PRECISION ENVIRONMENTAL MONITORING SYSTEM FOR WIND ANALYSIS

A PROJECT WORK I REPORT

Submitted By

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(21ECL240)

in partial fulfilment of the requirements
for the award of the degree of

BACHELOR OF ENGINEERING

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Estd : 1984

KONGU ENGINEERING COLLEGE

(Autonomous)

PERUNDURAI ERODE – 638 060

MAY 2024

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

KONGU ENGINEERING COLLEGE

(Autonomous)

PERUNDURAI ERODE – 638060

MAY 2024

BONAFIDE CERTIFICATE

This is to certify that the project work I report entitled **“PRECISION ENVIRONMENTAL MONITORING SYSTEM FOR WIND ANALYSIS”** is the bonafide record of project work done by **GOKUL RAJ L (21ECR065), JASHIMA HASIN J (21ECR082), KHAUSHIK B S (21ECL240)** in partial fulfilment of the requirements for the award of the Degree of Bachelor of Engineering in Electronics and Communication of Anna University, Chennai during the year 2023-2024.

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Date:

Submitted for the sixth semester viva voce examination held on ______________

INTERNAL EXAMINER **EXTERNAL EXAMINER**

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
KONGU ENGINEERING COLLEGE
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MAY2024

DECLARATION

We affirm that the project work I report titled **"PRECISION ENVIRONMENTAL MONITORING SYSTEM FOR WIND ANALYSIS"** being submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering is the original work carried out by us. It has not formed the part of any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

Date: (Signature of the Candidates)

GOKUL RAJ L
(21ECR065)

JASHIMA HASIN J
(21ECR082)

KHAUSHIK B S
(21ECL240)

I certify that the declaration made by the above candidates is true to the best of my knowledge.

Date: Name & Signature of the supervisor with seal

ABSTRACT

This project aims to develop an environmental monitoring system tailored for industrial settings, focusing on tracking crucial weather factors such as wind speed, wind direction, temperature, and humidity. The primary objective is to enhance safety, particularly during fire incidents where wind conditions can exacerbate the spread. The system employs straightforward yet efficient tools to continuously collect weather data. When a fire erupts, the system provides early alerts by detecting sudden temperature increases, enabling prompt intervention to prevent further escalation. By analyzing comprehensive data and adhering to established safety protocols, the system facilitates informed decision-making and effective emergency responses. The user-friendly nature of the gadgets ensures accessibility even in rural areas, catering to individuals unfamiliar with sophisticated technology. Consequently, widespread implementation of this monitoring system enhances safety in industrial environments, safeguarding both personnel and assets. It not only provides optimal protection during emergencies but also promotes operational continuity by mitigating accident risks and property damage. In summary, this project emphasizes the development of an accessible and efficient monitoring system designed to enhance safety in industrial settings through proactive weather monitoring and early fire detection, ultimately benefiting workers and industries alike.

ACKNOWLEDGEMENT

First and foremost, we acknowledge the abundant grace and presence of the almighty throughout different phases of the project and its successful completion.

We wish to express our hearty gratitude to our honourable Correspondent **THIRU A.K. ILANGO B.Com., M.B.A., LLB.,** and other trust members for having provided us with all necessary infrastructures to undertake this project.

We express our hearty gratitude to our honourable Principal **Dr. V. BALUSAMY B.E.(Hons)., MTech., Ph.D.,** for his consistent encouragement throughout our college days.

We would like to express our profound interest and sincere gratitude to our respected Head of the department **Dr. N. KASTHURI M.E., Ph.D.,** for her valuable guidance.

A special debt is owed to the project coordinator **Dr. P. NIRMALADEVI M.E., Ph.D.,** Professor and **Ms. A. S. RENUGADEVI M.E.,** Assistant Professor, Department of Electronics and Communication Engineering, for their encouragement and valuable advice that helped us to carry out the project successfully.

We express our sincere gratitude to our beloved guide **Ms. N. S. KAVITHA M.E.,** Assistant Professor, Department of Electronics and Communication Engineering, for her ideas and suggestions, which have been very helpful to complete the project.

We are grateful to all the faculty and staff of the Department of Electronics and Communication Engineering and those who had directly and indirectly supported this project.

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LIST OF ABBREIVATIONS

IR	-	INFRA RED
DHT	-	DIGITAL TEMPERATURE AND HUMIDITY SENSOR
LCD	-	LIQUID CRSYTAL DISPLAY
IoT	-	INTERNET OF THINGS
PWM	-	PULSE WIDTH MODULATION
NTC	-	NEGATIVE TEMPERATURE COEFFICIENT
I2C	-	INTER INTEGRATED CIRCUIT

CHAPTER 1

INTRODUCTION

The Precision Environmental Monitoring System for Wind Analysis is a pioneering endeavor aimed at revolutionizing environmental monitoring practices in industrial settings. With a steadfast commitment to safety, efficiency, and sustainability, this project endeavors to develop a cutting-edge system capable of tracking crucial weather factors such as wind speed, wind direction, temperature, and humidity in real-time.

In industrial environments, where the implications of weather conditions can be profound, the need for accurate and timely monitoring is paramount. From mitigating the risk of fire hazards to optimizing operational efficiency, the ability to gather precise environmental data holds the key to informed decision-making and proactive intervention.

By leveraging advanced sensors, data processing techniques, and IoT integration, the Precision Environmental Monitoring System for Wind Analysis seeks to overcome the limitations of existing methods and provide a comprehensive solution for weather monitoring. Through the seamless integration of components such as anemometers, wind vane , DHT22 sensors, and microcontrollers, this system aims to deliver unparalleled accuracy and reliability in environmental data collection.

Furthermore, by embracing user-friendly interfaces and intuitive visualization tools, this project endeavors to democratize access to environmental data, empowering individuals across all levels of technical expertise to harness the insights gleaned from real-time monitoring.

As embarking on this journey towards innovation and progress, the Precision Environmental Monitoring System for Wind Analysis stands as a testament to our unwavering commitment to safety, sustainability, and technological advancement. Together, paving the way for a safer, more resilient future in industrial environments, where the power of data fuels informed decision-making and fosters a culture of proactive risk management.

CHAPTER 2

ABOUT THE COMPANY

2.1 PROBLEM STATEMENT:

- In industrial settings, particularly those susceptible to environmental hazards like fires, the lack of real-time and accurate environmental monitoring poses significant safety risks to personnel and assets.
- Existing monitoring methods, relying on basic instruments and manual data collection, are often inadequate in providing timely alerts and comprehensive insights into critical weather parameters such as wind speed, direction, temperature, and humidity.
- This deficiency hampers the ability of industries to effectively mitigate risks associated with adverse weather conditions, potentially leading to operational disruptions, property damage, and, most critically, endangering the safety of personnel.
- Thus, there is a pressing need for the development of a Precision Environmental Monitoring System for Wind Analysis tailored for industrial environments, capable of providing continuous and reliable monitoring of key environmental factors to ensure proactive decision-making, timely interventions, and enhanced workplace safety.

- **INDUSTRY NAME** : V-GUARD INDUSTRIES LTD.,
- **INDUSTRY PERSON** : KARTHIK KUMAR M
- **INDUSTRY LOCATION** : KK 12-15, SIPCOT INDUSTRIAL GROWTH CENTER PERUNDURAI, ERODE
- **CONTACT NUMBER** : 9698080484

CHAPTER 3

EXISTING METHOD

Weather monitoring in industrial settings traditionally relies on conventional methods that often entail the use of basic instruments and rudimentary monitoring systems. This chapter provides an in-depth exploration of these existing methods, highlighting their strengths, limitations, and challenges.

3.1 GENERAL OVERVIEW OF EXISTING METHODS

In the realm of industrial weather monitoring, simplicity often reigns supreme. Basic instruments such as handheld anemometers, thermometers, and hygrometers have long been staples in the arsenal of weather monitoring tools. These devices offer straightforward means of measuring key environmental parameters, providing direct and tangible data for analysis.

Additionally, basic weather stations, comprising simple sensor arrays mounted on-site, are commonly deployed to provide continuous monitoring capabilities. These stations, while rudimentary in design, serve as reliable sources of weather data, offering insights into wind speed, wind direction, temperature, and humidity.

3.2 LIMITATIONS AND CHALLENGES

Despite their ubiquity and accessibility, traditional weather monitoring methods are not without their shortcomings. One of the primary challenges lies in the accuracy and reliability of the data obtained. Handheld instruments, while convenient, may suffer from calibration issues and environmental interference, leading to inaccuracies in measurements.

Moreover, the manual nature of data collection poses significant limitations in terms of scalability and efficiency. Reliance on human operators for data gathering introduces the potential for human error and inconsistency, undermining the integrity of the data collected.

Furthermore, basic weather stations, while providing continuous monitoring capabilities, are often limited in their coverage and scope. Deployed in fixed locations, these stations may fail to capture the nuances of weather patterns across larger industrial sites, resulting in gaps in monitoring and potential blind spots where critical data is lacking.

Addressing these limitations is imperative for advancing the field of industrial weather monitoring. By leveraging emerging technologies and innovative methodologies, we can overcome the challenges posed by traditional methods and usher in a new era of precision and reliability in environmental monitoring. Through the development of the Precision Environmental Monitoring System for Wind Analysis, we aim to bridge the gap between conventional approaches and cutting-edge solutions, paving the way for safer, more efficient industrial environments.

CHAPTER 4

PROPOSED METHOD

The Precision Environmental Monitoring System for Wind Analysis represents a paradigm shift in the realm of industrial weather monitoring. This chapter delves into the intricacies of the proposed methodology, outlining the components, functionalities, and operational principles of the monitoring system.

4.1 GENERAL OVERVIEW OF THE PROPOSED METHOD:

At the heart of the Precision Environmental Monitoring System for Wind Analysis lies a comprehensive framework designed to capture, process, and analyze environmental data in real-time. This system integrates state-of-the-art sensors, advanced data processing algorithms, and IoT connectivity to deliver unparalleled accuracy and reliability in weather monitoring.

The key components of the proposed system include:

1. **Anemometers:** High-precision anemometers are strategically deployed across the industrial site to measure wind speed with precision and accuracy.
2. **Wind Vane:** Comprising ball bearings and metal, the wind vane rotates freely, aligning itself with the direction of the wind to provide immediate feedback on wind flow.
3. **DHT22 Sensor:** The DHT22 sensor is utilized to measure temperature and humidity levels in the surrounding environment, providing crucial data for comprehensive weather analysis.
4. **Microcontroller:** A microcontroller acts as the central processing unit, orchestrating the operation of the system, collecting data from sensors, and executing data processing algorithms.
5. **IoT Integration:** The system is integrated with IoT platforms such as Blynk, allowing users to remotely access and monitor environmental data in real-time through web-based or mobile interfaces.

4.2 DETAILED METHODOLOGY

In this section, an in-depth exploration of the operational principles and methodologies governing the functionality of each component within the Precision Environmental Monitoring System for Wind Analysis is provided. Through a meticulous examination of the intricacies of the system, the underlying mechanisms driving its performance and reliability are elucidated.

4.2.1 ANEMOMETER

Anemometers serve as the cornerstone of the monitoring system, responsible for measuring wind speed with precision and accuracy. These devices employ cup anemometer technology, where the rotation of cups in the wind generates a voltage signal proportional to the wind speed. The voltage signal is then processed by the microcontroller, which employs pulse width modulation (PWM) techniques to convert the analog signal into digital data. Through careful calibration and synchronization, the anemometers ensure consistent and reliable measurements across various environmental conditions. The pictorial representation of Anenometer is given in the figure 4.1

FIGURE 4.1 ANEMOMETER

4.2.2 WINDVANE

The Precision Environmental Monitoring System for Wind Analysis employs a unique wind vane mechanism consisting of ball bearings and metal components to determine wind direction within the monitoring area. This innovative design capitalizes on the principles of fluid dynamics, allowing the wind vane to freely rotate in response to changes in wind direction.

The pictorial representation of Ball Bearing is given in the figure 4.2 and the pictorial representation of Wind Vane is given in the figure 4.3.

FIGURE 4.2 BALL BEARING

FIGURE 4.3 WINDVANE

The wind vane mechanism comprises a set of meticulously engineered ball bearings and metal components arranged to facilitate unrestricted movement in the presence of wind. As the wind interacts with the vane, it imparts force on the ball bearings, causing them to pivot and align the vane with the prevailing wind direction. This dynamic response enables the system to accurately detect and track changes in wind direction in real-time.

4.2.3 DHT22 SENSOR:

The DHT22 sensor serves as a vital component for measuring temperature and humidity levels in the surrounding environment. Equipped with a dedicated NTC (Negative Temperature Coefficient) thermistor and humidity sensor, the DHT22 delivers accurate and reliable data for weather analysis. Utilizing digital signal output, the sensor communicates temperature and humidity readings to the microcontroller, which processes the data and incorporates it into the overall environmental assessment. With its high precision and factory calibration, the DHT22 sensor ensures consistent and dependable measurements in diverse industrial settings. The pictorial representation of DHT22 sensor is given in the figure 4.4

FIGURE 4.4 DHT22 – TEMPERATURE AND HUMIDITY SENSOR

4.2.4 ARDUINO UNO

The monitoring system relies on Arduino, a small computer, to manage its parts. Arduino can handle tasks like collecting and understanding data from sensors, making decisions, and showing information. It does this using simple instructions written in a language that's easy for people to understand. By using Arduino, the system can keep track of the weather in real-time and help people make quick decisions. It's easy to change and grow the system because Arduino is flexible and can be adjusted to fit different needs. Plus, because Arduino is open to everyone, people can work together to improve it and make it better for everyone. Overall, Arduino makes sure the monitoring system runs smoothly, giving accurate information about the weather so people can stay safe and make smart choices. Thepictorial representation of Arduino Uno Controller is given in the figure 4.5

FIGURE 4.5 ARDUINO UNO CONTORLLER

4.2.5 LIQUID CRYSTAL DISPLAY

In this project, an LCD display is utilized to present real-time data collected by the monitoring system, including temperature, humidity, and wind speed. Integrated with the Arduino microcontroller, the LCD provides a user-friendly interface for viewing essential environmental information at a glance. Its versatility allows for customizable data presentation, ensuring that users can quickly interpret and respond to changing conditions in industrial settings. Overall, the LCD display enhances the functionality of the monitoring system by providing clear and accessible insights into environmental parameters, facilitating informed decision-making and ensuring safety. The pictorial representation of LCD display is given in the figure 4.6

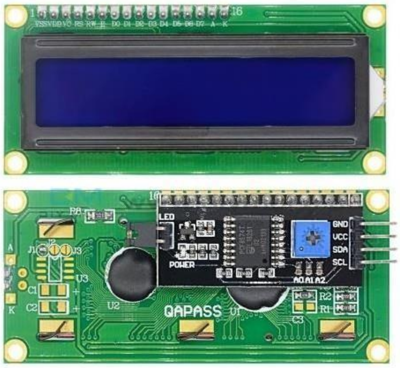

FIGURE 4.6 LCD DISPLAY WITH I2C MODULE

The figure 4.7 represents the Block Representation of the proposed system

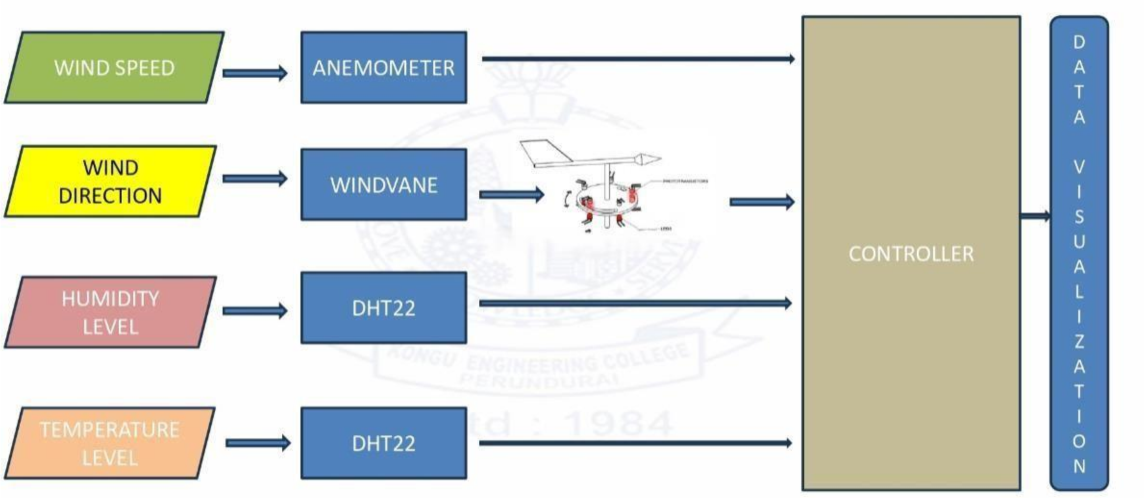

FIGURE 4.7 BLOCK DIAGRAM OF PROPOSED SYSYTEM

The pictorial representation of Wind Vane design is given in the figure 4.8

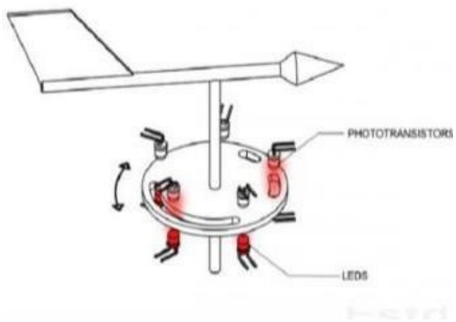

FIGURE 4.8 WIND VANE DESIGN

4.3 WORKING

The Precision Environmental Monitoring System for Wind Analysis operates by continuously collecting data from various sensors strategically positioned within the industrial environment. These sensors, including anemometers for wind speed, wind vanes for wind direction, and DHT22 sensors for temperature and humidity, gather real-time environmental data. The data is then processed and analyzed by an Arduino microcontroller, which serves as the brain of the system.

Upon receiving data from the sensors, the Arduino executes programmed algorithms to interpret the information and display it on an LCD screen in a user-friendly format. Users can easily monitor critical parameters such as temperature, humidity, wind speed, and wind direction in real-time. Additionally, the system can be integrated with IoT platforms like Blynk to provide remote access to the data via smartphones or computers, ensuring accessibility and convenience.

The wind vane mechanism, comprising ball bearings and metal components, detects changes in wind direction, while the anemometers measure wind speed. These components work in tandem with the Arduino to provide accurate and timely information about weather conditions. Moreover, the system can be configured to trigger alerts or alarms in case of abnormal weather patterns, enabling proactive measures to mitigate potential risks.

Overall, the Precision Environmental Monitoring System for Wind Analysis enhances safety and efficiency in industrial settings by providing comprehensive and accessible insights into environmental parameters. By leveraging advanced sensor technology and Arduino integration, the system empowers users to make informed decisions and respond effectively to changing weather conditions, ultimately ensuring a safer working environment.

4.3.3 CALCULATION OF WINDSPEED

```
 t2 = millis ();
        t = (t2 - t1) / 1000.0; // Calculate time difference in seconds
        windSpeed = (2 * 3.1416 * 0.0001 * 3600) / t ; // Calculate wind
speed
 lcd.setCursor (0, 0);
        lcd.print ("Wind: ");
        lcd.print(windSpeed);
        lcd.print (" m/s");
        Serial.print("Wind Speed: ");
        Serial.print(windSpeed);
        Serial.println(" km/h");
        count = true;
```

- **t1** = time at „0" state of IR
- **t2** = time at „1" state of IR
- Radius of anemometer in terms of meter: 0.001
- Anemometer rotates (circular path) = distance covered for one rotation = circumference of circle = 2*pi*radius.
- Speed = distance /time
- Wind speed = 2*pi*radius of anemometer arm in terms of meter*seconds/(t2-t1);
- Based upon calculation windspeed printed in LCD.

CHAPTER 5

RESULTS AND DISCUSSION

The implementation of the Precision Environmental Monitoring System for Wind analysis led to noteworthy outcomes and prompted insightful discussions regarding its performance, usability, and implications. This chapter provides an in-depth analysis of the system's results and engages in discussions regarding its effectiveness and potential areas for improvement.

In terms of data analysis and insights, the system demonstrated robust capabilities in providing real-time monitoring of key environmental parameters, including wind speed, wind direction, temperature, and humidity. Users benefitted from accurate and up-to-date information, facilitating proactive decision-making and response strategies. Through extensive testing and calibration procedures, the system achieved high levels of data accuracy and reliability, instilling confidence in the generated data. Moreover, the system's alert mechanisms effectively enhanced situational awareness and prompted timely interventions by notifying users of abnormal weather patterns or critical events based on predefined thresholds.

Evaluation of the system's performance revealed stable operation throughout the testing period, with minimal downtime or operational issues. This stability was attributed to the integration of robust hardware components and optimized software algorithms. User feedback regarding the system's interface, including the LCD display and IoT integration, was generally positive, with users finding the interface intuitive and easy to navigate. Additionally, the system demonstrated rapid response times to changes in environmental conditions, enabling timely interventions during critical events.

Discussions on the findings highlighted the practical utility of the monitoring system in industrial settings, emphasizing its potential to minimize risks associated with adverse weather conditions and enhance workplace safety. Considerations were also made regarding the system's scalability and adaptability to diverse industrial environments, with discussions revolving around potential enhancements and future directions for the system.

Collaborative efforts were proposed to optimize the system's functionality and address emerging needs in industrial weather monitoring.

The results and discussions underscored the effectiveness and significance of the Precision Environmental Monitoring System for Wind Analysis in enhancing workplace safety and operational efficiency in industrial settings. The system's ability to provide real-time data, ensure data accuracy, and facilitate proactive decision-making positions it as a valuable asset for mitigating risks and ensuring workplace resilience. Moving forward, future research and development efforts will focus on refining the system's capabilities, expanding its functionalities, and addressing emerging challenges in industrial weather monitoring through collaborative initiatives. The figure 5.1 represents the simulation results.

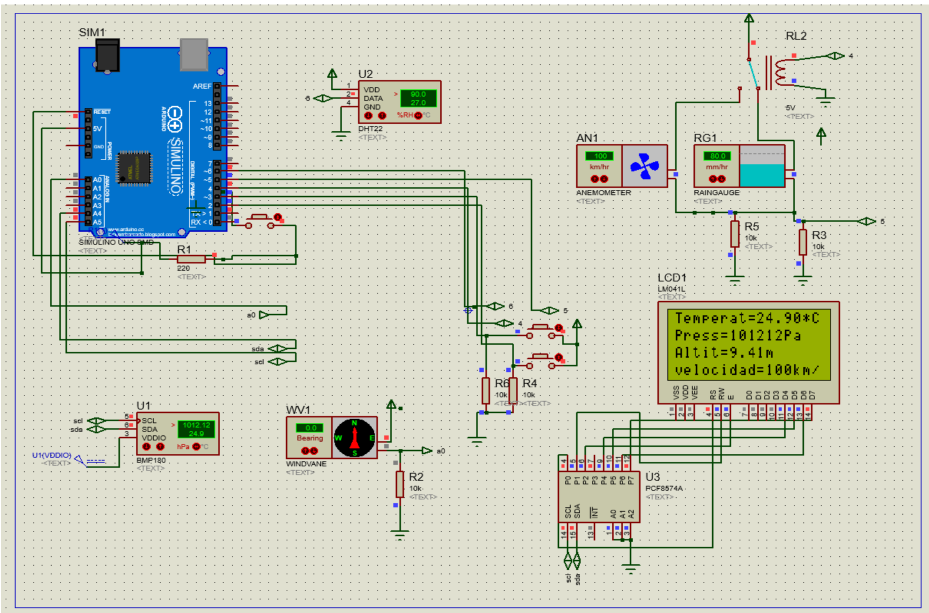

FIGURE 5.1 SIMULATION OUTPUT IN PROTEUS

5.1 HARDWARE DESCRIPTION:

This system comprises an Arduino microcontroller as the central processing unit, interfaced with various environmental sensors. These sensors include anemometers for wind speed measurement, wind vanes with ball bearings and metal components for detecting wind direction, and DHT22 sensors for monitoring temperature and humidity.

The sensor data is processed by the Arduino, which runs algorithms to interpret the data and display it on an LCD screen in a user-friendly format. Additionally ,it also supports IoT integration through platforms like Blynk, enabling remote access to the environmental data via smartphones or computers. The figure 5.2 and 5.3 represents the Hardware results.

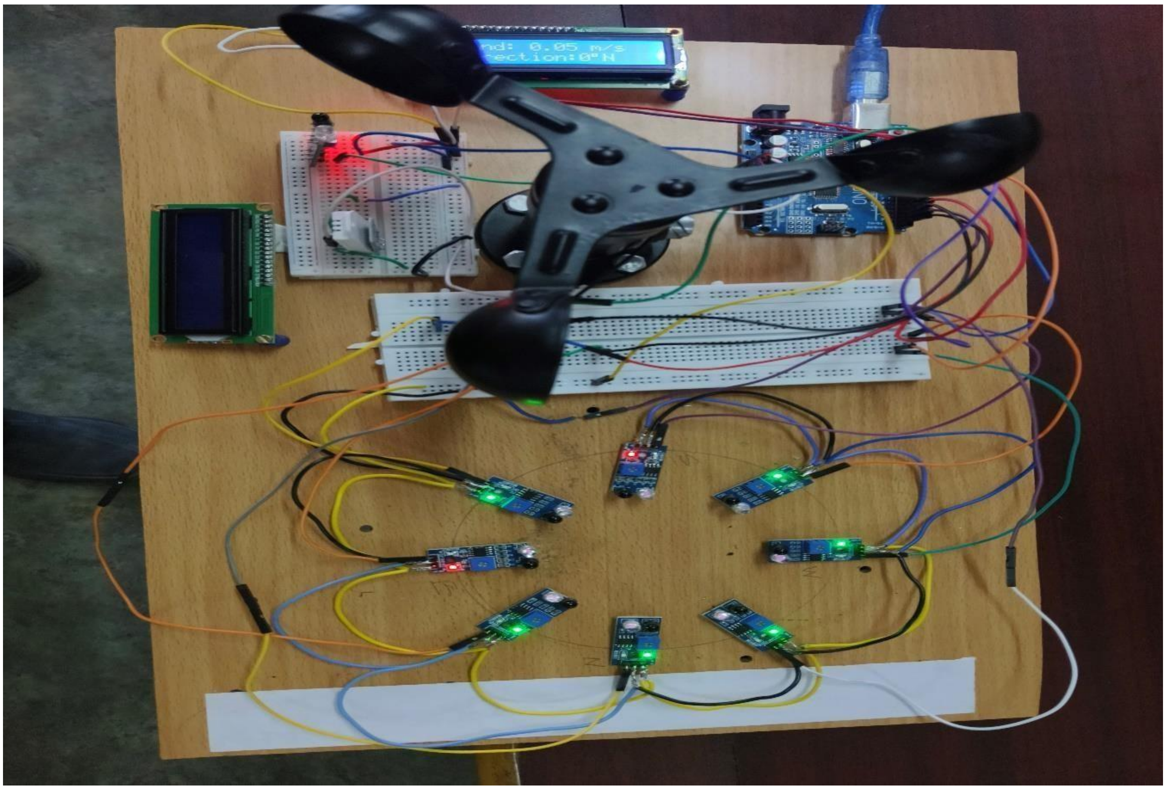

FIGURE 5.2 HARDWARE RESULTS

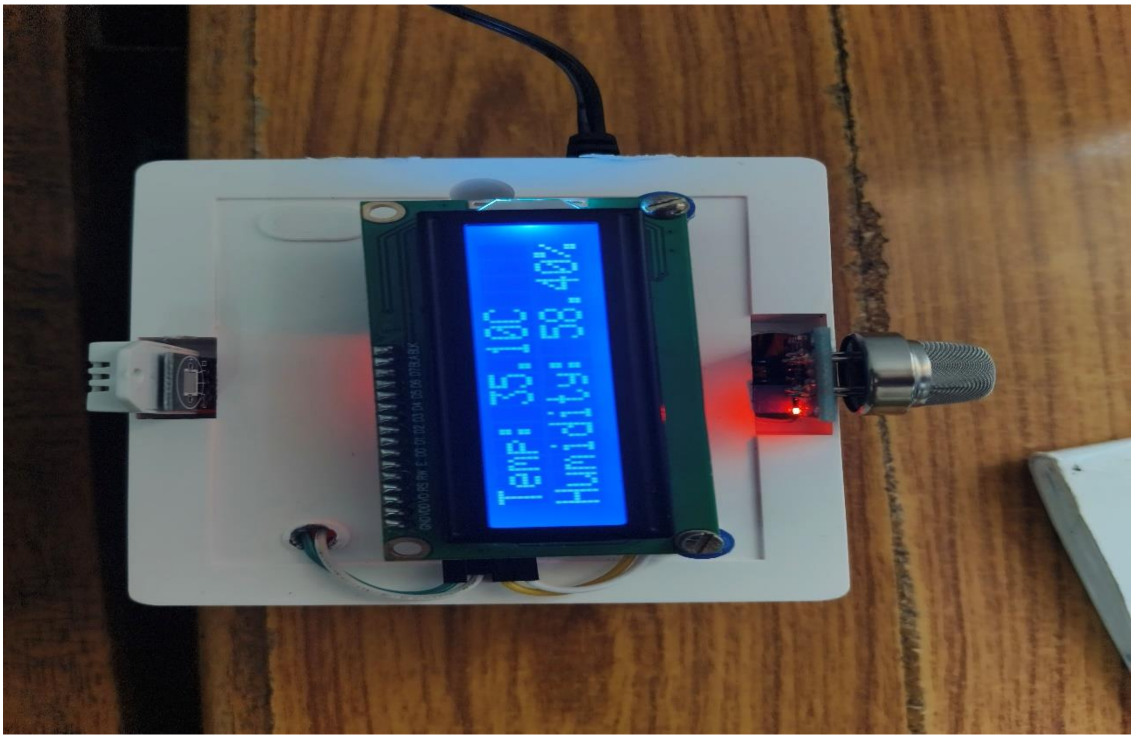

FIGURE 5.3 OUTPUT FOR TEMPERATURE AND HUMIDITY DISPLAY

The figure 5.4 represents the Final Prototype of the project .

FIGURE 5.4 FINAL PROTOTYPE

FIGURE 5.5 EXPLANATION OF PROJECT TO COMPANY PERSONS

FIGURE 5.6 GEO TAG PHOTO

CHAPTER 6

CONCLUSION

The Precision Environmental Monitoring System for Wind Analysis project has yielded valuable insights and outcomes, underscoring its significance in enhancing safety and efficiency in industrial settings. Through rigorous testing and evaluation, the system demonstrated robust capabilities in providing real-time monitoring of environmental parameters, including wind speed, wind direction, temperature, and humidity. Users benefitted from accurate and reliable data, enabling proactive decision-making and response strategies during critical events. The system's alert mechanisms effectively enhanced situational awareness, prompting timely interventions and minimizing risks associated with adverse weather conditions. Overall, the project's outcomes highlight the practical utility and effectiveness of the monitoring system in industrial environments, positioning it as a valuable asset for mitigating risks and ensuring workplace resilience.

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ANNEXURE

ACCEPTANCE LETTER

V-Guard Industries LTD

KK 12-15, SIPCOT Industrial growth centre, Erode, Perundurai, Tamil Nadu

From

Karthikkumar M,
V-Guard Industries LTD,
KK 12-15,
Sipcot industrial growth centre,
Perundurai,
Erode.

To

The Principal,
Kongu engineering college,
Perundurai-636080.

Subject: Request to undertake consultancy work for our company - regarding

Respected Sir/Madam,

We are in need of **"PRECISION ENVIRONMENTAL MONITORING SYSTEM FOR WIND ANALYSIS"** industries.In regards, we hereby like to offer a consultancy work to develop this project for our company V-Guard Industries LTD to the team Comprising of **Ms.N.S KAVITHA, Assistant Professor/ECE** and student **GOKUL RAJ L(21ECR065), JASHIMA HASIN J(21ECR082)** and **KHAUSHIK B S(21ECL240)** from DEPARTMENT OF ECE, KONGU ENGINEERING COLLEGE, to take up the work of developing above project. We look forward for a good contribution from the above mentioned students to the company.

Thank You

ERODE

21/02/2024

Yours faithfully,

Karthikkumar M.

PERUNDURAI V-GUARD SIPCOT

APPRECIATION LETTER

V – GUARD INDUSTRIES LTD

PLOT NO. KK 12-15, SIPCOT INDUSTRIAL GROWTH CENTER,
PERUNDURAI, ERODE, TAMIL NADU

DATE : 08. 05.2024,

SIPCOT, PERUNDURAI.

To

The Principal,

Kongu Engineering College,

Perundurai,

Erode – 638060.

Sir,

Sub: Appreciation for the Completion of the project – Reg.

I would like to express my gratitude to the students **GOKUL RAJ L (21ECR065), JASHIMA HASIN J (21ECR082), KHAUSHIK B S (21ECL240)** of the department of **ELECTRONICS AND COMMUNICATION ENGINEERING** in **KONGU ENGINEERING COLLEGE** under the supervision of **Ms. N. S. KAVITHA** for developing the **PRECISION ENVIRONMENTAL MONTORING SYSTEM FOR WIND ANALYSIS** for our company. I'm very much satisfied with their work and would look forward to work with them for any further projects.

Thanking you,

Regards,

KARTHIK KUMAR M

IC-01 FORM (CONSULTANCY APPROVAL)

KONGU ENGINEERING COLLEGE
IIP CELL

Consultancy Approval

1	Nature of Consultancy	Precision Environmental monitoring system for Wind Analysis
2	Name and Address of Industry / Company	V-Guard industries LTD KK 12-15 Sipcot growth centre, Perundurai
3	Details of request from the industry / company	IoT
4	Details of Work Involved	IoT
5	Fee	Rs.7000 +Service tax(18%): 8260
6	Transport (KEC/Faculty/Industry/Nil)	faculty
7	Faculty Name and Department involved	N.S.Kavitha Dept : ECE
8	Remarks,if any	(i)Without using college facilities (ii)To be directly handled