8266 D1 Mini, establishing a common reference point for the circuit's electrical potential. The VCC pin of the OLED display is connected to the 3.3V (3V3) pin of the ESP8266, providing the necessary voltage for the display to operate. Signal connections include connecting the D0 (SCK/Clock) pin of the display to the D3 (GPIO 0) pin of the microcontroller to synchronize clock signals for data transmission. The D1 (SDA/Data) pin of the display is connected to the D4 (GPIO 2) pin of the microcontroller to facilitate data transfer. The RES (Reset) pin of the display connects to the D0 (GPIO 16) pin of the microcontroller to allow the microcontroller to initialize or reset the display. The DC (Data/Command) pin connects to the D2 (GPIO 4) pin of the microcontroller, controlling whether the information sent to the display is data or a command, and the CS (Chip Select) pin connects to the D1 (GPIO 5) pin of the microcontroller to enable multiple devices to share the same SPI bus.

For the DHT11 sensors, their VCC pins are connected to the 3.3V pin of the ESP8266, providing the operating voltage for the sensors. The ground (GND) pins of the DHT11 sensors are connected to the ground (G) pin of the ESP8266, ensuring a common ground reference. Data connections include the DATA pin of the first DHT11 sensor connecting to the D5 (GPIO 14) pin of the microcontroller, enabling the sensor to send its temperature and humidity data to the microcontroller. Similarly, the DATA pin of the second DHT11 sensor connects to the D6 (GPIO 12) pin of the microcontroller, enabling data transmission from the second sensor.

This configuration showcases the ESP8266 D1 Mini microcontroller interfaced with two DHT11 sensors for environmental data acquisition and an OLED display for data visualization. The microcontroller processes the temperature and humidity data from the sensors and displays the readings in real-time on the OLED screen. Proper power and ground connections are crucial to ensure the stable operation of all components. This setup is particularly suited for environmental monitoring applications, where accurate and timely data display is essential for analysis and decision-making.

Components Used:

DHT11 Sensor



- Function: The DHT11 sensor is designed to measure temperature and humidity levels, providing digital readings that are easy to interface with microcontrollers.

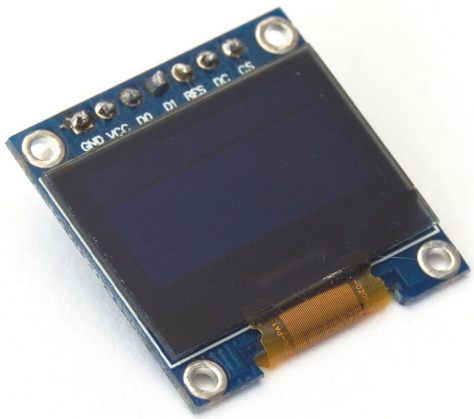
- Humidity Range: It offers relative humidity readings within the range of 20-90% RH, with an accuracy of ±5% RH, making it suitable for general humidity monitoring.

- Temperature Range: The sensor measures temperature from 0-50°C with an accuracy of ±2°C, covering a broad spectrum of typical ambient temperatures.

- Output: Data from the DHT11 is transmitted via a single-wire digital protocol, simplifying the connection to microcontrollers.

- Uses: This sensor is ideal for basic environmental sensing tasks, including weather monitoring, greenhouse control, and home automation systems where precise humidity and temperature control are beneficial.

SD 1306 OLED Display



- Features:

- High Contrast and True Blacks: Each pixel in an OLED display emits its own light, allowing for deep blacks and high contrast ratios, resulting in sharp and vibrant images.

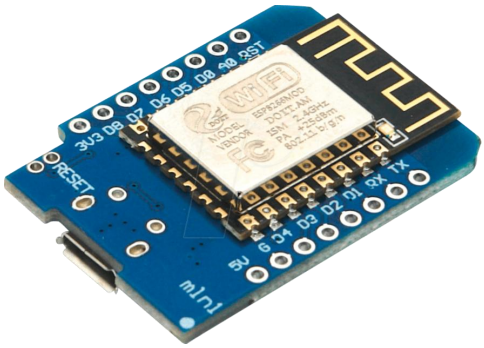
- Low Power Consumption: OLED displays are highly efficient, particularly when displaying darker images, which reduces overall power consumption.

- Wide Viewing Angles: The display maintains clarity and brightness from various angles, ensuring visibility from multiple viewing positions.

- Resolution: Common OLED displays have a resolution of 128x64 pixels, which is sufficient for displaying text, simple graphics, and sensor data.

- Interface: The display can be interfaced using the SPI communication protocol, which is widely supported by many microcontrollers and offers fast data transfer rates.

ESP8266 D1 Mini Microcontroller



- Processor: The ESP8266 D1 Mini is built around the Tensilica L106 32-bit RISC processor, providing sufficient processing power for various IoT applications.

- Wi-Fi: It features built-in Wi-Fi capabilities, supporting 802.11 b/g/n protocols, making it easy to connect to wireless networks and IoT platforms.

- GPIO Pins: The microcontroller includes multiple general-purpose input/output (GPIO) pins, allowing for the connection of various sensors, displays, and other peripherals.

- Programming: It can be programmed using the Arduino IDE or other development environments, offering flexibility and accessibility for both beginners and advanced users.

- Power: The ESP8266 D1 Mini operates at 3.3V, with some of its pins being tolerant to 5V inputs, providing compatibility with a range of sensors and modules.

Chapter 4

MATHEMATICAL FORMULATION

Humidity Calculation

The DHT11 sensor directly provides the relative humidity as a percentage. This value shows how much moisture is in the air compared to the maximum amount it can hold at that temperature.

Example:

- Humidity: 47.60%

This means the air contains 47.60% of the maximum moisture it can hold at the current temperature.

Temperature Calculation

The DHT11 sensor also directly measures the temperature. It can give this temperature in degrees Celsius (°C), and it can be converted to degrees Fahrenheit (°F) using a simple formula.

Conversion Formula:

$$\text{Temperature in } ^\circ\text{F} = (\text{Temperature in } ^\circ\text{C} \times \tfrac{9}{5}) + 32$$

Example:

- Temperature: 29.30°C

To convert 29.30°C to Fahrenheit:

$$\text{Temperature in } ^\circ\text{F} = (29.30 \times \tfrac{9}{5}) + 32 = 84.74^\circ F$$

Chapter 5

RESULTS & DISCUSSIONS

The weather station we developed works well in giving accurate, real-time information about temperature, humidity, and air quality. This helps people make smart choices about things like going outside or using energy wisely. It also helps raise awareness about how the environment affects our health and daily lives.

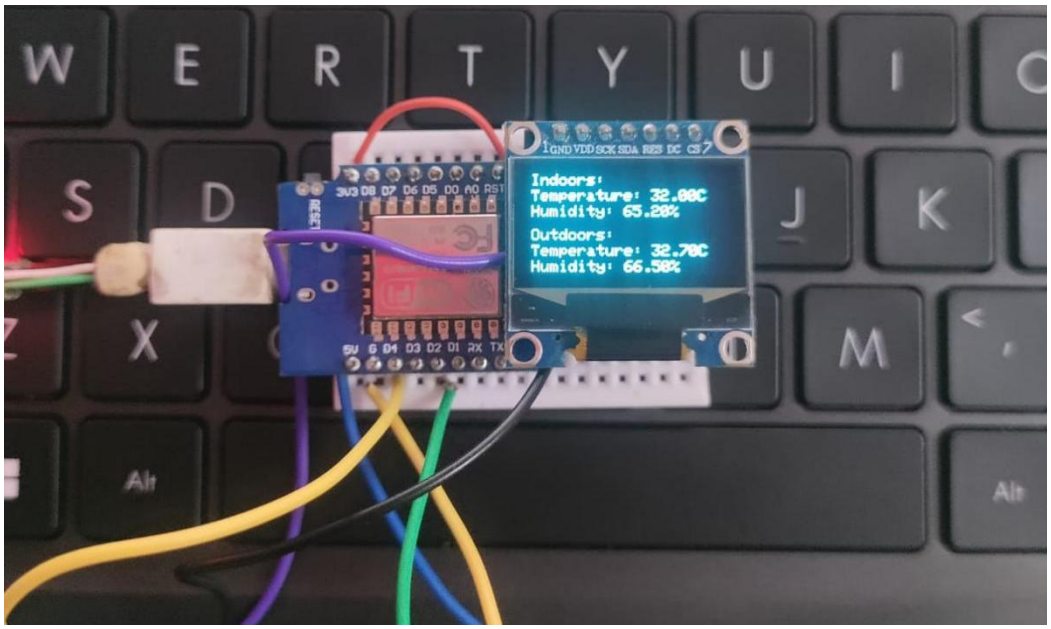


Fig.2. Temperature and Humidity Display

We found that people really engage with the weather station and find it helpful. They like being able to see what's happening around them and use the information to make better decisions. We also saw that there's potential to add more sensors to the station, like ones that measure pollutants in the air, to give an even clearer picture of the environment.

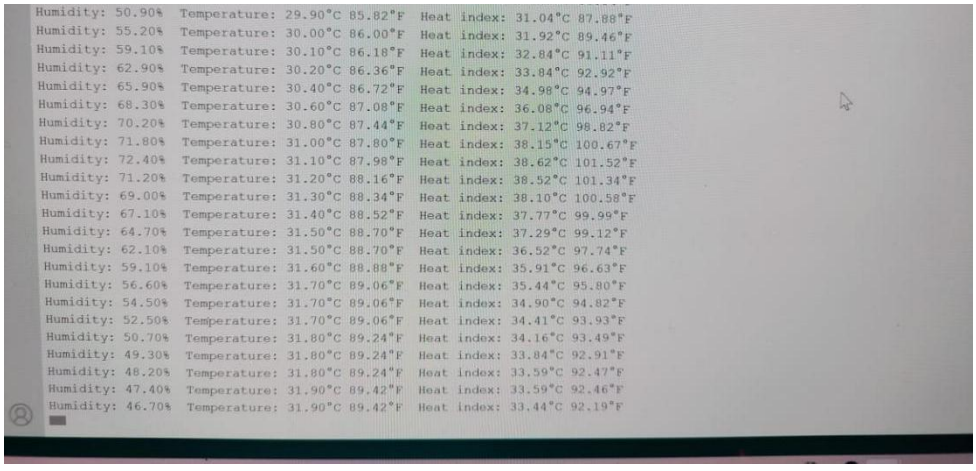


Fig.3. Terminal Output

While the weather station works great, we know there are still some challenges to overcome, like making sure the sensors stay accurate and making the data easier to understand. But we have ideas for making it even better, like using solar power and improving the way people interact with the station through their phones.

In summary, our weather station project shows how technology can make a real difference in how we understand and interact with our environment. It helps people stay informed and make choices that are good for their health and the planet. And we're excited to keep working on it to make it even more helpful in the future.

FUTURE PLAN:

Future improvements for the weather station could include adding self-calibrating sensors to ensure accuracy over time, using advanced data analysis tools to predict weather patterns, and designing more user-friendly interfaces. Integrating the weather station with renewable energy sources like solar panels can make it more sustainable. Enhancing mobile app features to provide customizable alerts and detailed data visualization will improve user experience. Expanding the station to include more sensors for pollutants like carbon monoxide and VOCs could offer a fuller picture of air quality. Overall, this project shows how engineering and technology can effectively monitor environmental conditions, helping users make better decisions for their comfort, health, and sustainability efforts.

REFERENCE:

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[2] https://www.arduino.cc/reference/en/libraries/

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[4] https://diyi0t.com/esp8266-wemos-d1-mini-tutorial/