Smart Solar Tracking with Enhanced Home Energy Management & IoT Interface

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Objectives

- To Maximize Solar Energy Efficiency
- To Prevent Energy Wastage
- To Provide Accurate Energy Monitoring.
- To Deliver a Low-Cost & User-Friendly Solution

Introduction

Our Smart Solar Tracking and Energy Management System revolutionizes renewable energy collection through intelligent automation. Unlike traditional fixed panels that waste potential energy, our solution employs light-dependent resistors (LDRs) and servo motors to create a dynamic dual-axis tracking system that precisely follows the sun's movement. The integrated energy management system combines real-time power monitoring (via ACS712 sensor), efficient battery charging (TP4056 module), and reliable energy storage (18650 Li-ion battery), with all critical data displayed on a 0.96" OLED screen. This comprehensive approach delivers optimal solar energy utilization in a user-friendly package.

Realizing the key components

1.Dual-Axis Tracking Mechanism - Utilizing four LDR sensors and two SG90 servo motors to maintain optimal panel orientation

2.Energy Harvesting System - Two 6V/2W solar panels with maximum power point tracking

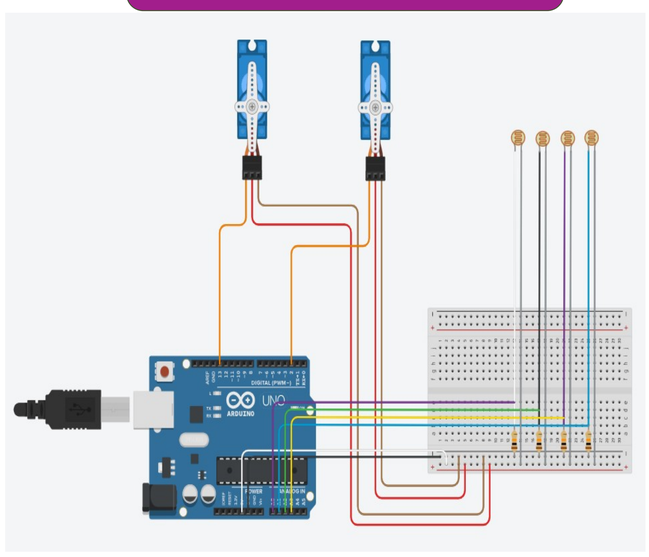
3.Power Management - TP4056 charging module with battery protection for the 18650 Li-ion cell

4.Monitoring Interface - 0.96" OLED display showing:

- Real-time power metrics (via ACS712 sensor)
- Battery charge status
- Solar panel positioning angles

5.Control Unit - Arduino Uno microcontroller processing sensor data **and coordinating system operations**

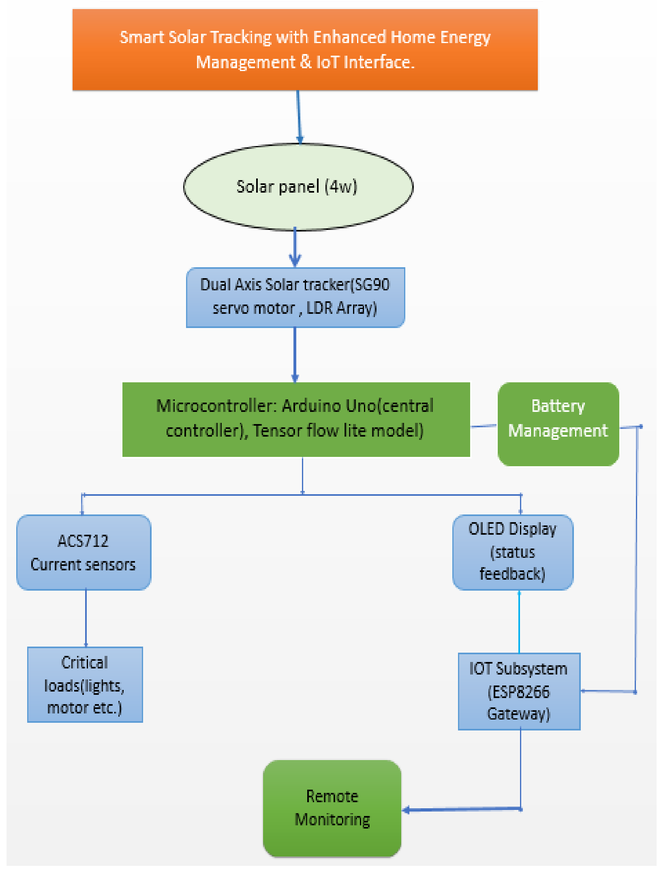
Circuit Diagram



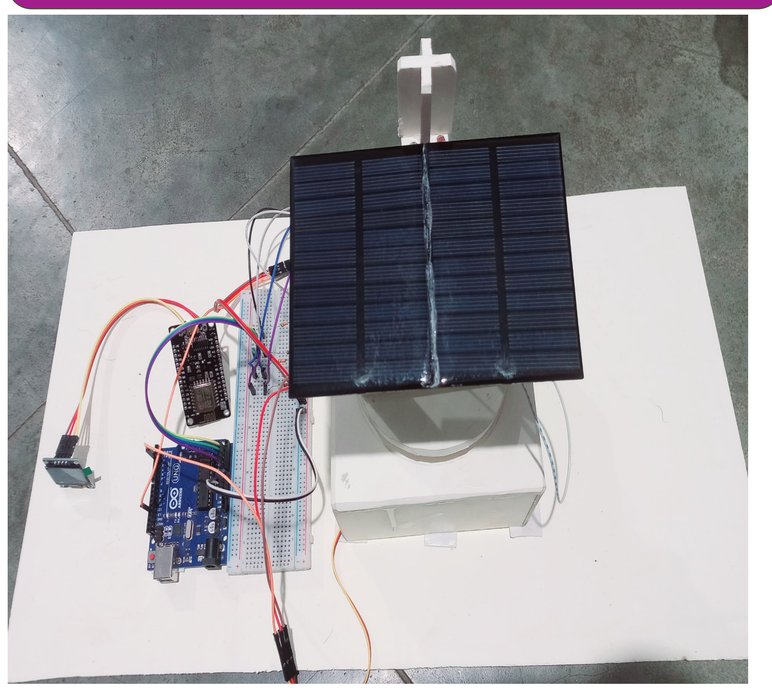
Methodology

The Smart Solar Tracking System was developed through a structured implementation process. First, all hardware components including the Arduino microcontroller, LDR sensors, servo motors, solar panels, and power management circuits were carefully integrated. The software was then programmed to process real-time sunlight data from the LDRs and adjust the servo motors accordingly for optimal solar panel positioning. A comprehensive testing phase verified the system's tracking accuracy under various lighting conditions and evaluated its energy management performance. The final implementation demonstrated significant improvements in solar energy harvesting efficiency while maintaining reliable operation. Designed with scalability in mind, the system's modular architecture allows for future enhancements such as IoT connectivity or expanded power capacity, ensuring its adaptability for different applications. The project successfully achieved its goal of creating an efficient, cost-effective solar tracking solution with practical energy monitoring capabilities

Flow Chart



Overview of Smart Solar Tracking with Enhanced Home Energy Management



Uses of IoT-based Smart Solar Tracking and Energy Management System

- Remote Solar Performance Monitoring
- Cloud-Based Energy Data Logging
- Predictive Maintenance Alerts
- Smart Grid Integration
- Weather-Adaptive Tracking
- Mobile App Control & Notifications
- Energy Usage Analytics Dashboard

Advantages & Disadvantages

Advantages:

- Increased Energy Efficiency Time-Efficient
- Cost-Effective Solution
- Real-Time Monitoring
- Automated Operation

Disadvantages:

- Higher Initial Cost
- Mechanical Wear & Tear
- Power Consumption by Tracking System
- Weather Vulnerability