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E-PROCEEDINGS

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"Fostering a Culture of Innovation and Entrepreneurial Excellence"

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PTDI, UiTM Cawangan Johor Kampus Pasir Gudang

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A-ST093: THE HOME-BASED AUTOMATIC SELF-SANITIZED WASTE MANAGEMENT SYSTEM

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ABSTRACT

The Home-Based Automatic Self-Sanitized Waste Management System is an innovative solution that automates waste disposal, improves sanitation, and promotes efficient waste segregation. The system utilizes key components such as the ESP32, ultrasonic sensors, servo motors, DHT22 humidity sensor, IR motion sensor, MQ 135 gas sensor and an LCD screen with I2C module, alongside Blynk for remote monitoring and control. The system detects motion using the IR sensor, automatically opening the lid via servo motors for a hands-free experience. The DHT22 sensor determines humidity to classify waste as dry or wet, while the ultrasonic sensor monitors the bin's fill level, displaying real-time data on the LCD screen and sending updates to the Blynk app. Additionally, a built-in self-sanitization mechanism helps maintain cleanliness and reduce odours, enhancing hygiene in home environments. This system stands out for its integration of IoT technology via ESP32 and Blynk, enabling remote monitoring and management, which fosters smarter waste management practices. The project offers significant socio-environmental benefits by encouraging cleaner spaces, reducing manual interaction with waste, and supporting improved public health. Its cost-effective design and user-friendly interface make it highly scalable and promising for commercial applications in both urban and rural settings. By modernizing conventional waste management systems, this solution contributes to smarter, cleaner, and healthier living environments.

Keywords: monitoring and control, hygiene, self-sanitization, humidity, Blynk

1. Product Description

The Home-Based Automatic Self-Sanitized Waste Management System is a smart waste disposal solution that integrates advanced sensors and automation to ensure efficiency, hygiene, and sustainability. Designed for modern households, this system combines key features for an enhanced waste management experience. An IR sensor detects motion near the bin and activates the servo motor to automatically open the lid, providing a hands-free, contactless operation. The DHT22 humidity sensor classifies waste into dry or wet categories based on its moisture content, supporting proper waste segregation. To monitor the bin's capacity, an ultrasonic sensor measures the fill level and ensures timely disposal. For maintaining hygiene, the system utilizes an MQ-135 gas sensor to detect harmful gases and trigger the self-sanitization mechanism, ensuring the interior remains clean and odour-free. An LCD display provides real-time updates on the status of the IR sensor, DHT22, ultrasonic sensor, and MQ-135 sensor, offering users a clear and organized overview of system operations. With its automated features and IoT integration through ESP32 and

Blynk, this smart bin simplifies waste management while promoting cleaner and healthier living environments.

2. Block Diagrams and Flowchart

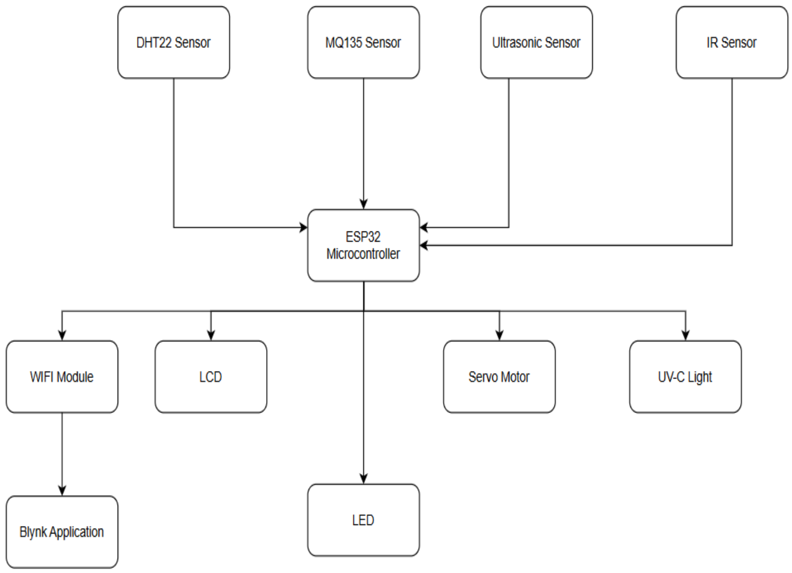


Figure 1. Block Diagram of The Home-based Automatic Self-Sanitized Waste Management System.

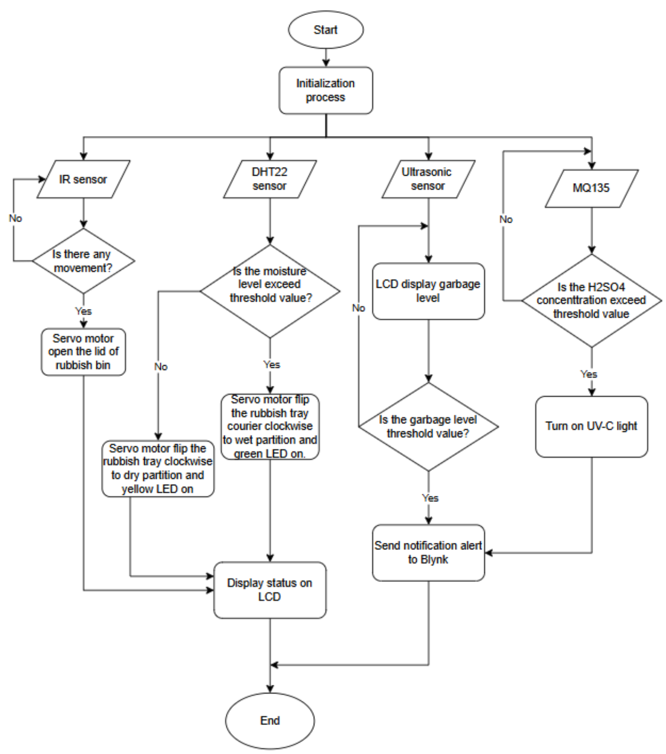


Figure 2. Flow chart of The Home-based Automatic Self-Sanitized Waste Management System.

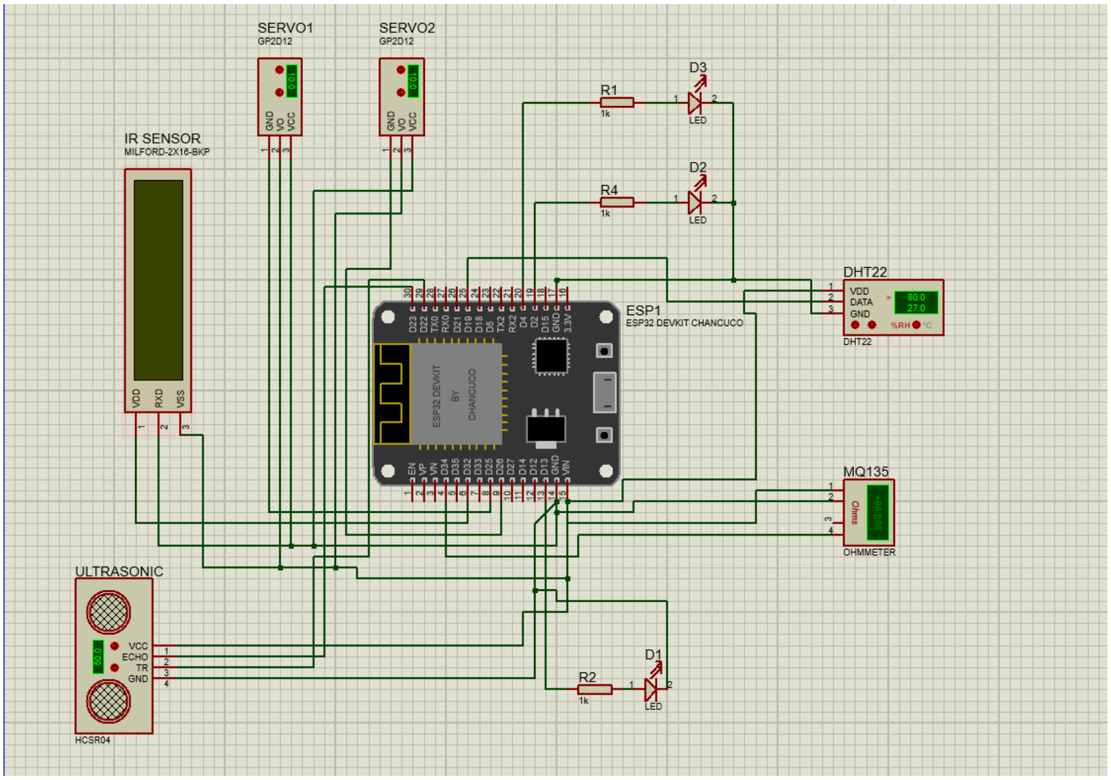


Figure 3. Schematic diagram of The Home-based Automatic Self-Sanitized Waste Management System.

3. Novelty and uniqueness

The Home-Based Automatic Self-Sanitized Waste Management System stands out due to its innovative combination of sensor technology, automation, and IoT integration to address traditional waste management challenges. Unlike conventional waste bins, this system offers a hands-free operation through an IR sensor and servo motor that automatically opens the lid when movement is detected, ensuring better hygiene. A unique feature of this system is the integration of the DHT22 humidity sensor, which classifies waste into dry or wet categories based on moisture content. This promotes effective waste segregation at the household level, contributing to more sustainable waste disposal practices.

Additionally, the MQ-135 gas sensor enables automatic self-sanitization by detecting harmful gases and odours, ensuring the bin's interior remains clean and odour-free. Combined with the ultrasonic sensor that monitors the bin's fill level, users are alerted when it needs to be emptied, enhancing overall efficiency. The LCD display provides a user-friendly interface that showcases the real-time status of all integrated sensors, while IoT connectivity through ESP32 and Blynk enables remote monitoring and control via smartphones. By integrating these features into a single system, the project demonstrates novelty in its automation, hygiene maintenance, and waste classification capabilities, making it a unique and practical solution for modern waste management.

4. Benefit to mankind

The Home-Based Automatic Self-Sanitized Waste Management System is an innovative solution for efficient, hygienic, and sustainable waste disposal in modern households. This smart system incorporates advanced sensors and automation to enhance the waste management experience. An infrared sensor detects motion near the bin, activating a servo motor to open the lid automatically, allowing for hands-free operation. A DHT22 humidity sensor classifies waste into dry or wet categories based on moisture content, facilitating proper segregation. An ultrasonic sensor monitors the bin's fill level, ensuring timely disposal. To maintain hygiene, the system employs an MQ-135 gas sensor to detect harmful gases, triggering a self-sanitization mechanism that keeps the interior clean and odour-free. Real-time updates are provided via an LCD display, giving users a clear overview of system operations. With IoT integration through ESP32 and Blynk, this smart bin simplifies waste management while promoting cleaner and healthier living environments.

5. Innovation and Entrepreneurial Impact

The Home-Based Automatic Self-Sanitized Waste Management System promotes innovation by integrating advanced technologies like IoT, sensors, and automation into everyday waste disposal, setting a precedent for smart home solutions. This project encourages entrepreneurship within the community by inspiring local startups to develop complementary products or services, such as maintenance, upgrades, or educational programs on sustainable practices. By showcasing a practical application of technology in waste management, it stimulates interest in environmental entrepreneurship and green technology initiatives. Institutions can adopt this system as part of their sustainability efforts, fostering research and development in waste management solutions. As communities embrace this innovative approach, it cultivates a culture of creativity and problem-solving, encouraging individuals to explore new ideas and business opportunities that contribute to a cleaner environment and sustainable living. Overall, your project serves as a catalyst for innovation and entrepreneurial spirit in addressing pressing environmental challenges.

6. Potential commercialization

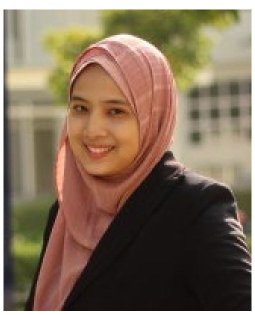
The potential commercialization of the Home-Based Automatic Self-Sanitized Waste Management System aligns perfectly with the rapidly growing smart waste management market, projected to reach $9.01 billion by 2033, with a CAGR of 11%. This system leverages advanced technologies such as IoT and automation, positioning it as an innovative solution in a sector increasingly focused on sustainability and efficiency. As urbanization and environmental awareness rise, there is a growing demand for smart waste solutions that improve waste collection and segregation processes. By addressing these needs, your project can tap into diverse markets, including residential, commercial, and municipal sectors. Furthermore, its implementation could inspire local entrepreneurship by encouraging startups to develop complementary services or products, fostering a culture of innovation within the community. Overall, this project not only offers a viable business opportunity but also contributes to sustainable waste management practices.

7. Acknowledgement

We would like to thank our project supervisor Dr Zatul Iffah Abdul Latiff for his invaluable guidance, insight and encouragement throughout the development of this project. We are also grateful to our institution, UiTM for providing the necessary resources, facilities and support that allowed us to complete our work successfully. Our sincere appreciation goes to our colleagues, whose constructive feedback and collaboration enriched our project. In addition, we would like to thank our family and friends for their unwavering support, encouragement and motivation. Finally, we would like to acknowledge any external resources, open-source platforms and technical communities that played an important role in inspiring and supporting the innovation of my project.

8. Authors' Biography

Noreen Sharina Mohamed Nor is pursuing a Diploma in Electrical and Electronic Engineering at Universiti Teknologi MARA (UiTM). She specializes in IoT systems, automation, and sensor integration. Through her academic projects, such as a smart dustbin with waste segregation and environmental monitoring, she has developed hands-on experience in Arduino programming, ESP32 integration, and IoT platforms like Blynk. Her work focuses on addressing environmental challenges through innovative and sustainable solutions. Committed to continuous learning, she aims to contribute to advancements in smart automation and sustainable technology, bridging theory and real-world applications.



Zatul Iffah Abd Latiff completed her PhD studies in Universiti Teknologi MARA, focusing on the research of Space and Earth Electromagnetism. She received her Bachelor of Engineering Degree in Electrical Engineering from Korea University, South Korea in 2010 and her Master of Science in Telecommunication and Information Engineering from Universiti Teknologi MARA (UiTM), Malaysia in 2013. She is one of the co-researchers of MAGDAS (Magnetic Data Acquisition System) network who is responsible for monitoring and maintaining one of the MAGDAS observatories located in Johor, Malaysia. Her research interests include geomagnetically induced currents (GICs) activity in the equatorial and low latitude region, space weather activity, ionospheric currents, Earth's electromagnetism, and application of ground magnetic and satellite data.

A-ST094: SMART WEATHER MONITORING SYSTEM FOR AGRICULTURE

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ABSTRACT

The weather monitoring system designed for agriculture integrates multiple sensors, including the DHT11 for temperature and humidity, BMP180 for atmospheric pressure, LDRs for light intensity, and MQ-7 for carbon dioxide levels, all powered by the ESP32 microcontroller. When the DHT11 sensor detects a temperature above the set limit, the system triggers an alert through the buzzer and illuminates an LED, providing immediate visual and auditory notifications to farmers. This IoT-based system provides real-time data collection on critical parameters essential for optimizing crop management. The system enables farmers to access comprehensive environmental data that informs their decision-making processes. Continuous monitoring allows for immediate responses to changing conditions, helping to adjust irrigation schedules and fertilization practices effectively. The user-friendly interface ensures that data is easily accessible via mobile devices, enhancing operational efficiency. This innovative approach not only increases crop yields by enabling precise agricultural practices but also promotes resource efficiency and sustainable farming methods. The market potential for this technology is substantial, as the demand for real-time weather monitoring solutions continues to grow in the agriculture sector. By integrating these advanced sensors, the system empowers farmers with the tools necessary to enhance productivity while contributing to environmentally friendly practices, making it a versatile and economically viable option for small-scale agricultural enterprises.

Keywords: Weather Monitoring, ESP32, Agriculture, IoT-based system

1. Product Description

The weather monitoring system for agriculture is an innovative IoT solution designed to enhance crop management through real-time environmental data collection. This system features an array of sensors, including the DHT11 for temperature and humidity, BMP180 for atmospheric pressure, LDRs for light intensity, and MQ-7 for carbon dioxide levels, all powered by the ESP32 microcontroller. A standout feature is the integrated LCD display, which provides immediate access to critical data such as temperature, humidity, pressure, light intensity, and CO_2 levels. The system includes a buzzer and LED alert mechanism that activates when temperatures exceed a predefined threshold, ensuring farmers receive timely notifications to protect their crops from heat stress. Continuous data collection allows for prompt adjustments in irrigation and fertilization practices based on current environmental conditions. Moreover, users can access all this information through the Blynk app on their smartphones, enabling them to monitor their agricultural environment remotely. The user-friendly interface of the Blynk app ensures that data is easily accessible, enhancing operational efficiency.

2. Flow Charts and tables

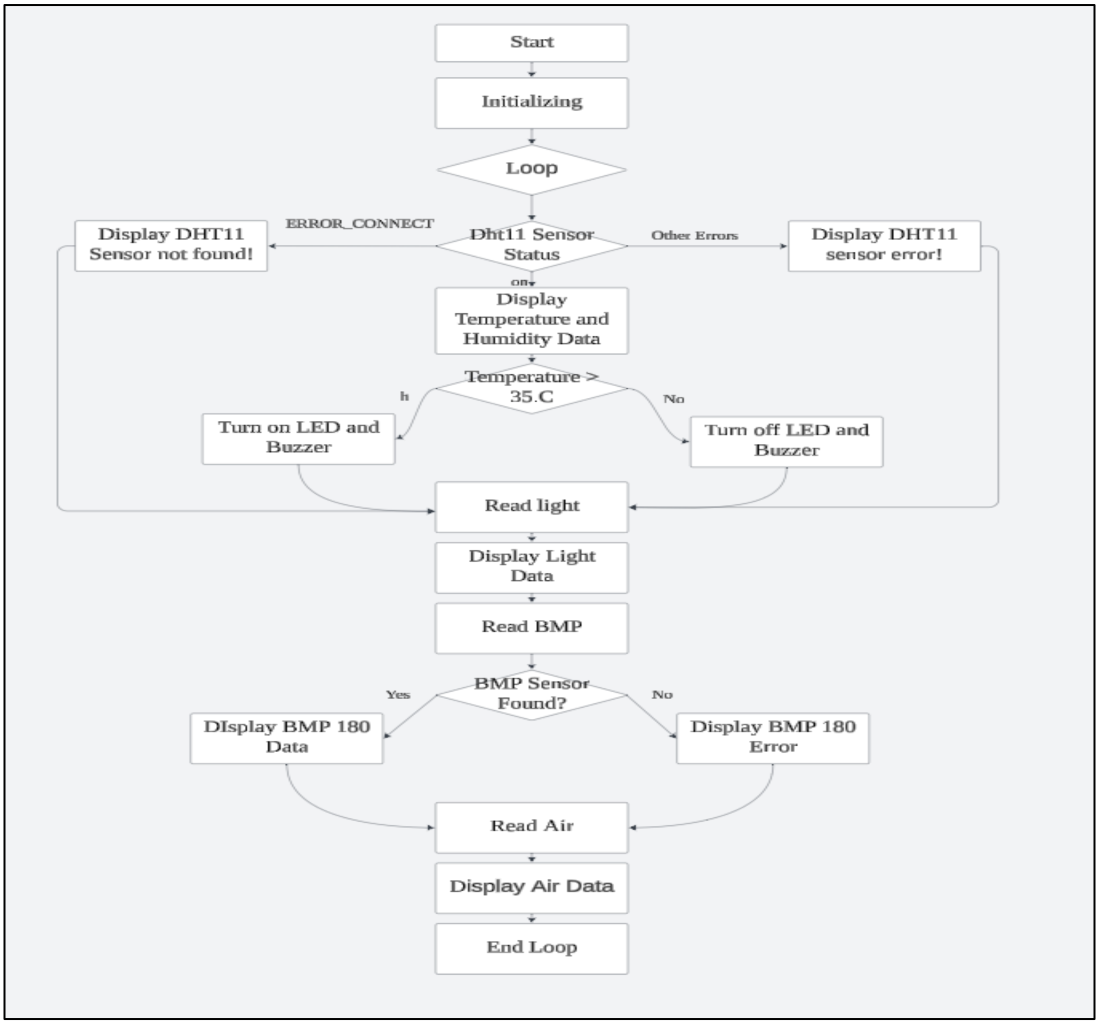

Figure 1. Flow chart of weather monitoring system

Figure 1 illustrates the operational sequence of a weather monitoring system designed for agricultural applications. The process begins with the initialization phase, during which the microcontroller and sensors are powered on and checked to ensure readiness for data collection.

After initialization, the system enters a loop to continuously monitor environmental parameters. It starts by verifying the status of the DHT11 sensor. If the sensor is not connected, the system displays a "DHT11 Sensor Not Found" message and restarts the loop. For other types of errors, it displays a general "DHT11 Sensor Error" message. If the sensor functions correctly, the system proceeds to collect and display temperature and humidity data. Next, the system checks if the temperature exceeds 35°C. If so, it activates an LED and buzzer as a high-temperature alert. If the temperature is below the threshold, the LED and buzzer are turned off. The system then reads data from the light sensor and displays the collected light intensity. Following this, it attempts to read data from the BMP180 sensor. If the sensor is detected, the system displays the corresponding data. Otherwise, it shows a "BMP180 Sensor Error" message.

Finally, the system reads air quality data and displays it before completing the loop. This continuous cycle of monitoring and error handling ensures that the weather monitoring system provides real-time and reliable environmental data for effective agricultural management.

Table 1. List of components

No	*Component*	*Function*
1.	Esp 32	Control all the sensors by processing all the information and connect to the internet for remote monitoring.
2.	Barometric pressure sensor	Measures the atmospheric pressure.
3.	Temperature and humidity sensors	Measure ambient temperature and humidity levels.
4.	Light dependent resistor	Changes based on the amount of light it is exposed to.
5.	Carbon Dioxide sensor	Detects the presence carbon dioxide.
6.	Lcd display	Display the intended text and information.
7.	Piezo buzzer	Produces sound or alarm.
8.	Led	Emit light

Table 1 shows a barometric pressure sensor, temperature and humidity sensors, a light-dependent resistor (LDR), a carbon dioxide sensor, an LCD display, the ESP32 microcontroller, a piezo buzzer, and an LED. Each component plays a critical role in ensuring accurate, reliable, and real-time data acquisition and display, which is essential for agriculture.

The barometric pressure sensor, with its ability to measure atmospheric pressure, is pivotal in predicting weather changes. The temperature and humidity sensors contribute by providing precise measurements of ambient conditions. The light-dependent resistor (LDR) adds another dimension by detecting light intensity, thus enabling automated lighting solutions that adjust based on ambient light levels, improving energy efficiency and user comfort. Meanwhile, the carbon dioxide sensor ensures that the system can monitor and react to the presence of harmful gases, safeguarding corps health by maintaining optimal reading level.

Central to this system is the ESP32 microcontroller, which facilitates seamless internet connectivity. This microcontroller not only enables remote monitoring and control via Wi-Fi but also supports data logging and cloud integration. Such capabilities are indispensable for modern IoT (Internet of Things) applications, where data accessibility and real-time responsiveness are paramount. The user interface, managed through the LCD display, provides an intuitive platform for users to interact with the system, view current data, and receive immediate feedback. The inclusion of a piezo buzzer serves as an audible alert mechanism, ensuring users are promptly notified of any critical changes or anomalies in the monitored environment. The LED indicator further enhances user experience by providing a simple visual cue of the system's operational status.

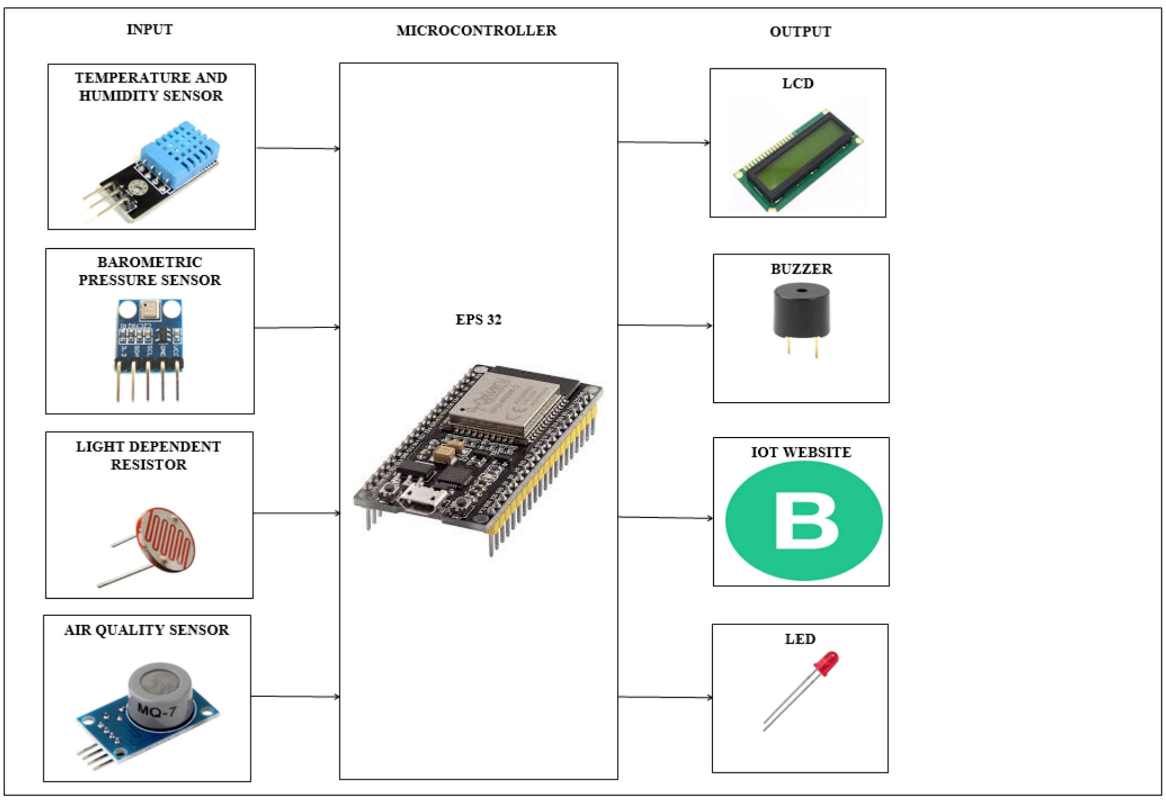

Figure 2. Block Diagram of Weather Monitoring System

Figure 2 illustrates the architecture of an ESP32-based weather monitoring system specifically designed for agricultural applications. The system collects critical environmental data, displays it locally on an LCD, and transmits it to an online platform for remote monitoring. The main components include an ESP32 microcontroller, a suite of sensors, an LCD for real-time data display, and IoT integration for enhanced accessibility.

In the input section, four essential sensors are utilized: a Temperature and Humidity Sensor (DHT11) to monitor ambient conditions, a Barometric Pressure Sensor (BMP180) to measure atmospheric pressure, a Light Dependent Resistor (LDR) to detect light intensity, and an Air Quality Sensor (MQ-7) to assess air quality by detecting gases such as carbon monoxide. These sensors are connected to the ESP32 microcontroller, which serves as the central processing unit, collecting data and managing system outputs.

The processed data is displayed on a Liquid Crystal Display (LCD) for immediate on-site visualization. Additionally, the ESP32's built-in Wi-Fi functionality allows the system to transmit the collected data to an online IoT platform, such as the Blynk IoT website, for remote access. The system is equipped with a buzzer and an LED for alert mechanisms, which are activated when specific conditions, such as high temperatures, are detected.

The data flow starts with the sensors gathering information on atmospheric pressure, temperature, humidity, light intensity, and air quality. This data is sent to the ESP32 microcontroller for processing. Once processed, it is displayed on the LCD and transmitted to the IoT platform, enabling real-time monitoring both locally and remotely. This system provides farmers and agricultural stakeholders with reliable and continuous weather data, supporting better decision-making and improving agricultural productivity.

3. Novelty and uniqueness

The novelty of the weather monitoring system for agriculture lies in its seamless integration of multiple sensors, making it user-friendly and highly effective for farmers. This system combines an array of sensors into a single platform powered by the ESP32 microcontroller. This comprehensive approach allows farmers to monitor various environmental factors simultaneously, enhancing their ability to make informed decisions about crop management. The product stands out when compared to other agricultural weather stations available on the market. Many existing solutions are either prohibitively expensive or lack the same array of sensors that this system offers. While some systems may include basic temperature and humidity sensors, they often do not provide the complete suite of environmental data needed for precision agriculture, such as carbon dioxide levels or light intensity.

Additionally, this advanced monitoring system simplifies the user experience with features like real-time alerts and remote access via the Blynk app, allowing farmers to stay connected with their operations from anywhere. The affordability of this product, combined with its extensive sensor capabilities, empowers farmers to optimize their operations while promoting sustainable agricultural practices. By providing critical insights at a competitive price point, this system not only enhances productivity but also supports environmentally responsible farming methods.

4. Benefit to mankind

The weather monitoring system for agriculture provides significant benefits that enhance food security and sustainability for mankind. By integrating multiple sensors including temperature, humidity, atmospheric pressure, light intensity, and carbon dioxide levels this system delivers accurate and timely weather data that empowers farmers to make informed decisions regarding their agricultural practices. One of the primary benefits of this system is its ability to minimize crop losses due to adverse weather conditions. With real-time alerts for temperature extremes and comprehensive environmental monitoring, farmers can proactively adjust irrigation schedules and protect their crops from heat stress of frost. This proactive approach is crucial in an era of increasing climate variability.

Additionally, the system promotes efficient resource use by enabling precision agriculture. Farmers can optimize water usage based on real-time soil moisture data and atmospheric conditions, reducing waste and conserving vital water resources. The integration of sensors also helps in managing fertilizer and pesticide applications more effectively, minimizing chemical runoff and promoting environmentally sustainable practices.

Furthermore, by providing insights into pest and disease conditions through environmental monitoring, the system helps farmers anticipate outbreaks and take preventive measures, leading to healthier crops and livestock. Overall, this advanced weather monitoring system not only increases agricultural productivity but also supports rural economies by enhancing farmers' resilience against climate challenges, ultimately contributing to global food security and environmental sustainability.

5. Innovation and Entrepreneurial Impact

The weather monitoring system for agriculture fosters innovation by integrating cutting-edge IoT technologies and multiple environmental sensors into a single, user-friendly platform. This project encourages local entrepreneurs and agricultural startups to adopt smart farming practices, enhancing productivity and sustainability. By providing an affordable solution that offers real-time data and remote access via the Blynk app, it empowers farmers to make informed decisions, thereby reducing risks associated with climate variability.

Moreover, the system serves as a catalyst for collaboration between technology developers, agricultural experts, and farmers, promoting knowledge sharing and skill development within the community. As farmers experience the benefits of this innovative approach, they are more likely to invest in further technological advancements, creating a culture of entrepreneurship that drives economic growth. Ultimately, this project not only enhances agricultural practices but also inspires a new generation of innovators committed to sustainable farming and community resilience.

6. Potential commercialization

The commercialization potential of the advanced weather monitoring system for agriculture is substantial, driven by the increasing global demand for food and the need for sustainable agricultural practices. As farmers seek innovative solutions to enhance crop yields and manage resources efficiently, this system provides a timely response to those needs with its unique combination of affordability, comprehensive sensor integration, and user-friendly features. This distinctiveness allows it to stand out in a crowded market, appealing to a diverse range of farmers from smallholders to larger agricultural enterprises. Furthermore, partnerships with agricultural cooperatives, universities, and research institutions can facilitate pilot programs and demonstrations that showcase the system's capabilities, accelerating adoption among users. The system also has potential applications in related sectors such as horticulture and urban gardening initiatives, broadening its market reach even further. With a growing emphasis on sustainability in agriculture, this product aligns perfectly with global initiatives aimed at reducing resource waste and promoting eco-friendly practices. This alignment not only enhances its appeal but can also attract both public and private investment, positioning it as a key tool in achieving sustainable farming goals and significantly boosting its commercialization prospects.

7. Acknowledgment

We would like to express our deepest gratitude to the Electrical Engineering Studies, College of Engineering, Universiti Teknologi MARA, Johor Branch, Pasir Gudang Campus, for their support and resources that made this project possible. Special thanks to Dr. Zatul Iffah Abd Latiff, for her invaluable guidance and encouragement throughout the development of this project. Our heartfelt appreciation goes to our peers and colleagues for their constructive feedback and assistance during the project's implementation. We also acknowledge the contributions of the I-TIEC 2025 committee, whose platform provided us with the opportunity to showcase our innovation. Finally, we extend our sincere thanks to our families and friends for their unwavering support and motivation, which fueled our determination to complete this project successfully.

8. Authors' Biography

Luqman Hakim Bin Ismail is a 5th-year Electrical Engineering student at UiTM Pasir Gudang. Currently working on a weather monitoring system for agriculture, the project focuses on providing accurate, real-time weather data to assist farmers in optimizing crop management. This project aims to enhance agricultural productivity, minimize resource wastage, and support sustainable farming practices. With a strong foundation in electrical engineering principles and an interest in innovative solutions, this research hopes this research will have a meaningful impact, and empowering communities.

Zatul Iffah Abd Latiff completed her PhD studies in Universiti Teknologi MARA, focusing on the research of Space and Earth Electromagnetism. She received her Bachelor of Engineering Degree in Electrical Engineering from Korea University, South Korea in 2010 and her Master of Science in Telecommunication and Information Engineering from Universiti Teknologi MARA in 2013. She is one of the co-researchers of MAGDAS (Magnetic Data Acquisition System) network who is responsible for monitoring and maintaining one of the MAGDAS observatories located in Johor, Malaysia. Her research interests include geomagnetically induced currents (GICs) activity in the equatorial and low latitude region, space weather activity, ionospheric currents, Earth's electromagnetism, and application of ground magnetic and satellite data.

Arif Hakimi Bin Hairee is a 5th -semester in Diploma in Electrical Engineering (Electronic) at UiTM Pasir Gudang. He demonstrated outstanding performance in both academic and extracurricular activities. Currently working on a weather monitoring system for agriculture, the project focuses on providing accurate, real-time weather data to assist farmers in optimizing crop management