LAPORAN KERJA PRAKTEK
DESIGN OF AN AUTOMATIC SOLAR PANEL WEB MONITORING SYSTEM
International Course Program (ICP)

Disusun Oleh :

Nugraha Rahmadan Diyanto
(228160049)

TEKNIK INFORMATIKA
FAKULTAS TEKNIK
UNIVERSITAS MEDAN AREA
2025

LEMBAR PENGESAHAN

LAPORAN KERJA PRAKTEK

DESIGN OF AN AUTOMATIC SOLAR PANEL WEB MONITORING SYSTEM

Diajukan Untuk Memenuhi Salah Satu Syarat Mata Kuliah Kerja Praktik Jenjang Studi S – 1 Program Studi Teknik Informatika
Oleh :

Nugraha Rahmadan Diyanto (228160049)

Medan, 14 September 2025

Mahasiswa	Menyetujui Dosen Pembimbing
Nugraha Rahmadan Diyanto NPM:228160049	Andre Hasudungan Lubis, S.Ti, M.Sc NIDN:0126029101

Mengetahui,
Ketua Program Studi Teknik Informatika

Rizki Muliono, S.Kom, M.Kom
NIDN:0109038902

UNIVERSITAS MEDAN AREA

FAKULTAS TEKNIK

PROGRAM STUDI TEKNIK INFORMATIKA

Kampus I : Jalan Kolam Nomor 1 Medan Estate ☎ (061) 7360168, Medan, 20223
Kampus II : Jalan Setiabudi Nomor 79 / Jalan Sei Serayu Nomor 70 A ☎ (061) 42402994, Medan, 20122
Website: www.teknik.uma.ac.id **E-mail:** univ_medanarea@uma.ac.id

BERITA ACARA DAN NILAI SEMINAR KERJA PRAKTEK

Pada hari ini 26 Juli 2025 telah diselenggarakan Seminar Kerja Praktek Program Studi Teknik Informatika untuk Tahun Akademik 2025/2026 atas :

Nama	:	**Nugraha Rahmadan Diyanto**
NIM	:	228160049
Program Studi	:	Teknik Informatika
Jenjang Pendidikan	:	S1 (Sarjana)
Judul Kerja Praktek	:	*Design Of An Automatic Solar Panel Web Monitoring System*
Tempat Seminar	:	Ruang Seminar Fakultas Teknik

Tanda Tangan Pembawa Seminar : ____________

Nilai Pembawa Seminar : 90 (A)

Seminar Kerja Praktek bersangkutan disetujui/tidak disetujui dengan catatan perubahan seperti yang tercantum pada tabel berikut :

Saran:	***Andre Hasudungan Lubis S.Ti., M.Sc*** *Pembimbing Kerja Praktek*
Persetujuan Seminar :	
Saran:	***Rizki Muliono S.Kom, M.Kom*** *Ka. Prodi*
Persetujuan Seminar :	

PANITIA SEMINAR KERJA PRAKTEK:

No.	Jabatan	Nama Dosen	Tanda Tangan
1	Pembimbing Kerja Praktek	Andre Hasudungan Lubis S.Ti., M.Sc	1
2	Ka. Prodi	Rizki Muliono S.Kom, M.Kom	2

Medan, 26 Juli 2025
Ketua Prodi.

Rizki Muliono S.Kom, M.Kom

ABSTRACT

The Design of an Automatic Solar Panel Web Monitoring System project aimed to address the inefficiency of manual solar panel monitoring by creating an accessible, real-time solution. This project, executed as part of the International Course Program, involved the design and implementation of an integrated system on a miniature house prototype. The methodology centered on programming an ESP8266 microcontroller to serve as both the system's brain and a web server. The microcontroller was developed to automatically track the sun's position using light sensors to control servo motors, thereby maximizing energy absorption. A static index.html web page was created and hosted directly on the ESP8266 to display real-time data on the panel's position, light intensity, and operational status. The project successfully demonstrated the system's ability to provide automated tracking and remote data access, proving the practical application of IoT technology. While the project achieved its core objectives, its limitation lies in the static nature of the web interface. Future recommendations include developing a more dynamic web application with a database for long-term data storage and trend analysis, and scaling the system for a real-world installation to test its full effectiveness.

Keywords: Solar Panel, Monitoring, Real-Time, Web Interface, ESP8266, IoT

FOREWORD

All praise and gratitude are due to Allah SWT for His grace and blessings, which have enabled me to complete this International Course Program (ICP) report. This report has been prepared as a partial fulfillment of the requirements for completing my studies in the Informatics Engineering Study Program at Universitas Medan Area.

I would like to express my deepest gratitude to:

1. Andre Hasudungan Lubis, S.Ti, M.Sc as the International Course Program (ICP) supervisor.
2. Rizki Muliono, S.Kom, M.Kom, as the Head of the Informatics Engineering Study Program, Faculty of Engineering, Universitas Medan Area.
3. All parties who have contributed to and assisted with the final project of the International Course Program (ICP).

I realize there are still many shortcomings in this report. Constructive criticism and suggestions are greatly appreciated for future improvements. Finally, I would like to extend my sincere thanks to all who have supported me throughout this journey.

Medan, July 31, 2025

Nugraha Rahmadan Diyanto
228160049

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER I
INTRODUCTION

1.1. Background

The utilization of solar energy as a renewable power source is experiencing rapid growth worldwide (Ramli & Jabbar, 2022). Solar panels are the primary components that convert sunlight into electrical energy (Al Anzy et al., 2023).However, to ensure the efficiency and reliability of these systems, continuous performance monitoring is required (Ismail Mohammed & M. T. Ibraheem Al-Naib, 2023). Conventional manual monitoring methods are no longer efficient, especially for large-scale installations, as they are time-consuming, labor-intensive, and prone to human error (Kombo et al., 2021).

With the advancement of information technology, various web-based remote monitoring solutions have emerged (Holovatyy, 2021) (Sundah et al., 2024) (Hamdani et al., 2021). These solutions allow users to monitor real-time data on energy production, voltage, current, and the operational status of solar panels from anywhere (Kassim & Lazim, 2022) (Hamdani et al., 2021). Although many monitoring systems are already available on the market, challenges remain regarding their complex interfaces, lack of interactive data visualization, and high implementation costs (Alshammari, 2023) (Kombo et al., 2021). This often makes it difficult for a layperson to understand the data intuitively (Lakshmikantha et al., 2021).

Considering these factors, designing an intuitive and user-friendly web-based monitoring system is highly relevant. Therefore, this report will outline the design and implementation process of a DESIGN OF AN AUTOMATIC SOLAR PANEL WEB MONITORING SYSTEM that not only provides accurate real-time data but also prioritizes ease of use. This system is expected to be an efficient and easily accessible solution that helps users optimize the performance of their solar panels.

1.2. Problem Formulation

Considering the background, the primary questions to be addressed in this International Course Program (ICP) activity are as follows:

1. What is the design process for the DESIGN OF AN AUTOMATIC SOLAR PANEL WEB MONITORING SYSTEM?
2. What features are necessary for the web to be operated optimally and to be user-friendly?

1.3. Objectives

This activity aims to monitor the movement of solar panels via a web-based system, increase efficiency, and enable broader data management of solar panel movement information for relevant parties, with the following objective:

1. To design and implement a DESIGN OF AN AUTOMATIC SOLAR PANEL WEB MONITORING SYSTEM for solar panel users.

1.4. Benefits

Some of the benefits that can be obtained from this web design process are as follows:

1. To apply the knowledge and theories gained during lectures into a project activity.
2. To gain hands-on experience in the process of web design, development, and implementation.

1.5. Location and Schedule of ICP Implementation

The International Course Program (ICP) was conducted at the Universitas Medan Area Campus, located in Medan City. This activity was designed to be carried out over one semester, from March 13, 2025, to July 12, 2025. During this period, students performed observation, design, and implementation in the Green Engineering course.

1.6. Participants

This International Course Program (ICP) was carried out by a group of students from Universitas Medan Area who have met the academic requirements to participate in the program. The participants from the Informatics Engineering Study Program consist of five people, with the following details:

1. M. Rizky Aulia Hrp (228160024)
2. Nugraha Ramadhan Diyanto (228160049)
3. Andre Nugraha Wageardoyo (228160028)
4. Ananda Nabila (228160026)
5. Rabiatul Adawiyah Hasibuan (228160004)

CHAPTER II
THEORETICAL REVIEW

2.1. System Design Methodology

2.1.1. Flowchart

A flowchart is a visual representation of the steps and logical sequence in a process or algorithm (Alsayaydeh et al., 2023). In the context of system design, this diagram is used to model the overall system workflow, from the sensor data acquisition process by the microcontroller to the data presentation on the web interface (Abdullah et al., n.d.). A flowchart helps identify the correct process sequence and potential logical errors before the implementation phase (Sutikno et al., 2021).

2.1.2. DFD (Data Flow Diagram)

A Data Flow Diagram (DFD) is a graphical representation showing how data flows within a system (Putra et al., 2024). A DFD focuses on the movement of data from one entity to another, regardless of how the process is performed (Putra et al., 2024). In this solar panel monitoring system, a DFD can be used to illustrate the data flow from the sensor, into the microcontroller (process), and then displayed to the user (external entity) through the web interface (Putra et al., 2024) (Sutikno et al., 2021).

2.1.3. UML (Unified Modeling Language)

UML is a standard language for modeling software systems (Suartana et al., 2024). For this project, several relevant UML diagrams can be used to explain system interactions and activities (Suartana et al., 2024). Use Case Diagram: This diagram illustrates the system's functionality from the user's perspective (Sutabri, 2022) (Putra et al., 2024). It shows how users interact with the system to achieve specific goals, such as "View Real-Time Data" or "Analyze Panel Performance"(Putra et al., 2024) (Sutabri, 2022).

2.2. Supporting Technology Theory

2.2.1. Microcontroller

A microcontroller is a small computer that acts as the brain of the hardware (Sutikno et al., 2021). In this project, the ESP8266 is used (Abdullah et al., n.d.).

This microcontroller was chosen for its efficient and low-cost capabilities, as well as its integrated Wi-Fi feature that allows the device to connect to the internet and function as a server (Sutikno et al., 2021).

2.2.2. Web Server on Microcontroller

This concept refers to the ability of a microcontroller, such as the ESP8266, to act as a web server (Abdullah et al., n.d.). Instead of uploading data to an external server, the microcontroller can store web files (such as the index.html file) in its memory. When the device is connected to Wi-Fi, users can access the microcontroller's IP address through a browser to view the web page that presents the data directly.

2.2.3. HTML and CSS

HTML (HyperText Markup Language) is the standard language used to create the structure of a web page, including text, images, and tables (Kim et al., 2022). CSS (Cascading Style Sheets) is used to manage the visual appearance of the web page, such as colors, layout, and fonts (Kim et al., 2022). In this project, both languages are used to design a simple yet informative web interface that can be accessed through the microcontroller.

CHAPTER III
DISCUSSION OF ICP RESULTS

3.1. Individual Task Results in the ICP Project

In the miniature house project, my primary task was to focus on the program development for the solar panel tracking system. This role was crucial as it involved all the logic behind monitoring the solar panel's movement and presenting the data in real-time through the web interface.

My responsibilities began with designing the program code to be uploaded to the ESP8266 microcontroller. This program was designed to read data from sensors that detect light intensity. Based on this data, the microcontroller sends commands to the servo motors to move the solar panel so that it constantly faces the brightest sunlight, thereby maximizing energy absorption.

In addition to controlling the panel's movement, the program I developed also functions as a web server. I was responsible for ensuring that the ESP8266 could serve the static web page (index.html) that had been designed. This web page would then display real-time data from the sensors, such as the solar panel's position, the received light intensity, and other operational statuses.

Overall, my role encompassed the entire process from the solar panel's movement logic to the web server's functionality on the hardware. This ensures that the system can operate automatically and that its data can be easily accessed by users through the web platform.

3.2. Flowchart Design

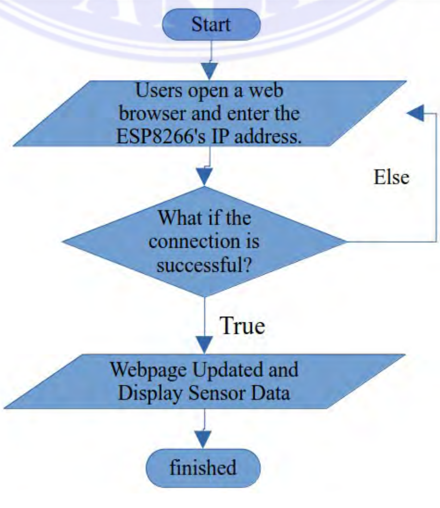

Figure 3.1. Flowchart Design.

The interaction process between the user and the web-based monitoring system is visually detailed in Figure 3.1. Flowchart Design. As depicted in the figure, the process initiates when the user opens a web browser and enters the IP address of the ESP8266 microcontroller. Following this, the system reaches a decision point to verify the connection. If the connection is successful, the flowchart proceeds along a path where the webpage automatically updates to display real-time sensor data such as light intensity and the solar panel's position and the process then concludes. If the connection fails, however, the flowchart indicates a loop that returns to the initial step, prompting the user to re-attempt the connection.

3.3. DFD (Data Flow Diagram) Design

3.3.1. DFD Level 0 (Context Diagram)

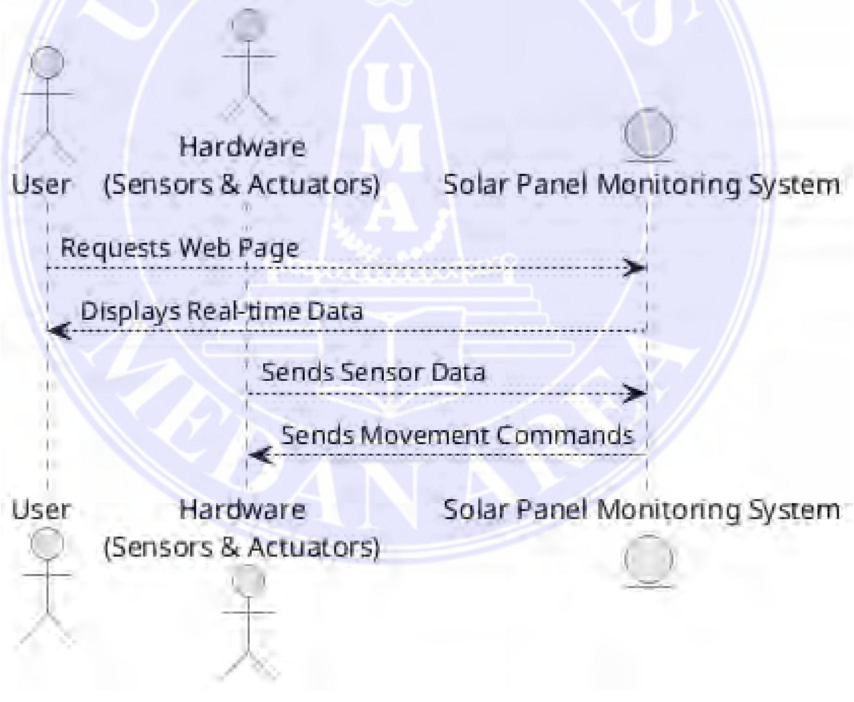

Figure 3.2. DFD Level 0 (Context Diagram).

Figure 3.2. DFD Level 0 (Context Diagram) provides a high-level overview of the system, treating it as a single, centralized process. This diagram illustrates the primary data exchanges between the Solar Panel Monitoring System and its two main external entities: the User and the Hardware. The User interacts

with the system by initiating a web page request and, in return, receives a display of real-time data. The Hardware entity, comprising sensors and actuators, serves a dual role: it provides the system with raw sensor data and receives movement commands from the system. The Solar Panel Monitoring System itself is depicted as the central process that mediates all of these data interactions.

3.3.2. DFD Level 1 (Detailed Diagram)

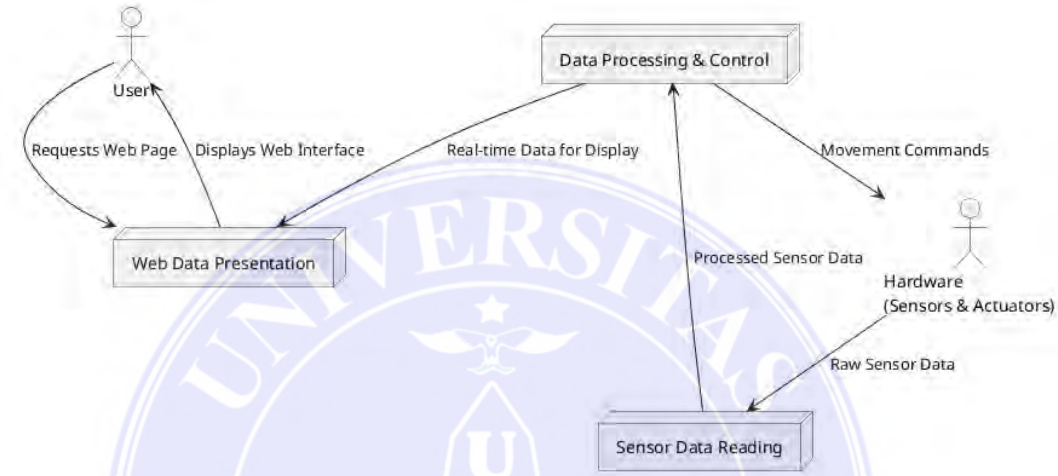

Figure 3.3. DFD Level 1 (Detailed Diagram).

Moving beyond the high-level context diagram, Figure 3.3. DFD Level 1 (Detailed Diagram) offers a more granular look into the system's internal workings. This diagram deconstructs the single process from the context diagram into three distinct sub-processes. The data's journey begins with the Sensor Data Reading process, where raw data is captured from the hardware. This information is then passed to the central Data Processing & Control unit. This core process handles the crucial tasks of interpreting the sensor data, preparing it for display, and simultaneously sending control commands back to the hardware. Finally, the prepared data reaches the Web Data Presentation process, which manages user requests and delivers the formatted information to the web interface.

3.4. UML (Unified Modeling Language)

3.4.1. Use Case Diagram

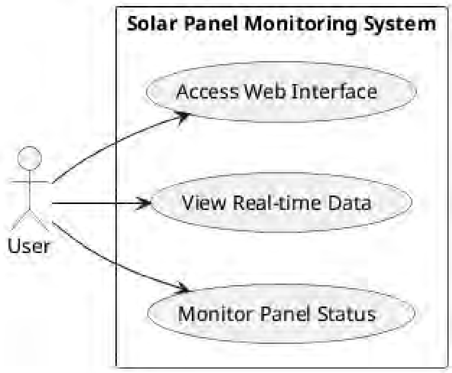

Figure 3.4. Use Case Diagram.

Figure 3.4. Use Case Diagram illustrates the system's functionality from the end-user's perspective. This model features a single primary actor, the User, who interacts with the functions contained within the "Solar Panel Monitoring System" boundary. The main objectives the user can accomplish are detailed in three key use cases. The initial interaction, Access Web Interface, involves connecting to the device's IP address through a browser. Once connected, the user can proceed to View Real-time Data to observe continuously updated sensor readings. Furthermore, the Monitor Panel Status use case enables the user to inspect specific operational details, such as the panel's current position and status.

3.5. Web Interface Design

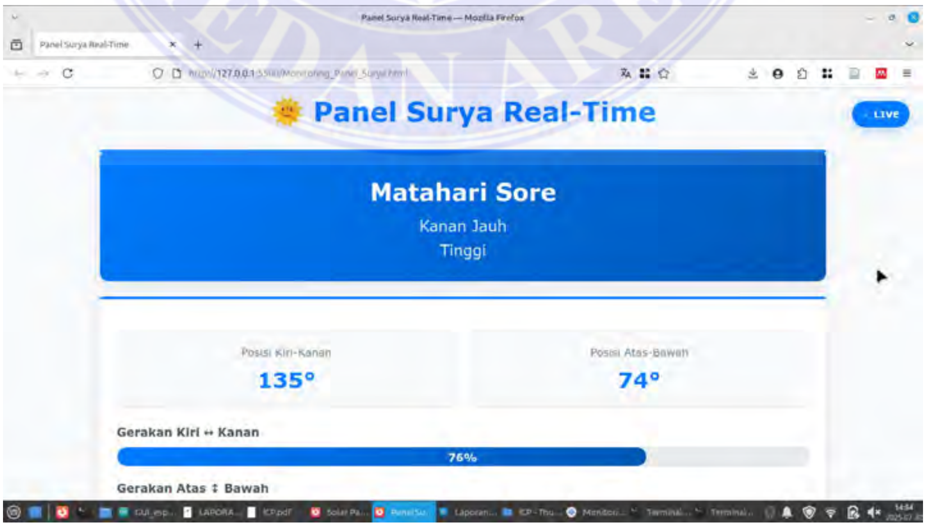

Figure 3.5. Web Monitoring Interface.

As shown in Figure 3.5, the main web interface is designed to provide a quick and easy-to-read overview of the solar panel system's status. At the top of the page, an active "LIVE" indicator confirms to the user that the displayed data is real-time. Below this, a large information box offers a descriptive summary of the current conditions, such as "Afternoon Sun", along with the panel's general position, "Far Right" and "High". For more precise data, two cards present the quantitative position: the "Left-Right Position" indicates the horizontal angle is 135°, while the "Up-Down Position" shows the vertical angle is 74°. Finally, the progress bar for the "Left ↔ Right Movement" provides a visual representation of the servo motor's position, allowing for easy monitoring at a glance.

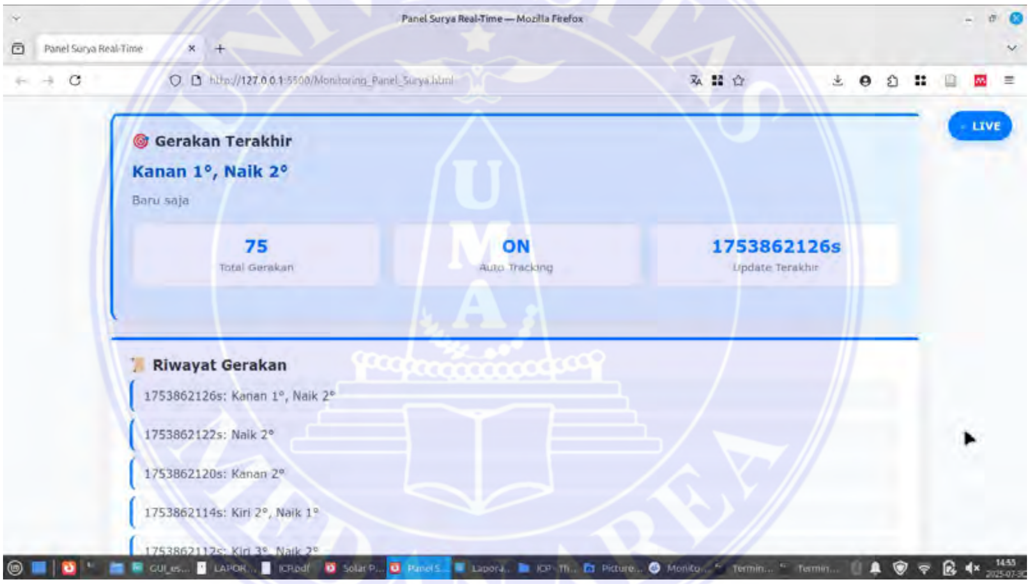

Figure 3.6. Advanced Status and Movement History Interface.

As seen in Figure 3.6, this interface provides a more in-depth status display and a history of the panel's movements. The "Last Movement" information box details the latest position adjustment, combining horizontal and vertical movements (e.g., "Right 1°, Up 2°") with a "Just now" timestamp. Directly below, three additional data cards offer a comprehensive operational summary, including the "Total Movements" made by the system, the "Auto Tracking" status indicating if the feature is ON, and the "Last Update" timestamp for the most recent data. Furthermore, the "Movement History" section serves as a historical log that chronologically records each panel movement, allowing the user to review all system activities in detail.

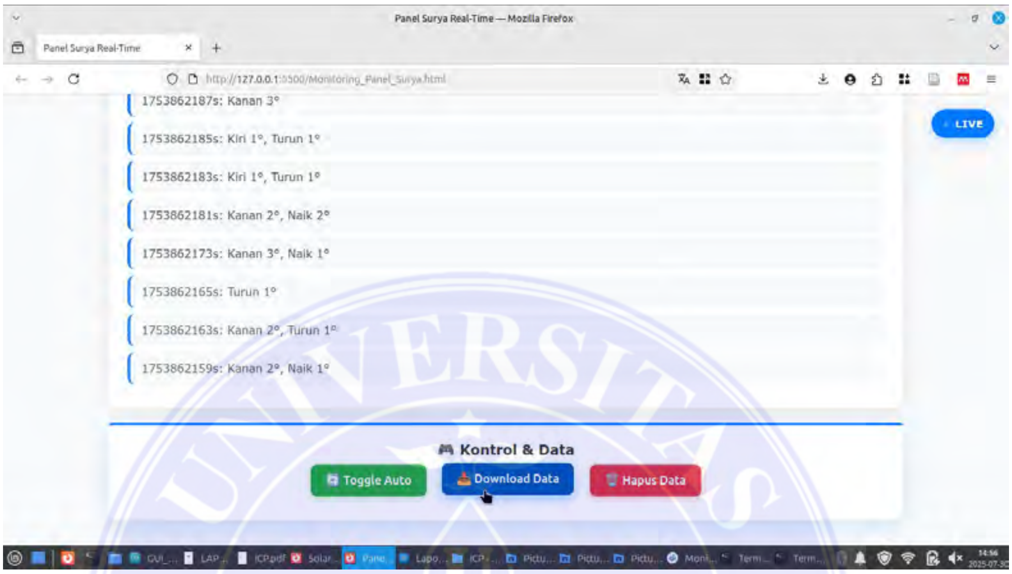

Figure 3.7. Control and Data Management Panel.

As shown in Figure 3.7, the bottom section of the web interface features a "Control & Data" panel that provides interactive functionalities for the user. This panel contains three main buttons for managing the system's operation and its recorded data. The first button, "Toggle Auto" (green), allows the user to enable or disable the solar panel's automatic tracking mode. The second button, "Download Data" (blue), is used to download the recorded movement history as a file, allowing the data to be further analyzed offline. Finally, the "Delete Data" (red) button gives the user the option to clear or reset the movement history data stored within the system.

CHAPTER IV
CONCLUSION

5.1. Conclusion

Based on the entire process that has been carried out, it can be concluded that the design and implementation of the DESIGN OF AN AUTOMATIC SOLAR PANEL WEB MONITORING SYSTEM was successfully executed. Throughout this project, we successfully applied the theoretical knowledge gained in class, specifically from the Green Engineering and Informatics Engineering courses, into a real-world solution. The ESP8266 microcontroller was successfully programmed to not only control the movement of servo motors so that the solar panel always faces the best light but also to function as a web server that presents real-time data. The main benefit of this project is the creation of an efficient and easily accessible monitoring system. The simple web interface allows users to monitor the solar panel's performance remotely without being on-site, and the valuable experience in designing this integrated system proves that IoT technology can be practically applied to optimize the use of renewable energy.

5.2 Recommendations

Although this project has achieved its objectives, there are several aspects that can be improved and developed further. The limitation of this project lies in the use of a static web page; therefore, it is recommended to develop a more dynamic web interface using a web framework and a database. This would allow for long-term data storage, trend analysis, and the generation of solar panel performance reports. On the hardware side, the current system only focuses on light tracking. A recommendation for the next project is to add other sensors, such as humidity, wind speed, or a UV Index sensor, for more comprehensive data, or even to add the capability for remote control. Furthermore, as a miniature-scale prototype, this system needs to be tested on a real-world, full-scale solar panel installation to measure its effectiveness and reliability in an actual environment, as well as to identify challenges that may arise in the field.

BIBLIOGRAPHY

Abdullah, E., Shuhaimi, N. I., Mohamad, R., Kamaluddin, N. A., Hidayat, N. M., & Burham, N. (n.d.). *Development of Real-Time Energy Monitoring System and Data Log Using NodeMCU ESP 8266 and MYSQL Database*.

Al Anzy, L. A. R., Abdullah, A. A., & Aquraishi, A. K. L. (2023). IoT Cloud System Based Dual Axis Solar Tracker Using Arduino. *Journal of Internet Services and Information Security*, *13*(2), 193–202. https://doi.org/10.58346/JISIS.2023.I2.012

Alsayaydeh, J. A. J., Yusof, M. F. B., Halim, M. Z. B. A., Zainudin, M. N. S., & Herawan, S. G. (2023). Patient Health Monitoring System Development using ESP8266 and Arduino with IoT Platform. *International Journal of Advanced Computer Science and Applications*, *14*(4). https://doi.org/10.14569/IJACSA.2023.0140467

Alshammari, H. H. (2023). The internet of things healthcare monitoring system based on MQTT protocol. *Alexandria Engineering Journal*, *69*, 275–287. https://doi.org/10.1016/j.aej.2023.01.065

Hamdani, H., Pulungan, A. B., Myori, D. E., Elmubdi, F., & Hasannuddin, T. (2021). Real Time Monitoring System on Solar Panel Orientation Control Using Visual Basic. *Journal of Applied Engineering and Technological Science (JAETS)*, *2*(2), 112–124. https://doi.org/10.37385/jaets.v2i2.249

Holovatyy, A. (2021). Development of IoT Weather Monitoring System Based on Arduino and ESP8266 Wi-Fi Module. *IOP Conference Series: Materials Science and Engineering*, *1016*(1), 012014. https://doi.org/10.1088/1757-899X/1016/1/012014

Ismail Mohammed, M., & M. T. Ibraheem Al-Naib, A. (2023). Web Server Based Data Monitoring System of PV Panels Using S7-1200 PLC. *NTU Journal of Renewable Energy*, *5*(1), 103–111. https://doi.org/10.56286/ntujre.v5i1.653

Kassim, M., & Lazim, F. (2022). Adaptive photovoltaic solar module based on internet of things and web-based monitoring system. *International Journal* *of Electrical and Computer Engineering (IJECE)*, *12*(1), 924. https://doi.org/10.11591/ijece.v12i1.pp924-935

Kim, T. S., Choi, D., Choi, Y., & Kim, J. (2022). Stylette: Styling the Web with Natural Language. *CHI Conference on Human Factors in Computing Systems*, 1–17. https://doi.org/10.1145/3491102.3501931

Kombo, O. H., Kumaran, S., & Bovim, A. (2021). Design and Application of a Low-Cost, Low- Power, LoRa-GSM, IoT Enabled System for Monitoring of Groundwater Resources With Energy Harvesting Integration. *IEEE Access*, *9*, 128417–128433. https://doi.org/10.1109/ACCESS.2021.3112519

Lakshmikantha, V., Hiriyannagowda, A., Manjunath, A., Patted, A., Basavaiah, J., & Anthony, A. A. (2021). IoT based smart water quality monitoring system. *Global Transitions Proceedings*, *2*(2), 181–186. https://doi.org/10.1016/j.gltp.2021.08.062

Putra, I. W. K. W., Putera, I. G. A. A., & Suryantara P, I. P. G. (2024). Development of a Website-Based Project Monitoring, Evaluation, and Reporting Information System in Community-Based Infrastructure Programs. *Journal of Asian Multicultural Research for Economy and Management Study*, *5*(3), 55–64. https://doi.org/10.47616/jamrems.v5i3.507

Ramli, R. M., & Jabbar, W. A. (2022). Design and implementation of solar-powered with IoT-Enabled portable irrigation system. *Internet of Things and Cyber-Physical Systems*, *2*, 212–225. https://doi.org/10.1016/j.iotcps.2022.12.002

Suartana, I. M., Puspitaningayu, P., Pratama, S. A., Dwiyanti, S., Maspiyah, & Haryudo, S. I. (2024). Modeling agile development of Web application e-monev using UML. *E3S Web of Conferences*, *513*, 02010. https://doi.org/10.1051/e3sconf/202451302010

Sundah, J., Makal, J. F., Pongoh, J., Katuuk, R., & Ramschie, A. (2024). Automatic Solar Panel Cleaning And Cooling System Based On IoT.

International Journal of Computer Applications, *186*(53), 10–19. https://doi.org/10.5120/ijca2024924203

Sutabri, T. (2022). *Design of A Web-Based Social Network Information System*. *6*(1).

Sutikno, T., Satrian Purnama, H., Pamungkas, A., Fadlil, A., Mohd Alsofyani, I., & Jopri, M. H. (2021). Internet of things-based photovoltaics parameter monitoring system using NodeMCU ESP8266. *International Journal of Electrical and Computer Engineering (IJECE)*, *11*(6), 5578. https://doi.org/10.11591/ijece.v11i6.pp5578-5587

APPENDICES

18% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

Filtered from the Report

- Bibliography
- Cited Text

Match Groups

- **59** Not Cited or Quoted 18%
  Matches with neither in-text citation nor quotation marks
- **0** Missing Quotations 0%
  Matches that are still very similar to source material
- **0** Missing Citation 0%
  Matches that have quotation marks, but no in-text citation
- **0** Cited and Quoted 0%
  Matches with in-text citation present, but no quotation marks

Top Sources

10% Internet sources
5% Publications
12% Submitted works (Student Papers)