A REPORT OF FOUR WEEK TRAINING (14 PT.)

at

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD

OF THE DEGREE OF (12pt.)

BACHELOR OF TECHNOLOGY (14 pt.)

(Computer Science and Engineering) (14pt.)

JUNE-JULY, 2025 (14 pt.)

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(12pt.)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (12pt.)

GURU NANAK DEV ENGINEERING COLLEGE LUDHIANA (14pt.)

CERTIFICATE BY INSTITUTE :

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This is certified that Ms./Mr. Kashish Gujral *D/o, S/o* Arvind Kumar Gujral *Roll No.* 2302584 *of college* Guru Nanak Dev Engineering College *branch Civil Engg. / Mechanical Engg. / Electronics & Communication Engg. / Electrical Engg. / Computer Science & Engg. / Information Technology has successfully completed participated Industrial Training / Institutional Training Programme on* SMART FUSION (AI-ML-IoT)

from 23rd June, 2025 *to* 21st July, 2025

Co-ordinator Head of the Department Dean (T & C) Principal

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

CANDIDATE'S DECLARATION

I KASHISH GUJRAL hereby declare that I have undertaken four week training GURU NANAK DEV ENGINEERING COLLEGE during a period from __25-6-25__ to ___18-7-25____ in partial fulfillment of requirements for the award of degree of B.Tech. (Computer Science and Engineering) at Guru Nanak Dev Engineering College, Ludhiana. The work which is being presented in the training report submitted to Department of Computer Science and Engineering at Guru Nanak Dev Engineering College, Ludhiana is an authentic record of training work.

Name Of Students	Signature of Students
1. Kashish Gujral	
2. Kareena	
3. Kajal	
4. Lovejot Kaur	

The four week industrial training Viva–Voce Examination of_ SMARTFUSION (AI-ML-IOT)__ has been held on ____16-10-25________ and accepted.

Signature of Internal Examiner   Signature of External Examiner

ABSTRACT

This report summarizes the work carried out during the four-week industrial training at Smart Fusion, Guru Nanak Dev Engineering College, Ludhiana. The primary objective of our project was to design and implement “AgroSolAR – Automated Rotation”, a sunflower solar tracking system using the ESP32 microcontroller, Light Dependent Resistors (LDRs), and IoT technology.

The system is designed to maximize solar energy collection by automatically aligning the solar panel towards the direction of maximum sunlight. During the training, we developed the hardware and wrote the firmware to interface ESP32 with sensors and motors. Real-time monitoring and control were achieved through IoT integration.

Our prototype showed a significant improvement in energy harvesting efficiency compared to fixed solar panels. This project demonstrates the practical application of AI, ML, and IoT in the field of renewable energy. The experience gained helped us understand embedded systems design and teamwork in an industrial environment.

ACKNOWLEDGEMENT

We wish to express our sincere gratitude to **Smart Fusion** and **Guru Nanak Dev Engineering College, Ludhiana,** for providing us with the opportunity to undertake the four-week training and work on **the “AgroSolAR – Automated Rotation”** project.

We are thankful to our professor, training coordinator, and all faculty members for their valuable guidance, encouragement, and support during the project. We also extend our thanks to our group members and friends for their cooperation and teamwork.

The experience added to our practical knowledge in computer science and engineering, and we are grateful for this learning opportunity.

ABOUT SMART FUSION (TRAINING PROGRAM)

Smart Fusion is a technology-driven training institute that offers practical skill development in the fields of computer science, AI, IoT, and machine learning. The four-week training program for B.Tech students at Guru Nanak Dev Engineering College focuses on industrial applications, hands-on projects, and exposure to current technological trends.

During our training, we learned about microcontroller development, sensor interfacing, and AI/ML implementation through our group project—AgroSolAR (Automated Rotation). The program's emphasis on teamwork, project-based learning, and industry interaction helped us gain practical knowledge to support our academic studies.

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CHAPTER - 1

INTRODUCTION

1.1 OVERVIEW

In Today's World, Energy Consumption Is Increasing Every Day, And Renewable Energy Sources Are Becoming More Important To Meet These Growing Demands. Solar Energy Is One Of The Cleanest And Most Reliable Sources Of Power. However, The Major Challenge With Conventional Solar Panels Is That They Are Usually Fixed At One Angle And Cannot Track The Movement Of The Sun Throughout The Day. Because Of This, Fixed Panels Capture Less Sunlight And Generate Less Power, Especially In The Morning And Evening Hours. To Overcome This Issue, The Concept Of Solar Tracking Systems Was Introduced. These Systems Adjust The Position Of Solar Panels According To The Sun's Direction To Maximize Power Generation.The Agrosolar (Agro Solar – Autorotation) Project Is Designed To Automatically Rotate The Solar Panel To Face The Direction Of Maximum Sunlight Using Sensors And A Microcontroller. The System Is Also Enhanced With Ai (Artificial Intelligence), Iot (Internet Of Things), And Ml (Machine Learning) Technologies To Make It More Efficient And Intelligent.This Project Is Mainly Developed For Agricultural Applications, Where Solar Energy Can Be Used To Run Irrigation Systems, Measure Environmental Parameters, And Support Smart Farming Practices.

Figure 1.1: Image of the AgroSolAR system setup

1.2 Problem Statement

Farmers in rural areas often depend on electric pumps or diesel generators for irrigation, which are costly and harmful to the environment. Solar energy offers a great alternative, but the efficiency of solar panels decreases when they are not properly aligned with the sun.The AgroSolAR system aims to solve this problem by designing a smart solar panel that automatically follows the sun's movement, ensuring maximum sunlight exposure and higher energy output.

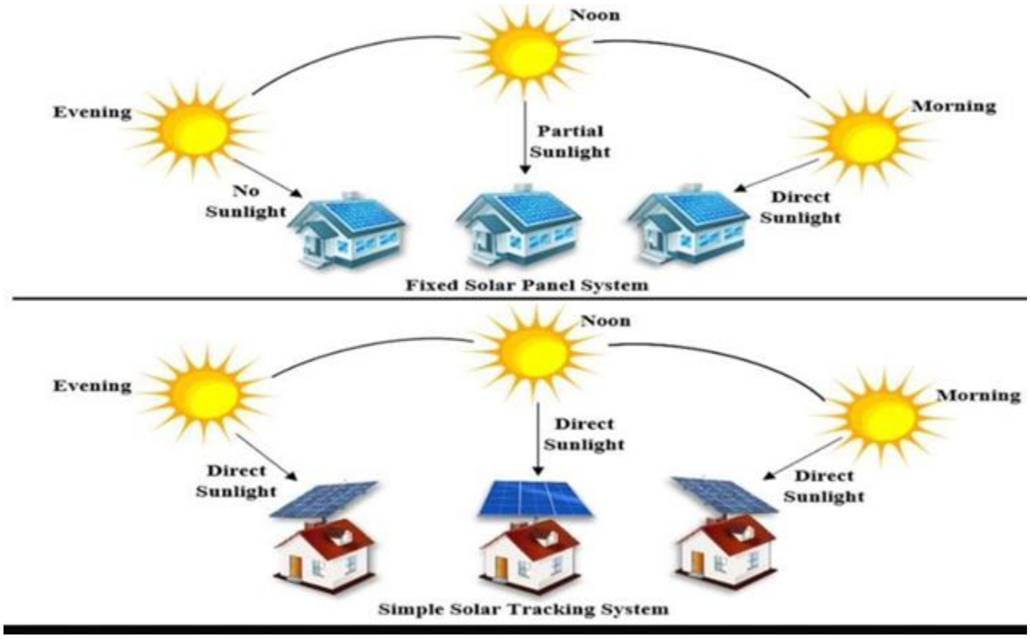


Figure 1.2: Diagram showing difference between fixed and tracking panels

1.3 Objectives

The main objectives of this project are:

- To design and implement an automatic solar tracking system using LDR sensors, DC gear motors, and an ESP32 microcontroller.
- To use IoT for collecting and displaying environmental data such as temperature, humidity, and sunlight intensity.
- To integrate AI and ML to make the system capable of learning sunlight movement patterns and predicting future positions for better tracking.
- To develop a cost-effective and energy-efficient solution that can be used in agricultural fields.

1.4 Project Motivation

The motivation behind this project comes from the need to promote smart and sustainable farming. Many farms in India have large open spaces with plenty of sunlight throughout the year, making them ideal for solar installations. By automating solar tracking and adding AI-based intelligence, we can help farmers get more power from the same panels and reduce dependency on expensive energy sources.

Additionally, integrating IoT allows remote monitoring of field conditions, giving farmers access to real-time data and helping them make better decisions related to irrigation and power usage.

1.5 Technologies Used

The AgroSolAR (Agro Solar – Autorotation) project combines both hardware and software technologies. Each component and technology plays an important role in making the system automatic, intelligent, and connected through the internet. The major technologies used are explained below:

1.5.1 ESP32 Microcontroller

The ESP32 is the main control unit of the system. It is a low-cost, low-power microcontroller with built-in Wi-Fi and Bluetooth connectivity. It reads the sensor data from the LDR and DHT11, processes it, and sends the proper control signals to the L298N motor driver to rotate the solar panel. It also uploads data to the IoT platform through Wi-Fi. Its dual-core processor and large memory make it suitable for IoT and AI-based projects.

Figure 1.3: ESP32 Microcontroller Board

1.5.2 LDR (Light Dependent Resistor) Sensors

LDRs are used to detect the intensity of sunlight falling on the solar panel. When the light intensity changes, the resistance of the LDR changes. The ESP32 reads these variations and decides which side of the panel receives more sunlight. The panel then rotates toward the side with higher light intensity to maximize energy capture .

Figure 1.4 LDR Sensors

1.5.3 L298N Motor Driver Module

The L298N motor driver acts as a bridge between the ESP32 and the DC gear motors.It allows the microcontroller to control the direction and speed of rotation of the motors.By giving HIGH or LOW logic signals from the ESP32, the driver decides whether the motor should move left, right, or stop.

Figure 1.5: L298N Motor Driver Module

1.5.4 DC Gear Motors

Two DC gear motors are used to rotate the solar panel in both horizontal and vertical directions.The built-in gears reduce the motor speed and increase torque, allowing smooth and accurate panel movement even under load.The motors are powered by a 12 V battery and controlled through the L298N driver.

Figure 1.6: Motor Assembly for Panel Rotation

1.5.5 DHT11 Temperature and Humidity Sensor

The DHT11 sensor is used to measure the surrounding temperature and humidity in the agricultural field.This data is sent to the IoT platform for real-time monitoring.It helps farmers know environmental conditions that affect crop health and irrigation needs.

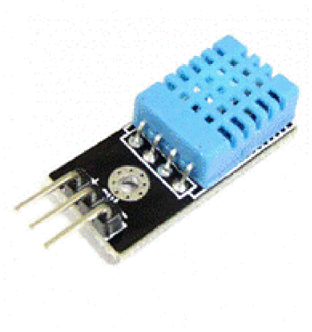
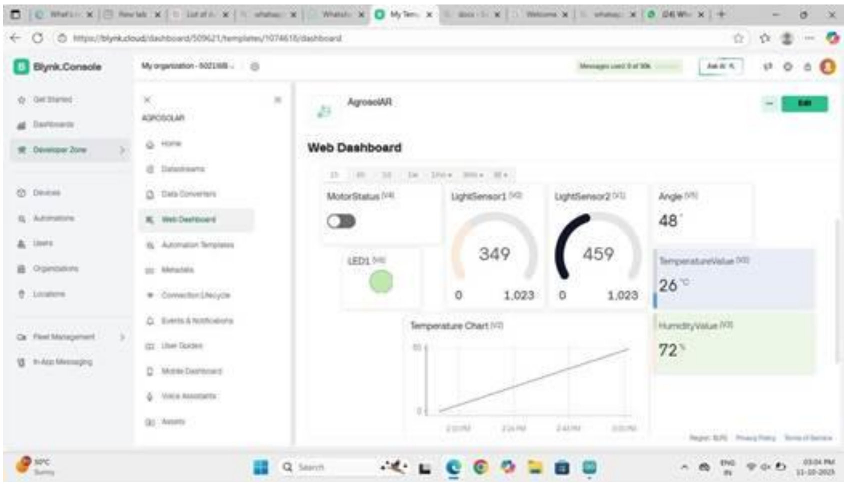


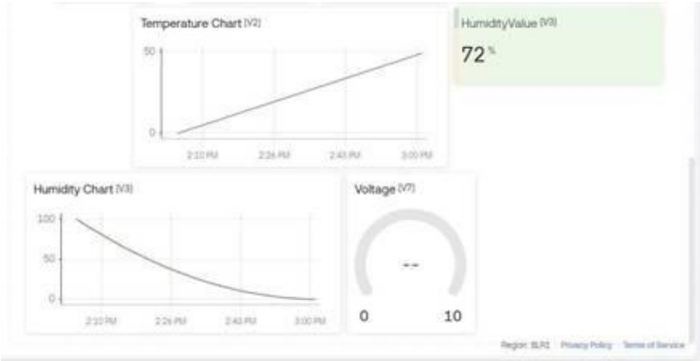
Figure 1.7: DHT11 Sensor

1.5.6 IoT (Internet of Things) Platform

The IoT platform Blynk displays the collected sensor data—light intensity, temperature, and humidity—on a web dashboard. It allows users to remotely monitor system performance from anywhere with an internet connection. This feature makes AgroSolAR part of a larger Smart Farming System.



(a)



(b)

Figure 1.8: (a), (b) Sample IoT Dashboard Screenshot

1.5.7 Artificial Intelligence (AI) and Machine Learning (ML)

The AgroSolAR (Agro Solar – Automated Rotation) system uses Artificial Intelligence (AI) and Machine Learning (ML) to make the solar tracker more efficient and intelligent. Instead of just reacting to light, the system learns from sunlight data and predicts how the solar panel should move to capture maximum energy throughout the day

AI plays an important role in controlling and decision-making. The ESP32 microcontroller, programmed using Arduino IDE, collects continuous readings from LDR sensors that detect sunlight intensity. Based on this data, the AI-based logic inside the ESP32 decides which motor should rotate and by how much. It also considers environmental factors like temperature and humidity to prevent unnecessary movement, ensuring smooth and stable tracking. For example, when the light difference between both sensors is small, the system makes only slight adjustments. When one sensor detects a sharp increase in light, the motor rotates more quickly. This intelligent control allows the system to behave like a human operator who continuously adjusts the solar panel for best results.

The Machine Learning (ML) part of AgroSolAR focuses on analyzing and improving system performance over time. Sensor readings such as light intensity, time of day, and motor angle are recorded and sent to the Blynk IoT platform through Wi-Fi. These readings are later used to train a simple linear regression model in Python to find relationships between light intensity and panel angle. Once trained, the model helps predict the ideal position of the solar panel at different times of the day, even when sunlight is low or cloudy conditions exist. The ESP32 uses these predictions to adjust motor movement more accurately.

This combination of AI decision-making and ML prediction makes AgroSolAR a smart, adaptive system. It not only reacts to real-time data but also learns from past behavior to optimize future performance. By using Arduino IDE for control logic and Blynk for IoT data monitoring, the project achieves an effective balance between automation and intelligence. This results in higher solar energy efficiency, reduced manual effort, and smoother operation. The integration of AI, IoT, and ML transforms AgroSolAR from a simple solar tracker into a self-learning, intelligent energy system designed especially for sustainable agricultural applications.

CHAPTER - 2

TRAINING WORK UNDERTAKEN

2.1 Introduction to Training

We completed our one-month industrial training at Guru Nanak Dev Engineering College, Ludhiana, under the Smart Fusion program conducted by the Department of Computer Science and Engineering. The main objective of this program was to provide practical knowledge of Artificial Intelligence (AI), Internet of Things (IoT), and Machine Learning (ML), and to guide students in applying these technologies to real-life problems. The training included both theoretical and hands-on sessions, which helped us understand how IoT devices, sensors, and microcontrollers communicate with cloud platforms to form intelligent systems. This foundation later supported the development of our project "AgroSolAR (Agro Solar – Autorotation)".

2.2 Topics Covered During Training

During the training, we were introduced to several key technologies and tools that are commonly used in smart systems. The major topics covered were**:**

- **Introduction to IoT –** Basics of connecting electronic devices to the internet for monitoring and control**.**
- **IoT Architecture –** Understanding perception, network, edge, cloud, and application layers in IoT systems.

- **Hardware Platforms –** Overview of Arduino, NodeMCU, and Raspberry Pi boards and their differences.

- **Sensors and Actuators –** Study of DHT11, LDR, and other sensors used for environmental sensing**.**

- **Cloud Computing for IoT –** Using online platforms such as ThingSpeak and Blynk for data storage and visualization.

- **Wokwi Simulator** – Practicing circuit design and code execution in a virtual environment.

- **Python Programming** – Learning basic syntax and data-handling libraries such as NumPy, Pandas, and Matplotlib.

- **Artificial Intelligence and Machine Learning** – Introduction to data-driven decision-making and model training.

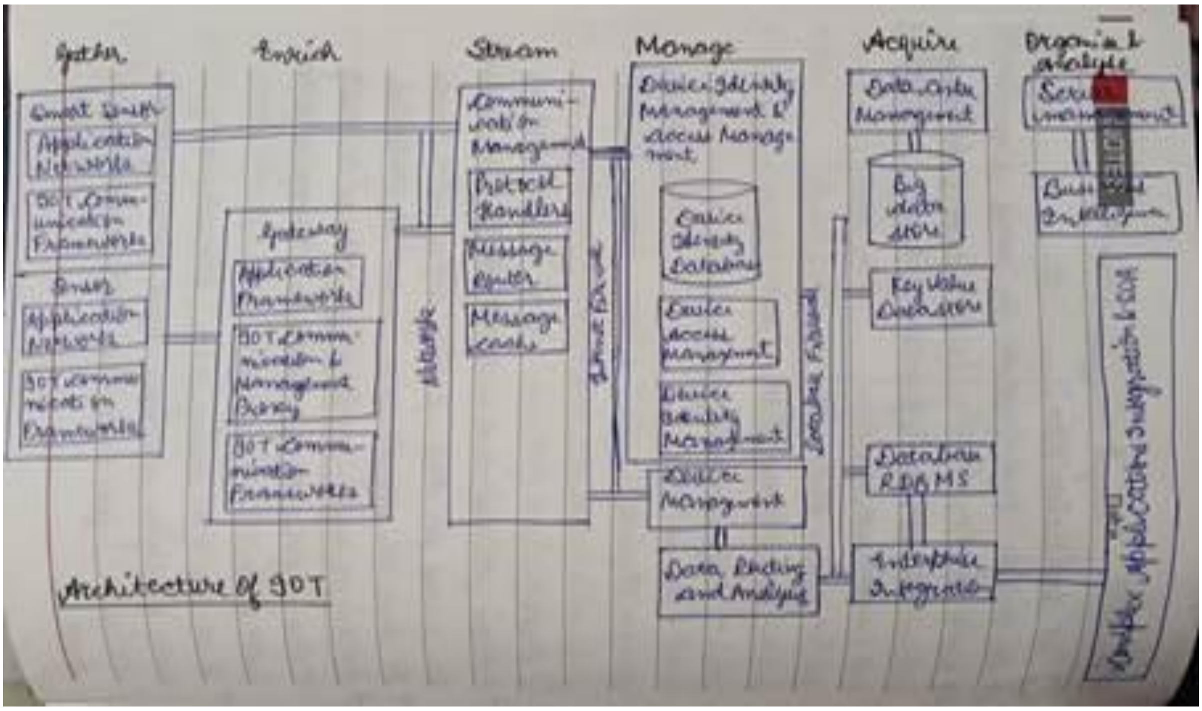


Figure 2.1 Diagram of IoT Architecture

2.3 Practical Sessions

After completing the theoretical part, we performed several practical experiments to understand IoT applications. We connected the DHT11 sensor with ESP32 and NodeMCU boards and programmed them through the Arduino IDE to read temperature and humidity data. This data was sent to the ThingSpeak cloud platform, where real-time graphs were automatically generated. This exercise gave us a complete understanding of IoT data flow—from sensors to the microcontroller, then to the cloud, and finally to the user dashboard. It also provided the base knowledge for our final group project.

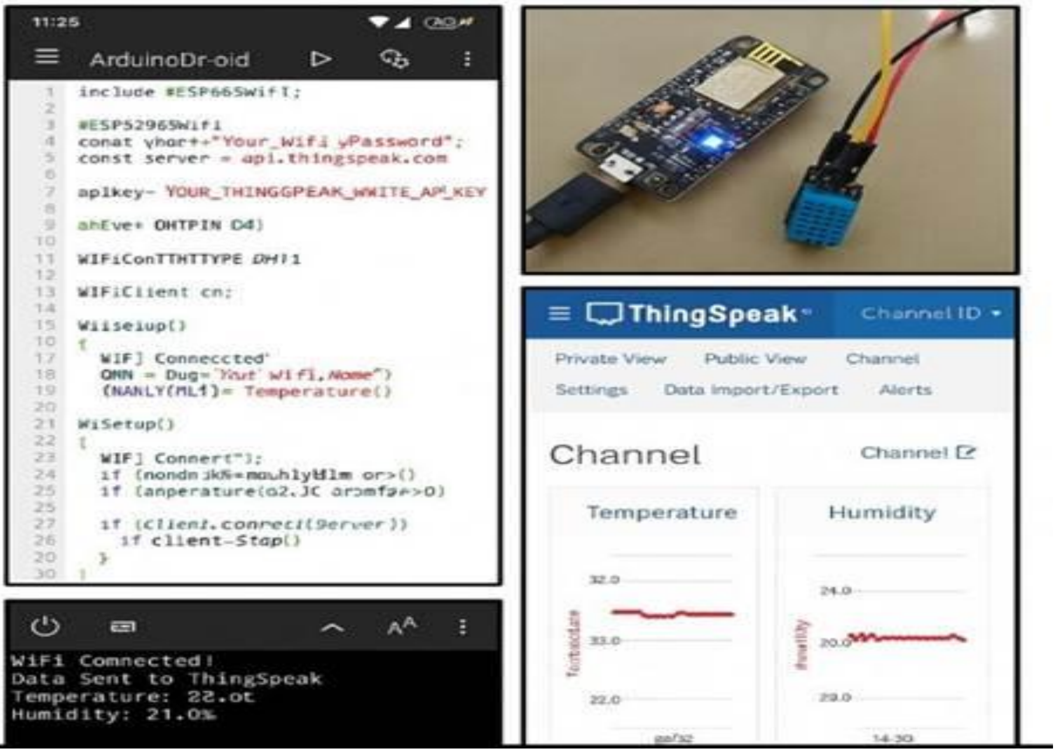


Figure 2.2 DHT11 Sensor on Wokwi Simulation / ThingSpeak Graph

2.4 Project Development – AgroSolAR

After the practice sessions, our group started developing the main project titled "AgroSolAR (Agro Solar – Automated Rotation)".The aim of this project was to design a smart solar-tracking system for agricultural applications that automatically aligns the solar panel with sunlight while monitoring environmental conditions through IoT. We applied the knowledge gained from the training in the following ways:

- **IoT integration:** Sending live sensor data to ThingSpeak and Blynk dashboards.
- **Arduino IDE programming:** Coding the ESP32 controller for sensor reading and motor control.
- **AI and ML logic:** Using predictive behavior for sunlight tracking.
- **Cloud computing:** Displaying DHT11 data and monitoring performance remotely.

2.5 Integration of IoT and Cloud Computing

In the project, the ESP32 microcontroller collected real-time temperature and humidity data through the DHT11 sensor and uploaded it to the ThingSpeak cloud via Wi-Fi. The ThingSpeak dashboard generated a single graph displaying both temperature and humidity variations over time. This validated that our IoT configuration and cloud communication were functioning correctly. The integration of cloud services made our system accessible from anywhere and demonstrated how IoT enables remote monitoring in smart agriculture.

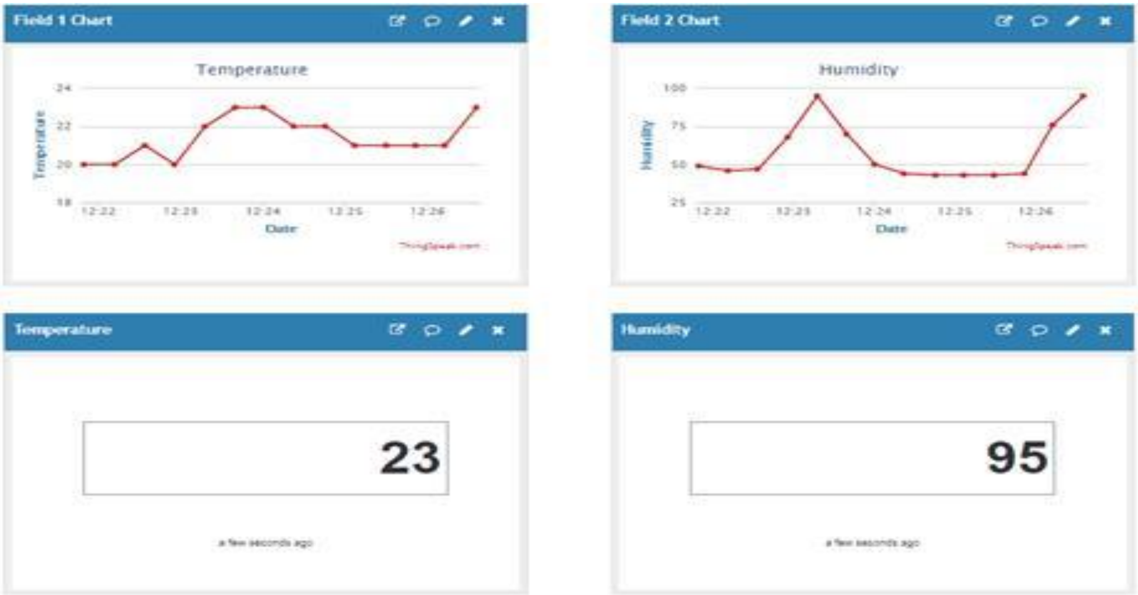


Figure 2.3 ThingSpeak Graph Showing Temperature and Humidity Readings

2.6 Team Experience and Skills Gained

Working as a group allowed us to share responsibilities and learn collaboratively. Some members focused on circuit wiring, while others handled coding, data visualization, and documentation. Through teamwork, we learned communication, coordination, and time management skills. Technically, we gained:

- Knowledge of IoT architecture and cloud integration.
- Practical experience in programming with Arduino IDE.
- Hands-on experience with ThingSpeak and Blynk.
- Understanding of AI and ML concepts for predictive automation.
- Confidence to design, test, and present a working prototype.

CHAPTER- 3

RESULTS AND DECISION

3.1 Results

The AgroSolAR system was tested under real environmental conditions, and its performance was evaluated based on solar tracking efficiency, energy generation, and environmental monitoring. The solar panel successfully followed the sun throughout the day using LDR sensors and motors. Light intensity graphs from the IoT dashboard confirmed that the panel consistently aligned with maximum sunlight. Energy output graphs showed increased energy production compared to a fixed panel, especially during peak sunlight hours. Temperature and humidity data were continuously monitored and displayed on the dashboard, providing valuable environmental information for agricultural applications. The AI and ML algorithms helped the system adapt to sunlight patterns, improving tracking accuracy over time. Overall, the results indicate that the system is effective in maximizing solar energy capture and providing real-time monitoring of environmental conditions.

3.2 Decision

Based on the dashboard data, graphs, and observed performance: The solar tracking system performs efficiently and is able to increase energy generation compared to static solar panels. The integration of IoT allows remote monitoring, which is useful for agricultural management. The use of AI and ML improves tracking accuracy, making the system adaptive to changing sunlight conditions. The system is feasible and practical for agricultural applications, such as powering irrigation systems, sensors, and other smart-farming devices.

Decision: The AgroSolAR project is successful, effective, and suitable for real-world agricultural use, combining renewable energy, IoT, and AI technologies for smart farming solutions.

CHAPTER 4

CONCLUSION AND FUTURE SCOPE

4.1 Conclusion

The AgroSolAR project successfully demonstrates a smart solar tracking system that integrates renewable energy, IoT, AI, and ML for efficient agricultural applications.Key conclusions from the project are:

1. The solar tracking system accurately follows the sun throughout the day, maximizing energy capture and improving overall efficiency compared to fixed solar panels.
2. The IoT dashboard provides real-time monitoring of environmental parameters such as temperature, humidity, light intensity, and panel position, enabling data-driven decisions for farm management.
3. The AI and ML algorithms enhance the system's performance by learning sunlight patterns and optimizing the movement of the solar panel over time.
4. The system is practical and feasible for agricultural applications, such as powering water pumps, soil sensors, and automated irrigation systems, which helps reduce electricity costs and promotes sustainable farming.
5. The integration of hardware and software components shows that modern technologies can be effectively combined to create intelligent, adaptive systems for real-world use.

In conclusion, the AgroSolAR project provides a reliable, efficient, and sustainable solution for using solar energy in agriculture, supporting smart farming practices and energy management.

4.2 Future Scope

The AgroSolAR project has great potential for expansion and improvement. Some possible future enhancements include:

1. **Integration with Additional IoT Devices**

   - Connect the solar tracker with soil moisture sensors, weather stations, and irrigation systems for fully automated smart farming.

   - Enable automated irrigation based on real-time data from the sensors.

2. **Improved AI and ML Models**

   - Use advanced machine learning algorithms to predict sunlight availability and energy generation more accurately.

   - Implement weather forecasting for better optimization of solar panel angles.

3. **Energy Storage Solutions**

   - Integrate battery storage systems to store excess energy generated during peak sunlight hours.

   - Enable the system to supply energy during nighttime or cloudy conditions.

4. **Scalability for Larger Farms**

   - Deploy multiple AgroSolAR units in larger agricultural fields to maximize energy outpu t and farm automation.

   - Use centralized monitoring dashboards to manage multiple units efficiently.

5. **Mobile Application for Monitoring and Control**

- Develop a mobile app to provide farmers with alerts, notifications, and control options remotely.
- Display energy statistics, environmental data, and panel alignment history for easy access.

6. **Hybrid Energy Integration**

- Combine solar energy with other renewable sources like wind or biogas to ensure continuous energy supply.
- Make the system more reliable for farms with varying energy demands.

Overall, the future scope of AgroSolAR lies in making it a complete smart-farming solution that not only generates energy efficiently but also automates agricultural operations for better productivity, cost savings, and sustainability.

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