E-PROCEEDINGS

INTERNATIONAL TINKER INNOVATION & ENTREPRENEURSHIP CHALLENGE (i-TIEC 2025)

"Fostering a Culture of Innovation and Entrepreneurial Excellence"

23 January 2025
PTDI, UiTM Cawangan Johor
Kampus Pasir Gudang

ORGANIZED BY:

Electrical Engineering Studies, College of Engineering
Universiti Teknologi MARA (UiTM) Cawangan Johor
Kampus Pasir Gudang
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PREFACE

It is with great pleasure that we present the e-proceedings of International Tinker Innovation & Entrepreneurship Challenge (i-TIEC 2025), which compiles the extended abstracts submitted to the International Tinker Innovation & Entrepreneurship Challenge (i-TIEC 2025), held on 23 January 2025 at **PTDI, Universiti Teknologi MARA (UiTM) Cawangan Johor, Kampus Pasir Gudang.** This publication serves as a valuable resource, showcasing the intellectual contributions on the invention and innovation among students, academics, researchers, and professionals.

The International Tinker Innovation & Entrepreneurship Challenge (i-TIEC 2025), organized under the theme "Fostering a Culture of Innovation and Entrepreneurial Excellence," is designed to inspire participants at various academic levels, from secondary students to higher education students and professionals. The competition emphasizes both innovation and entrepreneurship, encouraging the development of product prototypes that address real-world problems and have clear commercialization potential. By focusing on technological and social innovations, i-TIEC 2025 highlights the importance of turning creative ideas into viable, market-ready solutions that can benefit users and society. The extended abstracts in this e-proceedings book showcase the diverse perspectives and depth of research presented during the event, reflecting the strong entrepreneurial element at its core.

We extend our sincere gratitude to the contributors for their dedication in sharing their innovation and the organizing committee for their hard work in ensuring the success of the event and this publication. We also appreciate the support of our collaborators; Mass Rapid Transit Corporation Sdn. Bhd. (MRT Corp), Universitas Labuhanbatu, Indonesia (ULB), Universitas Riau Kepulauan, Indonesia (UNRIKA) and IEEE Young Professionals Malaysia, whose contributions have been instrumental in making this event and publication possible.

We hope that this e-proceedings book will serve as a valuable reference for researchers, educators, and practitioners, inspiring further studies and collaborations in both innovation and entrepreneurship. May the knowledge shared here continue to spark new ideas and market-ready solutions, advancing our collective expertise and fostering the growth of entrepreneurial ventures.

A-ST035: SMART FARMING: IOT-ENHANCED GREENHOUSE CONTROL SYSTEM

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ABSTRACT

The IoT-Enhanced Greenhouse Control System is a sustainable, cost-effective solution designed to optimize small-scale agriculture, particularly for household and urban farming. Using an ESP32 microcontroller, the system integrates sensors to monitor temperature, humidity, soil moisture, and light intensity, while actuators such as fans, water pumps, and LED indicators automate responses to environmental changes. Powered by solar energy, the system ensures energy efficiency and environmental sustainability. Real-time data is logged into Google Sheets and display through a web-based dashboard, enabling users to monitor and control greenhouse conditions remotely. This reduces manual labor, enhances precision farming and maintains ideal conditions for plant growth. By addressing challenges like inconsistent crop growth, inefficient water usage, and reliance on traditional energy sources, the system supports sustainable farming practices and food security. Its unique integration of IoT with renewable energy provides a scalable and affordable solution for urban households, community farms, and small-scale agricultural enterprises. Additionally, the system's user-friendly interface allows easy operation, making it accessible to non-expert users. With significant socio-economic and environmental impacts, including reduced carbon footprints and resource conservation, the project demonstrates strong commercialization potential in the growing smart agriculture market, catering to the rising demand for sustainable and automated farming solutions.

Keywords: IoT-Driven Automation, Greenhouse Control System, Smart Farming Innovation, Solar-Powered Agriculture, Environmental Monitoring

1. Product Description

The IoT-Enhanced Greenhouse Control System is a sustainable, technology-driven solution designed to automate greenhouse operations for household-scale farming. Built around the ESP32 microcontroller, the system integrates sensors to monitor environmental parameters such as temperature, humidity, soil moisture, and light intensity. Actuators, including fans, LEDs, and a water pump, respond dynamically to maintain optimal conditions for plant growth.

Powered by renewable energy through solar panels and battery storage, the system operates efficiently while minimizing its environmental footprint. Real-time data from the sensors is logged into Google Sheets and visualized through a user-friendly Looker Studio dashboard,

providing remote access and actionable insights for users. The system can function autonomously or be controlled via a web server interface.

Its modular design ensures ease of installation and adaptability, making it ideal for urban gardeners and small-scale farmers. By automating resource management, the product conserves water and energy, reduces labor, and enhances productivity. This affordable, eco-friendly solution addresses challenges such as resource scarcity, climate variability, and food security, transforming traditional farming practices into a modern, efficient process. Future enhancements, such as mobile application integration and AI-driven predictive analytics, aim to further increase its usability and market appeal.

2. Visual Representations of the System Design and Functionality.

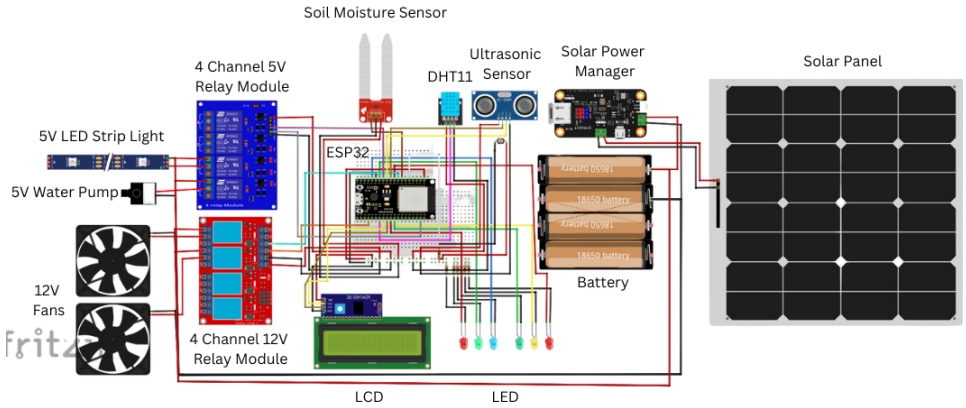

Figure 1. Circuit Diagram of the IoT-Enhanced Greenhouse System

The circuit diagram in **Figure 1** illustrates the integration of the ESP32 microcontroller with sensors and actuators. Key components include the DHT11 sensor (GPIO 4) for temperature and humidity, the soil moisture sensor (GPIO 35) for irrigation monitoring, and the LDR (GPIO 34) for light intensity detection. Actuators such as fans (GPIO 15, GPIO 33), LEDs, and a water pump (GPIO 23) provide automated responses to environmental changes. Solar panels and a rechargeable battery power the system, ensuring sustainability and uninterrupted operation.

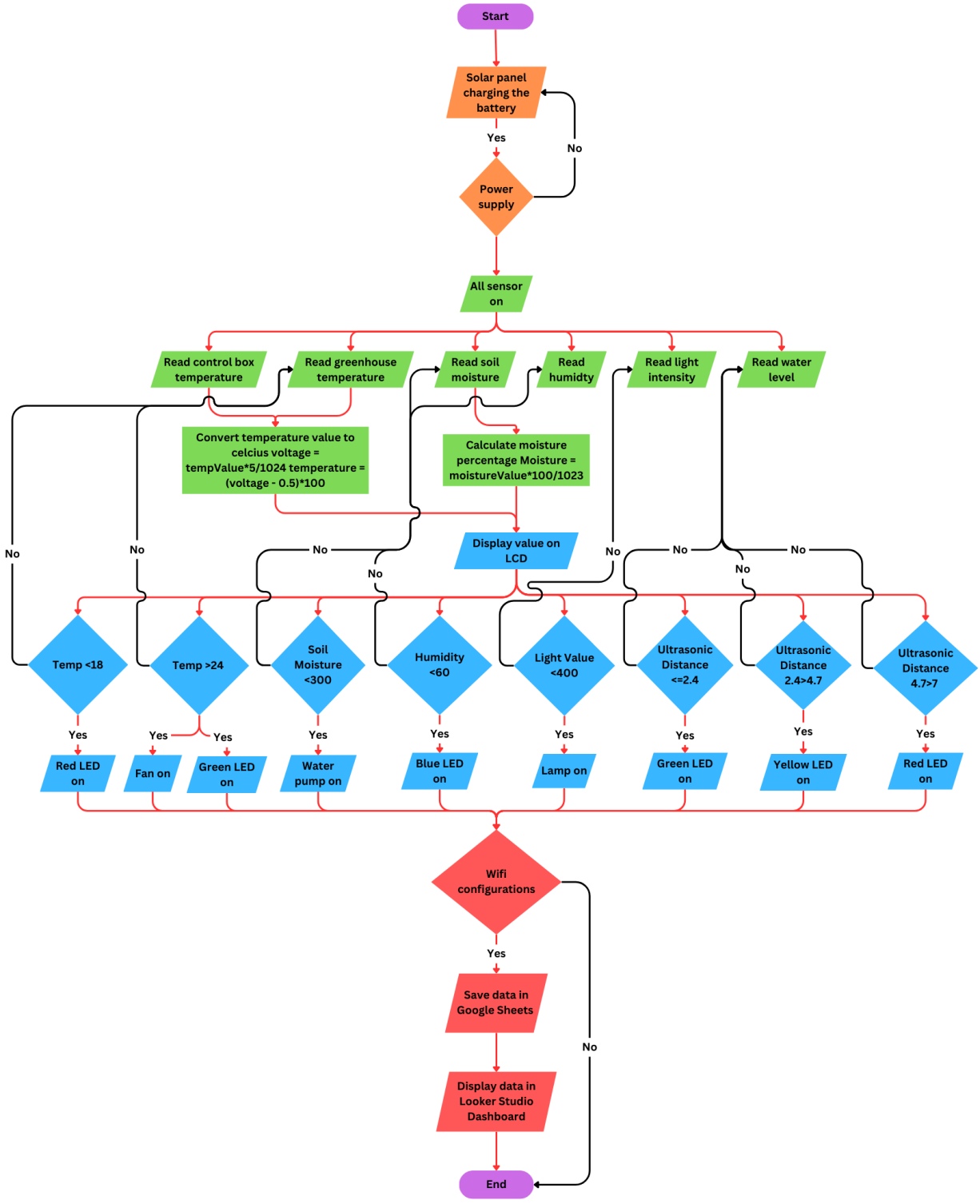

Figure 2. Operational Flowchart of the Smart Farming System

The operational flowchart in **Figure 2** outlines the step-by-step functioning of the system. Sensor data is first collected and processed by the ESP32 microcontroller. Based on the data,

the system triggers actuators like fans or the water pump to maintain optimal greenhouse conditions. The data is logged into Google Sheets and visualized on a Looker Studio dashboard. The system can also be accessed remotely via a web interface, ensuring real-time control and monitoring.

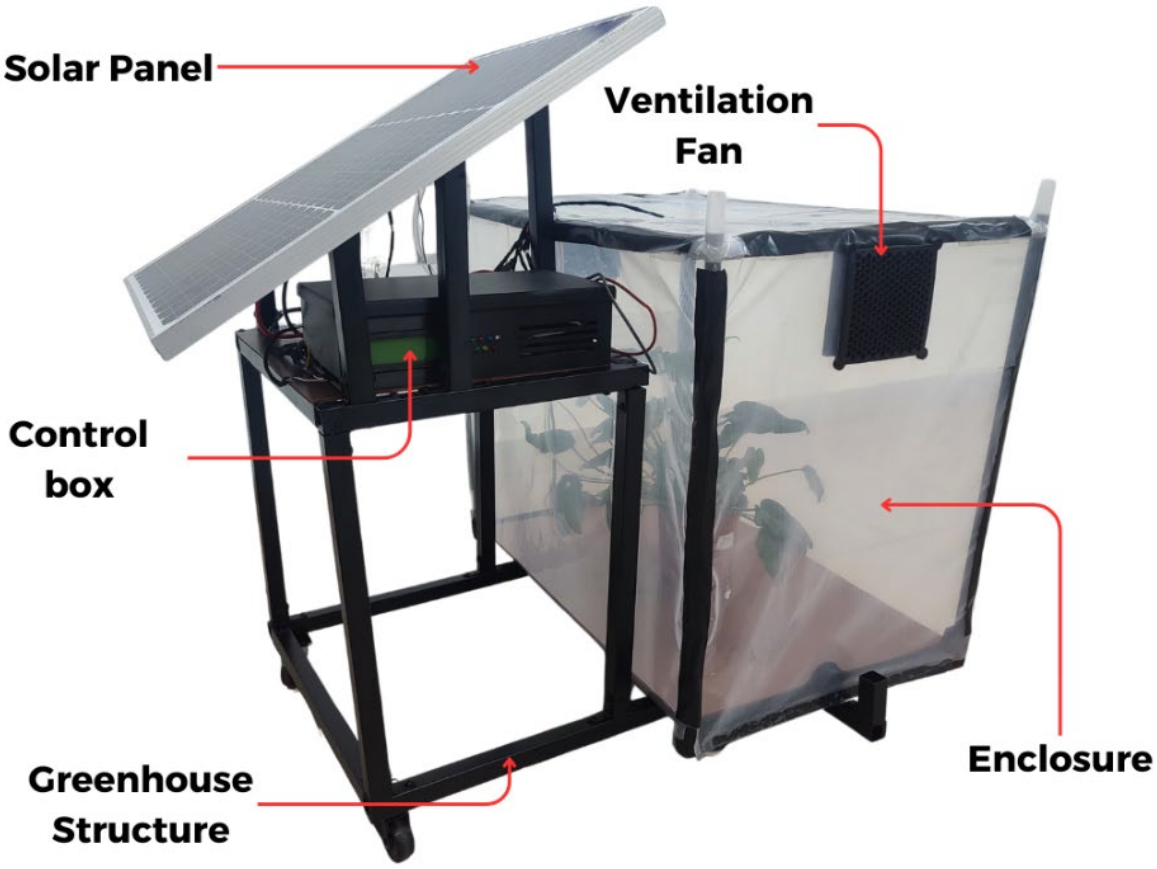

Figure 3. Project Design of the IoT-Enhanced Greenhouse System

The project design in **Figure 3** showcases the physical structure of the greenhouse system. The framework consists of modular steel beams and transparent panels to maximize sunlight exposure while protecting crops from external elements. Solar panels are mounted on the roof, powering the system. The control box, containing the ESP32 microcontroller and other electronics, is centrally positioned under the roof for protection against environmental factors and easy maintenance. This design balances functionality, durability, and ease of assembly, making it ideal for small-scale household farming applications.

DATA LOGGER

Date	Time	Month	Day	Sensor Reading Status	Temperature (°C)	Humidity (%)	LDR	Soil A0	Soil D0	Ultrasonic
31/10/2024	15:59:53	October	Thursday	Success	26.2	61	1023	0	1	8.82
31/10/2024	16:00:12	October	Thursday	Success	26.2	61	1023	0	1	8.82
31/10/2024	16:00:30	October	Thursday	Success	26.2	61	1017	0	1	8.82
31/10/2024	16:00:48	October	Thursday	Success	26.2	62	986	0	1	8.82
31/10/2024	16:01:06	October	Thursday	Success	26.2	62	1010	0	1	8.82
31/10/2024	16:01:24	October	Thursday	Success	26.2	62	971	0	1	8.82
31/10/2024	16:01:42	October	Thursday	Success	26.2	62	976	0	1	8.82
31/10/2024	16:02:00	October	Thursday	Success	26.2	62	976	0	1	8.82
31/10/2024	16:02:45	October	Thursday	Failed	0	0	863	2559	1	0
31/10/2024	16:03:02	October	Thursday	Success	25	62	806	0	1	3.99
31/10/2024	16:03:20	October	Thursday	Success	26.2	62	845	0	1	3.99
31/10/2024	16:03:38	October	Thursday	Failed	0	0	848	2413	1	0
31/10/2024	16:03:56	October	Thursday	Success	25	62	811	0	1	3.99
31/10/2024	16:04:14	October	Thursday	Success	25	62	826	0	1	3.99
31/10/2024	16:04:32	October	Thursday	Success	25	62	784	0	1	3.99

Figure 4. Real-Time Data Logger in Google Sheets

Figure 4 displays the system's real-time data logging capability. Parameters such as temperature, humidity, light intensity, soil moisture, and water levels are recorded alongside timestamps in Google Sheets. This enables users to track historical trends and ensure that the system operates effectively, with all data stored for future analysis.

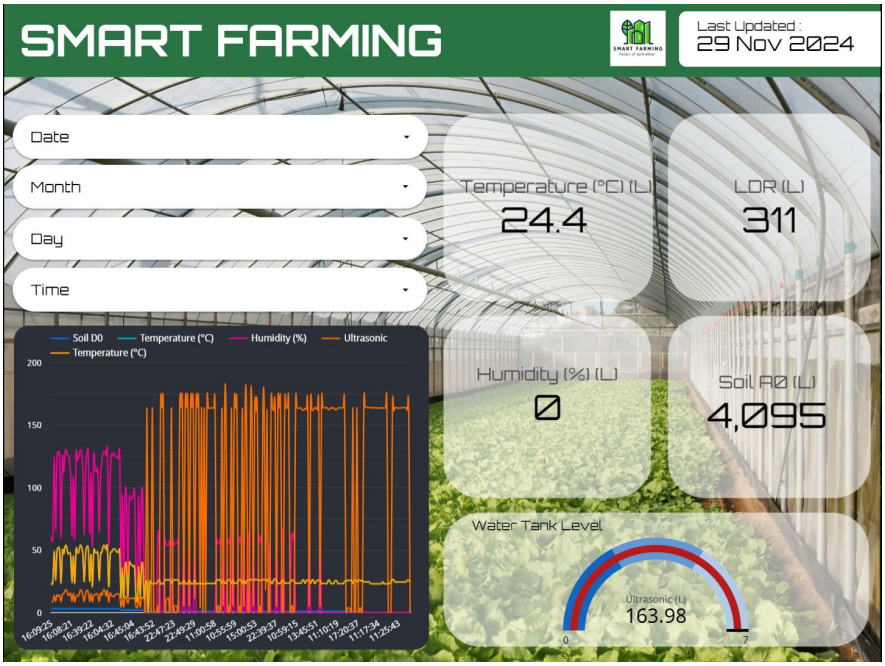

Figure 5. Smart Farming Dashboard in Looker Studio

The dashboard in **Figure 5** provides an intuitive graphical interface for real-time monitoring and management. Users can view temperature, humidity, soil moisture, and water levels at

a glance and also observe the real time recorded data for specific time and date. Features include interactive line charts for tracking historical data trends and a circular gauge to indicate water tank levels. The dashboard simplifies system monitoring, improving decision-making and operational efficiency.

3. Novelty and Uniqueness

The "Smart Farming: IoT-Enhanced Greenhouse Control System" introduces an intelligent novel approach to household farming by combining Internet of Things (IoT) technology with renewable energy for sustainable agricultural practices. Unlike traditional greenhouse systems that rely heavily on manual labour and wired control systems, this project integrates wireless sensors and actuators, managed by an ESP32 microcontroller, to automate environmental monitoring and control. The real-time data logging on Google Sheets and visualization through Looker Studio provide actionable insights for users. The system's energy independence, powered by solar panels and rechargeable batteries, reduces its environmental footprint while ensuring operational continuity in off-grid scenarios.

The unique feature of this system lies in its dual focus on sustainability and accessibility. It promotes efficient use of water and energy resources, while its compact, modular design makes it highly suitable for small-scale household applications. Additionally, the integration of a user-friendly dashboard with remote monitoring capabilities ensures ease of use, even for non-technical users. Future expansions, such as AI-powered predictive analytics and mobile application integration, further enhance its innovative potential, distinguishing it as a cutting-edge solution for modern agriculture.

4. Benefit to Mankind

This project addresses critical issues in modern agriculture, such as resource wastage and environmental degradation, by providing a sustainable and low-maintenance greenhouse solution. By automating temperature, humidity, soil moisture, and light intensity monitoring, the system reduces water and energy consumption, contributing to environmental conservation. Its renewable energy integration further aligns with global efforts to combat climate change. The system makes farming easier for urban households and individuals with little agricultural experience. By enabling year-round crop growth, it supports food security and promotes self-sufficiency, particularly in areas with harsh climates or limited agricultural land. The system's affordability and ease of installation make it an ideal choice for small-scale farmers, hobbyists, and eco-conscious individuals, fostering a broader adoption of sustainable practices.

5. Innovation and Entrepreneurial Impact

The Smart Farming system exemplifies innovation by leveraging IoT technology and renewable energy to modernize traditional agricultural practices. It fosters a culture of entrepreneurship by providing a scalable and customizable platform that can be adapted to various agricultural needs. Within the institution, it inspires students and researchers to explore interdisciplinary solutions combining engineering, sustainability, and agriculture. In the community, the system promotes awareness of smart farming technologies, encouraging

local entrepreneurs to invest in sustainable agriculture with intelligent IoT features and applications. By demonstrating the practicality and economic benefits of IoT-driven farming, it creates opportunities for startups focused on agricultural automation and renewable energy integration. The project also contributes to the industry by addressing the growing demand for eco-friendly farming solutions, setting a benchmark for future innovations in precision agriculture.

6. Potential Commercialization

The Smart Farming: IoT-Enhanced Greenhouse Control System has strong commercialization potential due to its affordability, sustainability, and user-friendly design. Targeted at urban households, small-scale farmers, and eco-conscious consumers, the system addresses the rising demand for sustainable and efficient agricultural solutions. Its modular design enables easy scalability, making it adaptable for larger agricultural setups with minimal modifications.

The integration of IoT and renewable energy technologies ensures that the system aligns with current market trends, including smart home devices and sustainable living solutions. Additionally, the proposed enhancements, such as mobile app development and AI-driven analytics, further increase its market appeal. Collaborations with agricultural equipment manufacturers and renewable energy providers can accelerate its commercialization. By offering a cost-effective and eco-friendly solution, the system has the potential to capture a significant share of the smart farming market, driving widespread adoption of sustainable agricultural practices.

7. Acknowledgment

This project was made possible through the guidance and support of Dr. Roshakimah Mohd Isa, Universiti Teknologi MARA, Shah Alam. We extend our gratitude to the School of Mechanical Engineering for providing resources and facilities essential to this research. Special thanks to our peers and family members for their encouragement and contributions throughout this endeavor. This project was conducted as part of the Final Year Project 2, showcasing the potential of IoT and renewable energy in advancing sustainable agricultural practices.

8. Authors' Biography

Muhammad Hafiy Naim Mohd Ismadi is a dedicated mechatronics engineering student at Universiti Teknologi MARA (UiTM) Shah Alam. He specializes in IoT applications, renewable energy integration, and sustainable technology. His expertise has been instrumental in developing an IoT-Enhanced Greenhouse Control System, focusing on optimizing small-scale agriculture using sensors, actuators, and solar energy. Hafiy has strong skills in programming (Python, C++), IoT platforms, and system design, which he applied to real-time data logging, automation, and remote monitoring for this project. Committed to innovation and sustainability, Hafiy aims to leverage his skills to create impactful, energy-efficient solutions for modern challenges.

Muhammad Nur Ezzuddean Miswan Hanis is a third-year student pursuing a Bachelor of Mechatronics Engineering Technology with Honours at Universiti Teknologi MARA (UiTM) Shah Alam. Though he currently lacks formal engineering experience, he is deeply passionate about researching and developing new technologies to advance scientific studies. His academic journey has nurtured a strong interest in creating innovative solutions that improve the understanding and application of science. He is also driven by a vision to contribute meaningfully to technology and research, aspiring to collaborate on impactful projects that address real-world challenges and benefit the scientific community.

Nur Iqmal Hasif Mohamad Zaidi, a Bachelor of Mechatronics Engineering Technology (Honours) student at Universiti Teknologi MARA (UiTM) Shah Alam.He passionate about exploring innovative solutions in automation and engineering technology, with experience in projects like automated sorting systems and award-winning engineering designs. While still building formal industry experience, He is driven by a desire to contribute to impactful projects that bridge academic knowledge with real-world applications, improving efficiency and solving practical challenges.

Amir Syarif Muhammad Akram is a third-year Bachelor of Mechanical Engineering with Honours student at Universiti Teknologi MARA (UiTM), Shah Alam. Despite lacking formal engineering experience, he demonstrates a strong passion for innovation and a determination to solve meaningful real-world challenges. His academic journey has inspired him to explore groundbreaking technologies and pursue impactful solutions for the betterment of society. With a clear vision of creating a brighter future, he aspires to collaborate on transformative research projects that positively impact lives and contribute to a more sustainable world.