LAPORAN KERJA PRAKTEK
INFORMATION SYSTEM DIAGRAMMING FOR THE SOLAR TRACKER PROJECT
International Course Program (ICP)

Disusun Oleh :

Rabiatul Adawiyah Hsb (228160004)

TEKNIK INFORMATIKA

FAKULTAS TEKNIK

UNIVERSITAS MEDAN AREA

2025

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LEMBAR PENGESAHAN

LAPORAN KERJA PRAKTEK

INFORMATION SYSTEM DIAGRAMMING FOR THE SOLAR TRACKER PROJECT

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

Rabiatul Adawiyah Hsb (228160004)

Medan, 14 September 2025
Menyetujui

Mahasiswa

Rabiatul Adawiyah Hsb
NPM:228160004

Dosen Pembimbing

Andre Hasudungan Lubis, S.Ti, M.Sc
NIDN:0126029101

Mengetahui,
Ketua Program Studi Teknik Informatika

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

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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	: **Rabiatul dawiyah Hsb**
NIM	: 228160004
Program Studi	: Teknik Informatika
Jenjang Pendidikan	: S1 (Sarjana)
Judul Kerja Praktek	: *Information System Diagramming For The Solar Tracker Project*
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.

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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

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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

Rabiatul Adawiyah Hsb
228160004

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TABLE OF CONTENTS

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LIST OF FIGURES

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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.

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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:

3. 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:

4. To apply the knowledge and theories gained during lectures into a project activity.
5. 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:

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6. M. Rizky Aulia Hrp (228160024)
7. Nugraha Ramadhan Diyanto (228160049)
8. Andre Nugraha Wageardoyo (228160028)
9. Ananda Nabila (228160026)
10. Rabiatul Adawiyah Hasibuan (228160004)

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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.).

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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.

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CHAPTER III

DISCUSSION OF ICP RESULTS

3.1. Individual Task Results in the ICP Project

In this Solar Tracker Project, my primary task focused on modeling and designing the information system diagrams (*Information System Diagramming*) for the solar panel tracking mechanism. This role was critical as it encompassed the entire process of visually documenting the data flow and system architecture that underlies the panel's movement logic and the presentation of real-time data through the web interface.

My responsibilities began by defining and designing the diagrams representing the interaction between hardware and software components:

3.2. Data Flow Diagrams (DFD

Data Flow Diagrams (DFD) or Sequence Diagrams that logically illustrate the sequence of processes: starting from the sensor data reading by the microcontroller up to the command transmission to the servo motors. These diagrams ensure that the tracking logic consistently optimizes energy absorption.

3.2.1. DFD Level 0 - Context Diagram

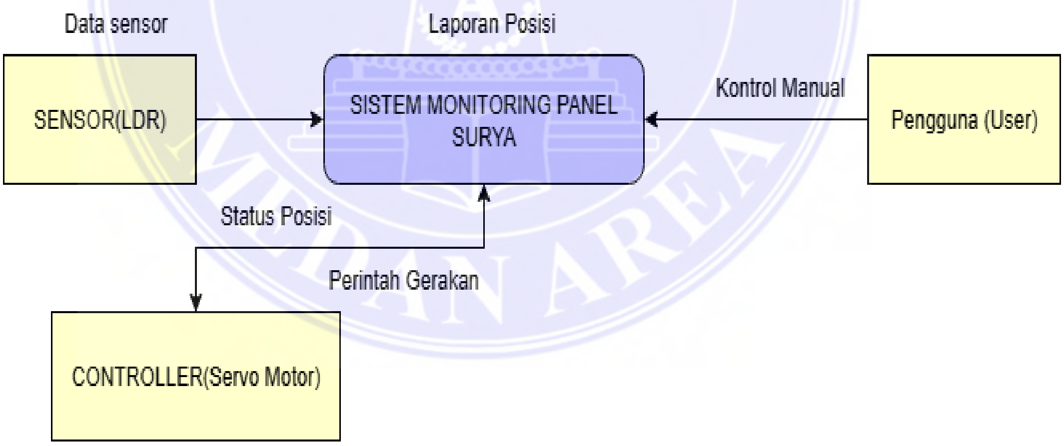

Figure 3.2.1. DFD Level 0.

The Context Diagram (DFD Level 0) visually represents the Solar Panel Monitoring System as a single, core process interacting with three main external entities: the SENSOR (LDR), the CONTROLLER (Servo Motor), and the Pengguna (User). The SENSOR (LDR) provides Data Sensor (*Sensor Data*), which is the

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measured light intensity, into the system. In turn, the system processes this data to generate a Perintah Gerakan (*Movement Command*) sent to the CONTROLLER (Servo Motor) to adjust the panel's position. Once the movement is executed, the CONTROLLER sends back the Status Posisi (*Position Status*) to the system. Furthermore, the system acts as a bidirectional interface for the Pengguna (User): the User can send Kontrol Manual (*Manual Control*), and in response, the system delivers a Laporan Posisi (*Position Report*) summarizing the operational status and real-time sensor data. Essentially, the system functions as a central decision-maker, receiving input from the environment and the user, and managing the output, which includes both physical actions on the hardware and information provided to the user.

3.2.2. DFD Level 1

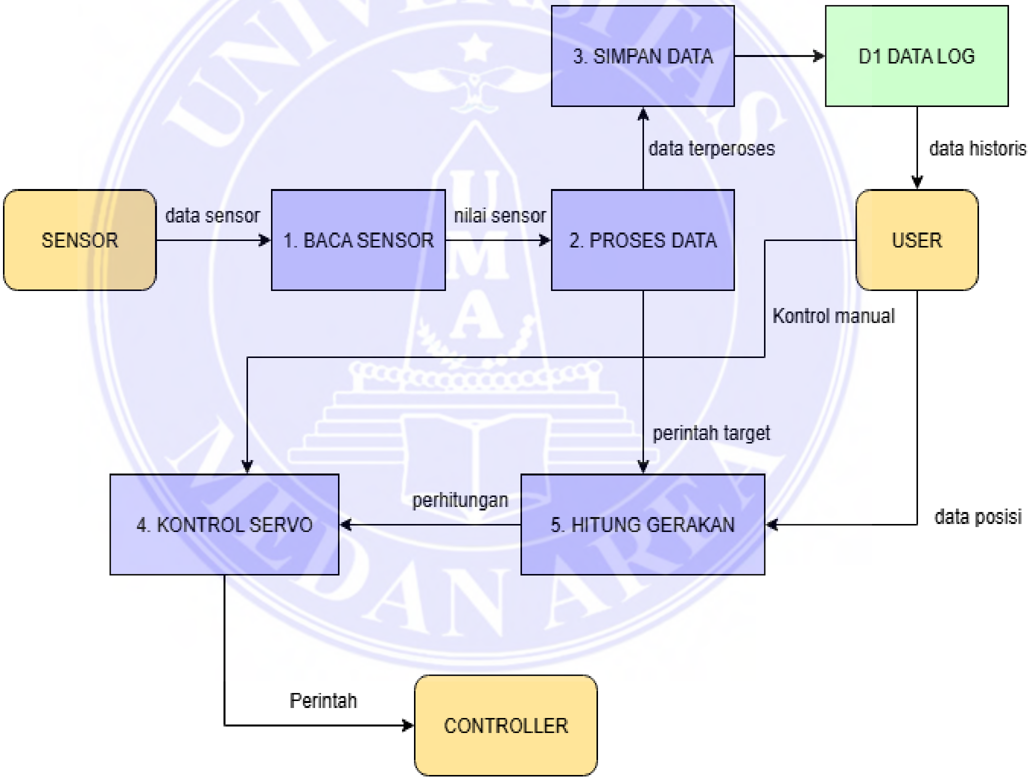

Figure 3.2.2. DFD Level 1.

This DFD Level 1 elaborates on the intelligent processes within the Solar Panel Monitoring System by dissecting the core function into five distinct sub-processes and illustrating their data interactions. The flow begins with the SENSOR providing raw Data Sensor (*sensor data*) to the BACA SENSOR (*Read Sensor*) process (1). This

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process extracts the nilai sensor (*sensor value*) and forwards it to the central PROSES DATA (*Process Data*) component (2). Process 2 acts as the system's brain: it receives Kontrol Manual (*Manual Control*) from the external USER, generates data terproses (*processed data*) for archival, and issues a perintah target (*target command*) for physical adjustment. The system branches as data terproses is sent to the SIMPAN DATA (*Store Data*) process (3), which logs it into the D1 DATA LOG data store. Crucially, the external USER can access data historis (*historical data*) directly from this log. Meanwhile, the perintah target flows to HITUNG GERAKAN (*Calculate Movement*) (5), which consults data posisi (*position data*) from the USER to compute the necessary perhitungan (*calculation*). Finally, this calculation is relayed to the KONTROL SERVO (*Servo Control*) process (4), which converts it into a final Perintah (*Command*) sent to the external CONTROLLER (Servo Motor), completing the loop from ambient light to physical action.

3.3. Entity Relationship Diagram (ERD)

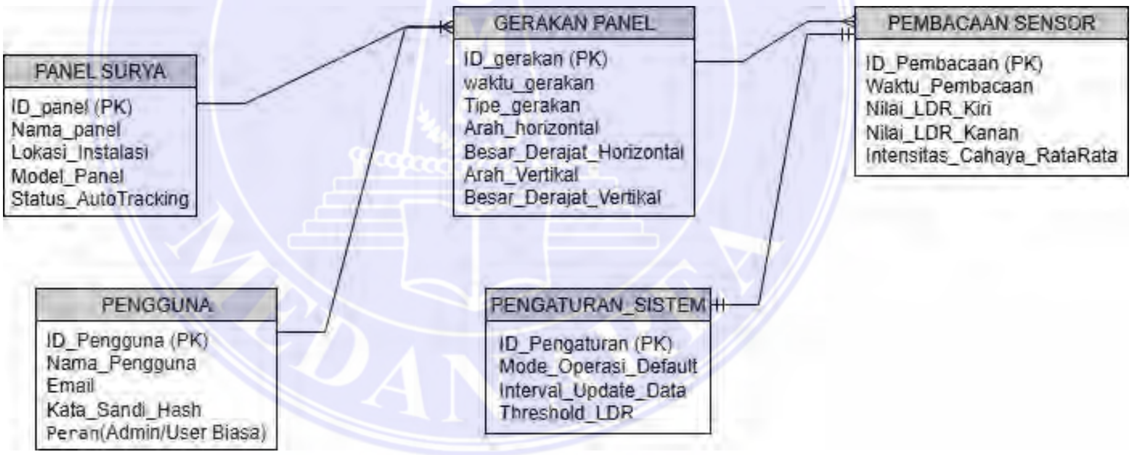

Figure 3.3. Entity Relationship Diagram(ERD).

This Entity-Relationship Diagram (ERD) models the core data structure of the Solar Tracker System, focusing on the relationships between key entities: PANEL SURYA (Solar Panel), GERAKAN PANEL (Panel Movement), PENGGUNA (User), PEMBACAAN SENSOR (Sensor Reading), and PENGATURAN SISTEM (System Settings).

The central entity is PANEL SURYA, which records descriptive information like

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ID_panel (Primary Key - PK), Nama_panel, and its operational status (Status_AutoT racking). The relationship between PANEL SURYA and GERAKAN PANEL is one-to-many: one solar panel can perform multiple movements, detailing data such as waktu_gerakan (movement time), Tipe_gerakan, and angular adjustments (Arah_Hor izontal, Besar_Derajat_Horizontal, etc.).

The PENGGUNA entity, storing details like ID_Pengguna (PK), Nama_Pengguna, and Peran (Role), interacts with the GERAKAN PANEL to log which user initiated or modified movement settings. Similarly, the system relates the GERAKAN PANEL to the PEMBACAAN SENSOR table, indicating that a specific movement decision corresponds to particular light readings. PEMBACAAN SENSOR tracks crucial time-series data, including Waktu_Pembacaan (reading time) and the light values from the left and right LDRs (Nilai_LDR_Kiri, Nilai_LDR_Kanan), resulting in a Intensitas_ Cahaya_RataRata (Average Light Intensity).

Finally, the PENGATURAN SISTEM (System Settings) entity holds configuration parameters, such as Mode_Operasi_Default and Interval_Update_Data, which dictate the system's overall behavior. This PENGATURAN SISTEM is linked to the PEMBACAAN SENSOR table, establishing the settings under which the sensor data was collected. This entire structure ensures that every piece of operational data, from user roles to motor movements and sensor readings, is meticulously recorded and interconnected for comprehensive monitoring and analysis.

3.4. Use Case Diagram

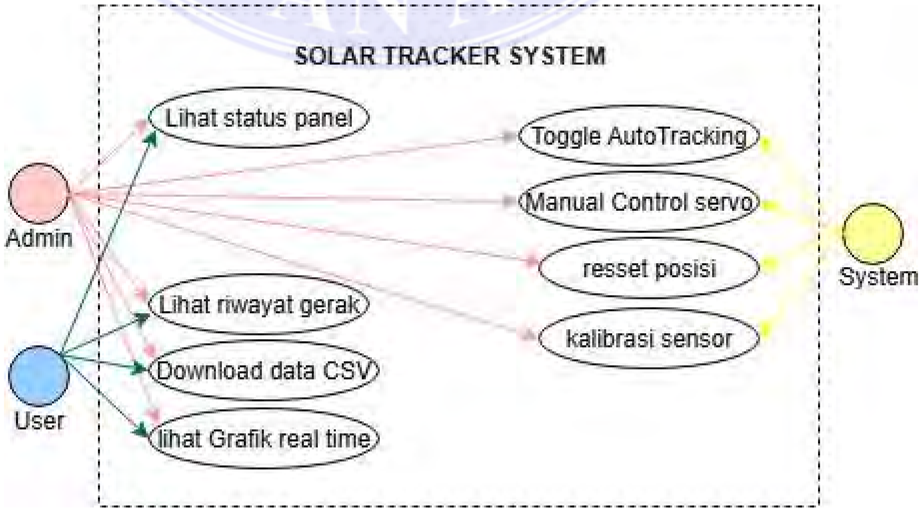

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Figure 3.4. Use Case Diagram.

The Use Case Diagram clearly delineates the functional scope of the Solar Tracker System, categorizing user interactions into two main actor roles: the Admin and the User. Both actors share core monitoring capabilities, such as Lihat status panel (View Panel Status), Lihat riwayat gerak (View Movement History), and Download data CSV (Download CSV Data), ensuring data transparency and accessibility for all stakeholders. The fundamental distinction lies in control and maintenance privileges, which are exclusively assigned to the Admin. The Admin is the only actor authorized to execute critical system functions like Toggle AutoTracking (switching between automatic and manual modes), Manual Control servo (directly moving the hardware), resett posisi (Reset Position), and kalibrasi sensor (Calibrate Sensor). These commands are executed by the System backend. In essence, the diagram illustrates a robust system architecture where the general User is focused solely on data consumption, while the Admin holds the necessary authority to configure, troubleshoot, and override the system's operational parameters

3.5. State Transition Diagram

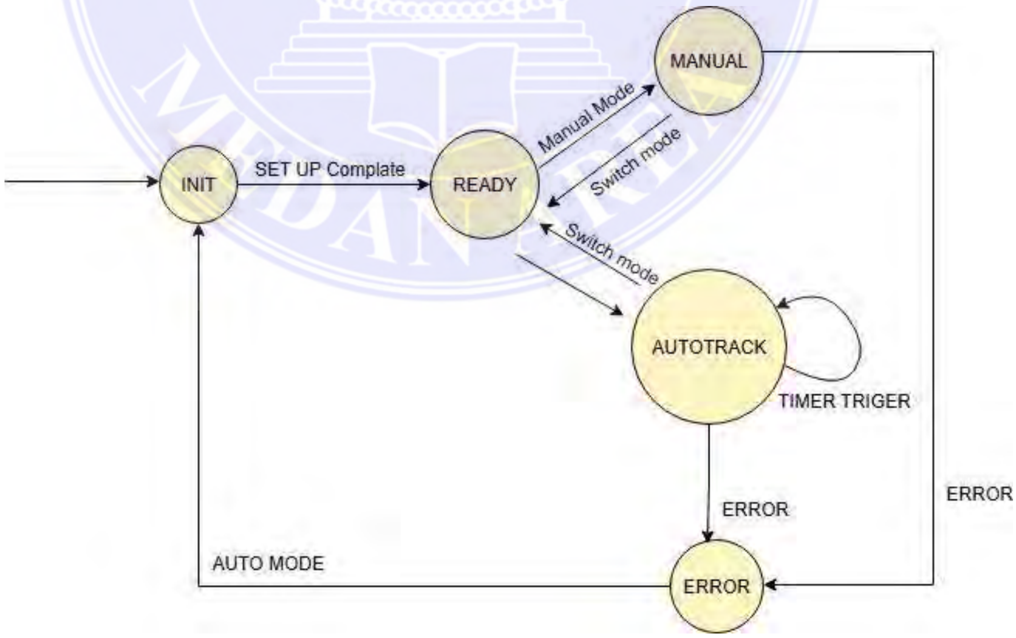

Figure 3.5. State Transition Diagram.

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The State Transition Diagram illustrates the dynamic operational logic of the Solar Tracker System, defining how the system moves between different modes of operation. The system always begins in the INIT (Initialization) state, signifying startup. Upon successful completion of the system setup, the transition labeled SET UP Complete moves the system into the READY state. From the READY state, the system can transition into two operational modes: MANUAL mode, triggered by the Manual Mode command, or AUTOTRACK mode, which is entered if the system is configured for AUTO MODE operation. While in the MANUAL state, the system can return to the READY state via the Switch mode command, or it can transition directly to the ERROR state if an ERROR condition is encountered. The AUTOTRACK state represents the core function, where the system continuously tracks the sun, shown by the self-loop labeled TIMER TRIGGER; it can exit this loop and switch back to the READY state via the Switch mode command, or it can immediately enter the ERROR state upon detection of an ERROR. Crucially, the ERROR state serves as a terminal point from any operational failure and will restart the entire process by transitioning back to the INIT state.

3.6. Sequence Diagram- Auto Tracking

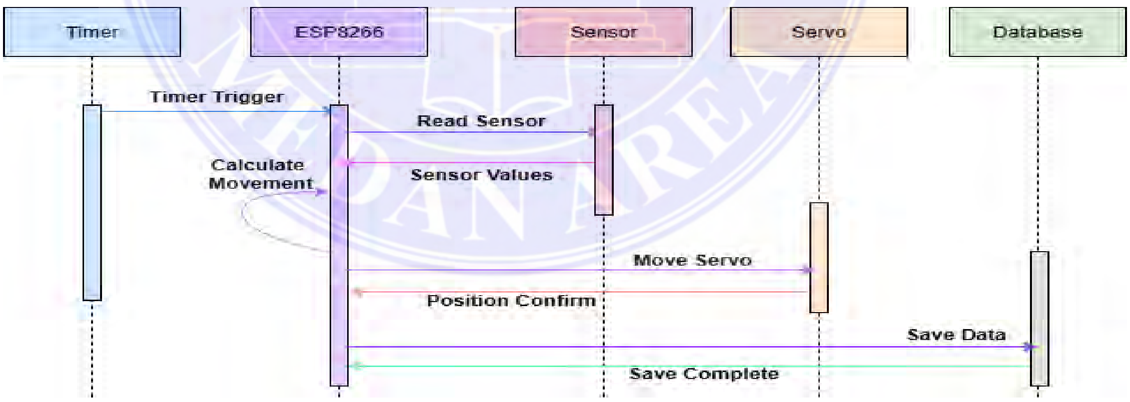

Figure 3.6. Sequence Diagram- Auto Tracking.

This Sequence Diagram illustrates the exact chronological flow of communication and actions required for the system's automatic tracking process. The process is initiated by the Timer object sending a Timer Trigger signal to the ESP8266 microcontroller, prompting the start of a tracking cycle. Upon receiving the trigger,

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the ESP8266 immediately sends a Read Sensor command to the Sensor (LDRs). The Sensor responds by providing Sensor Values (light intensity readings) back to the ESP8266. With this input, the ESP8266 executes the Calculate Movement process to determine the optimal panel angle. Following this calculation, the ESP8266 sends a Move Servo command to the Servo (motor). The Servo then physically adjusts the panel and sends a Position Confirm signal back to the ESP8266, confirming the completion of the physical task. Finally, the ESP8266 sends a Save Data command to the Database for logging the cycle's results. The Database completes the sequence by confirming the action with a Save Complete signal back to the ESP8266.

3.7. Activity Diagram-User Monitoring Process

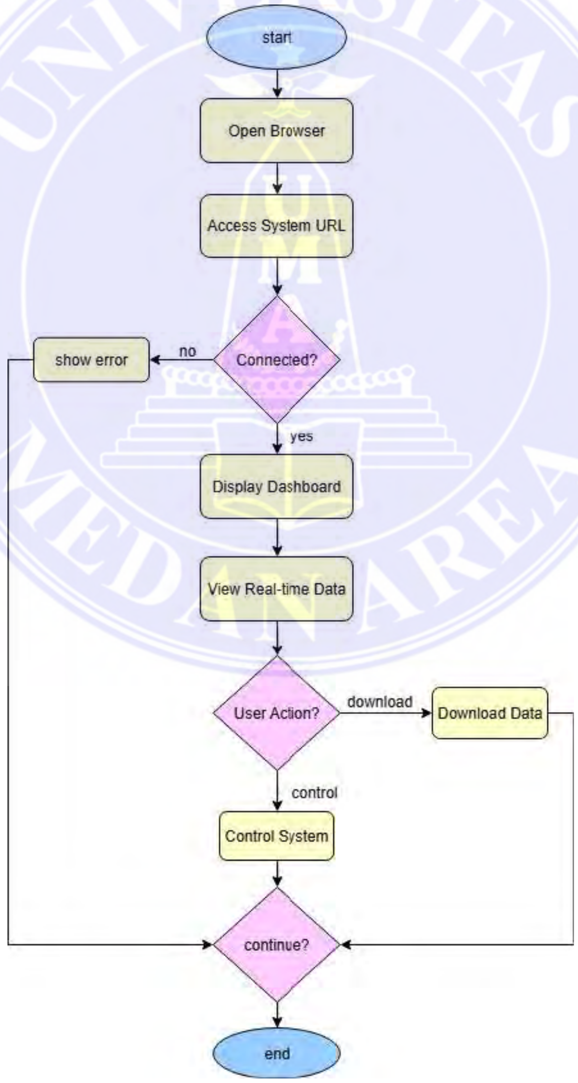

Figure 3.7. Activity Diagram-User Monitoring Process.

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This Activity Diagram maps the sequential steps and decision points involved in the User Monitoring Process for the Solar Tracker System. The flow begins with the user initiating the process at the start node and proceeding to Open Browser. This is immediately followed by Access System URL. A critical decision node is then reached: Connected? (Is the system accessible?). If the answer is "no," the system executes show error and loops back to the beginning of the connection attempt. If the connection is successful ("yes"), the system proceeds to Display Dashboard and subsequently to View Real-time Data. The flow then hits the User Action? decision node, where the path depends on the user's choice: if the choice is "download," the user executes the Download Data activity, and the flow moves forward. If the choice is "control," the flow proceeds to Control System. Finally, the process reaches the continue? decision node, which allows the flow to either loop back to the Open Browser step (implying continued monitoring) or proceed to the end node, terminating the activity.

3.8. Class Diagram of Automatic Solar Panel Monitoring System

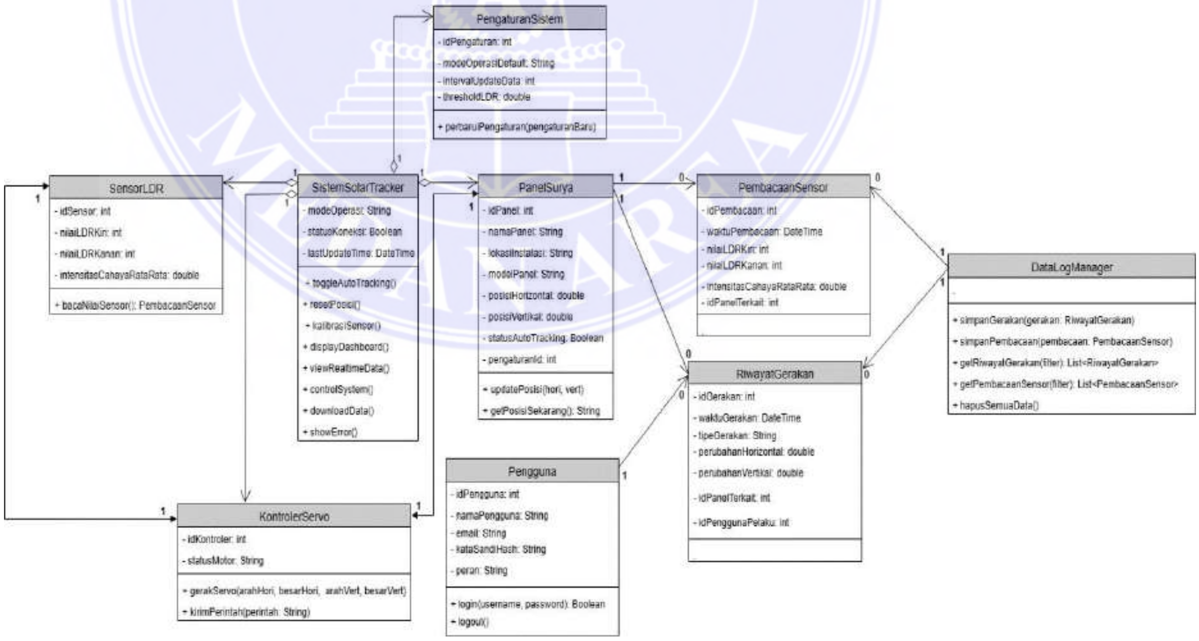

Figure 3.8. Class Diagram of Automatic Solar Panel Monitoring System.

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This Class Diagram meticulously maps the structural blueprint of the Automatic Solar Panel Monitoring System, detailing the components and their relationships. At its core is the SistemSolarTracker class, which serves as the central orchestrator, managing the system's operational status and providing core functionalities such as toggleAutoTracking(), resetPosisi(), and data presentation (displayDashboard(), viewRealtimeData()).

The SistemSolarTracker maintains crucial one-to-one relationships with key entities: SensorLDR (for light input), KontrolerServo (for movement output), and PengaturanSistem (System Settings, holding parameters like modeOperasiDefault and thresholdLDR). The Controller class handles servo commands (gerakServo()), while the Sensor class manages light input (bacaNilaiSensor()).

The system data involves the PanelSurya (Solar Panel) entity, which holds descriptive attributes and has a one-to-many relationship with RiwayatGerakan (Movement History), tracking detailed logs of every movement event. The data stream continues through the PembacaanSensor (Sensor Reading) class, which records light values (nilaiLDRKanan, nilaiLDRKiri, intensitasCahayaRataRata) and is managed by the DataLogManager class, responsible for storing and retrieving historical data (simpanGerakan(), getRiwayat()). Finally, the Pengguna (User) class manages authentication (login()) and interacts with the overall system, demonstrating which user is associated with which movement logs. This entire structure ensures high fidelity data tracking, central control, and clear separation of concerns among the system's components.

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3.9. Component Diagram

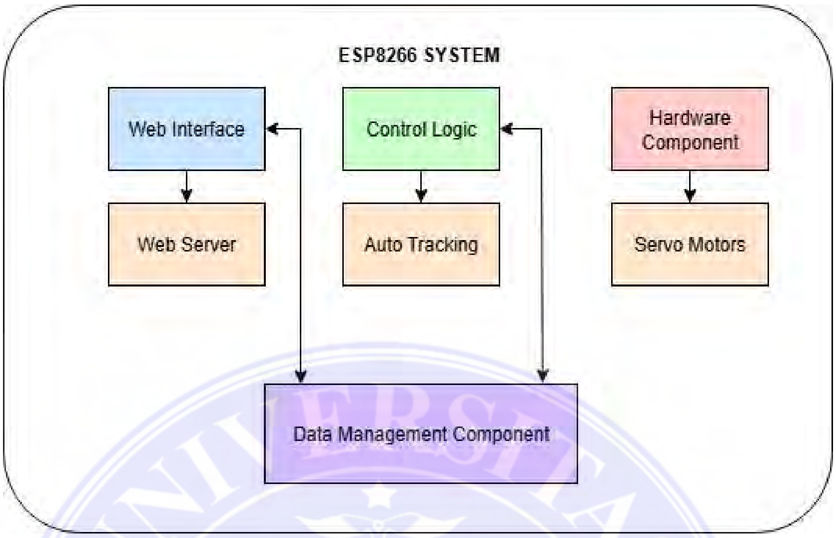

Figure 3.9. Component Diagram.

This Component Diagram illustrates the internal software and hardware components and their interdependencies within the ESP8266 System. The system's intelligence is managed by the Control Logic component, which handles all high-level decision-making. The Control Logic directs the Auto Tracking component, which executes the specific algorithm for sun movement optimization. Both the Control Logic and the Web Interface rely on the Data Management Component for logging and retrieving operational data. The system's output is handled by two closely linked physical components: the Hardware Component, which represents general electronics and sensors, and the Servo Motors, which execute the panel's movement commands based on input from the Control Logic. Conversely, the Web Interface is responsible for presenting data to the user, working in conjunction with the Web Server component to handle communication protocols and display the collected information retrieved from the Data Management Component. This architecture ensures a clear separation between sensing, controlling, communicating, and moving the solar panel.

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3.10. Network Architecture Diagram

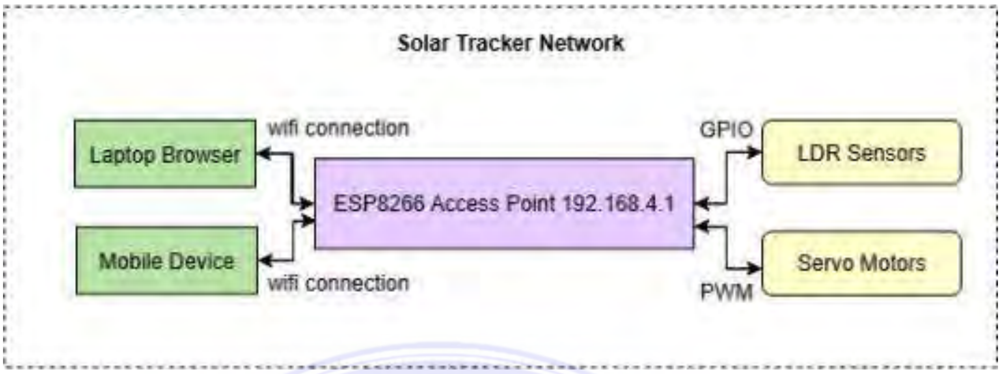

Figure 3.10. Network Arcitecture Diagram.

This Network Architecture Diagram outlines the connection and communication components of the Solar Tracker System. The central element of the network is the ESP8266 Access Point, configured with the IP address 192.168.4.1, which functions as the hub for all communication. On the client side, Laptop Browser and Mobile Device connect to the ESP8266 via wifi connection. These devices serve as the user interface for monitoring and control. On the hardware side, the ESP8266 communicates directly with the physical components: it uses the GPIO pins to receive light data input from the LDR Sensors and utilizes PWM (Pulse Width Modulation) outputs to send movement signals to the Servo Motors. This structure demonstrates a simple, self-contained network where the ESP8266 acts as both the logic controller and the dedicated access point for clients to interact with the system's sensors and actuators.

Overall, my role spanned the entire process of visual mapping and structural documentation from the hardware movement logic to the web server's architecture at the information system level. This ensures that the system not only operates automatically but also possesses a structurally designed, well-documented architecture that is understandable and scalable for future development.

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CHAPTER IV
CONCLUSION

4.1. 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.

4.2. 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.

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APPENDICES

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