SELF-SUSTAINING DUAL-AXIS SOLAR TRACKING SYSTEM

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Introduction :

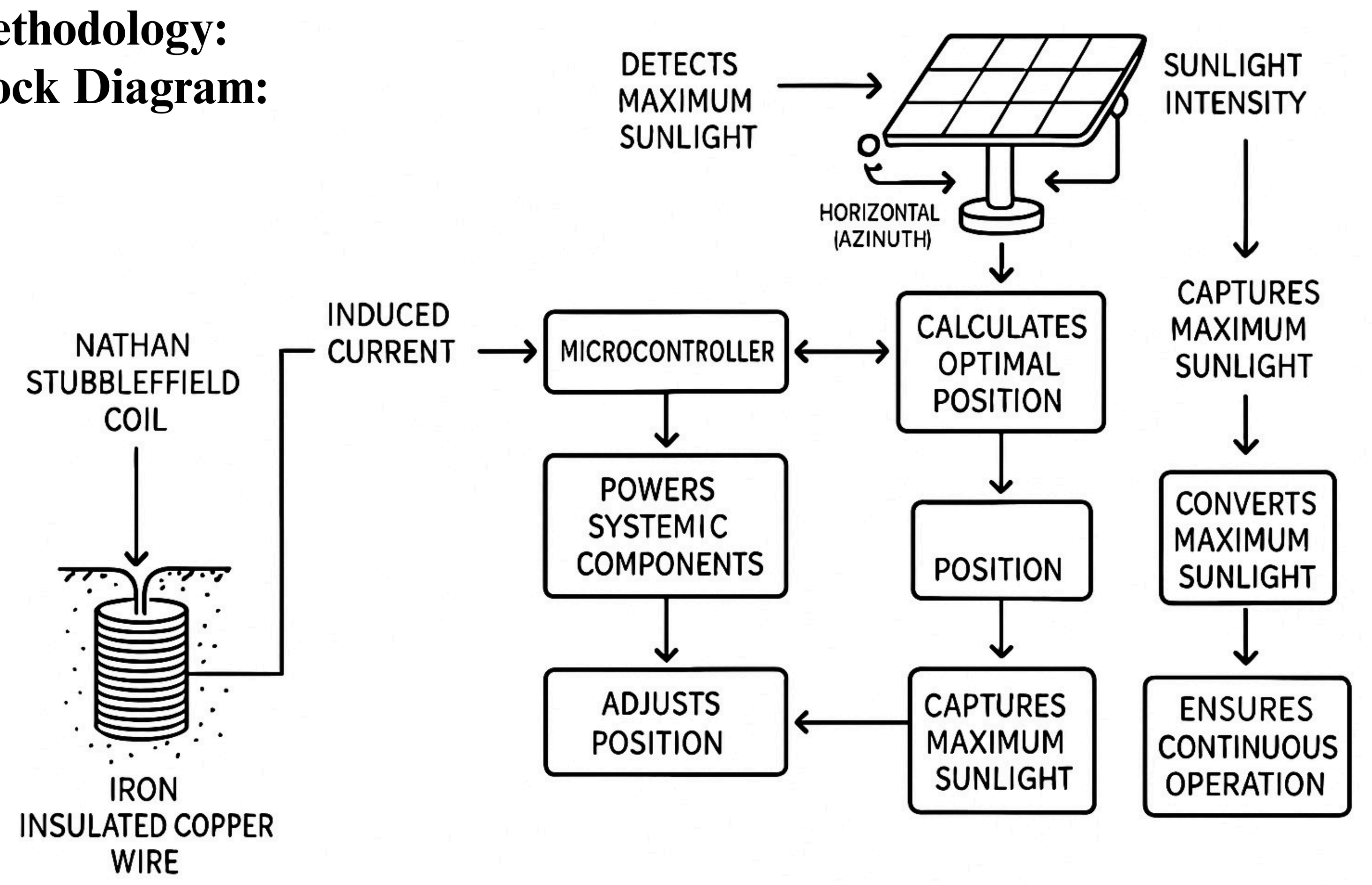
The system is a self-powered, dual-axis solar tracking solution designed to maximize solar energy harvesting without relying on external power sources or batteries. It utilizes a Nathan Stubblefield coil, which generates a continuous electric current through galvanic reactions in soil. This current powers a control unit based on an ATmega328 microcontroller, integrated with LDR sensors and MG995 servo motors. The system continuously adjusts the solar panel's orientation along both azimuth and altitude axes to maintain optimal alignment with the sun. An optional energy storage unit ensures uninterrupted operation during low-light conditions. By eliminating the need for grid power or chemical batteries, the system provides a cost-effective, environmentally friendly, and low-maintenance alternative to traditional trackers. It is well-suited for use in smart cities, agricultural fields, and off-grid locations, and contributes to global sustainability goals by increasing clean energy access, reducing carbon emissions, and supporting energy independence.

Objectives :

- Develop a self-sustaining solar tracker powered by a Nathan Stubblefield coil, removing the need for external power or chemical batteries.
- Implement dual-axis tracking using LDR sensors, an ATmega328 microcontroller, and servo motors for real-time solar alignment.
- Maximize energy efficiency through optimal panel orientation and optional energy storage for low-light operation.
- Advance sustainability goals by enabling eco-friendly, low-maintenance solutions for smart cities, agriculture, and off-grid areas.

Methodology:

Block Diagram:



- The **Nathan Stubblefield coil**, consisting of an iron core wrapped with insulated copper wire, is buried in the ground to generate electric current through galvanic reactions in the soil.
- This induced current is supplied to a microcontroller, enabling **self-sustained operation** without external power sources.
- The microcontroller powers all systemic components, including **sensors and servo motors**.
- **Light-dependent sensors** on the solar panel **detect sunlight intensity** and the direction of maximum sunlight.
- This data is fed into the microcontroller, which **calculates the optimal position** for the solar panel in both **horizontal (azimuth)** and **vertical (altitude)** directions.
- Based on these calculations, the microcontroller sends signals to **adjust the panel's position** using servo motors.
- The panel is moved to the newly calculated orientation to **capture the maximum amount of sunlight.**
- The captured sunlight is converted into electrical energy by the **photovoltaic cells** on the solar panel.
- This continuous adjustment ensures that the panel remains **optimally aligned**, thereby ensuring **continuous and efficient operation** of the system throughout the day.

Flow Chart:

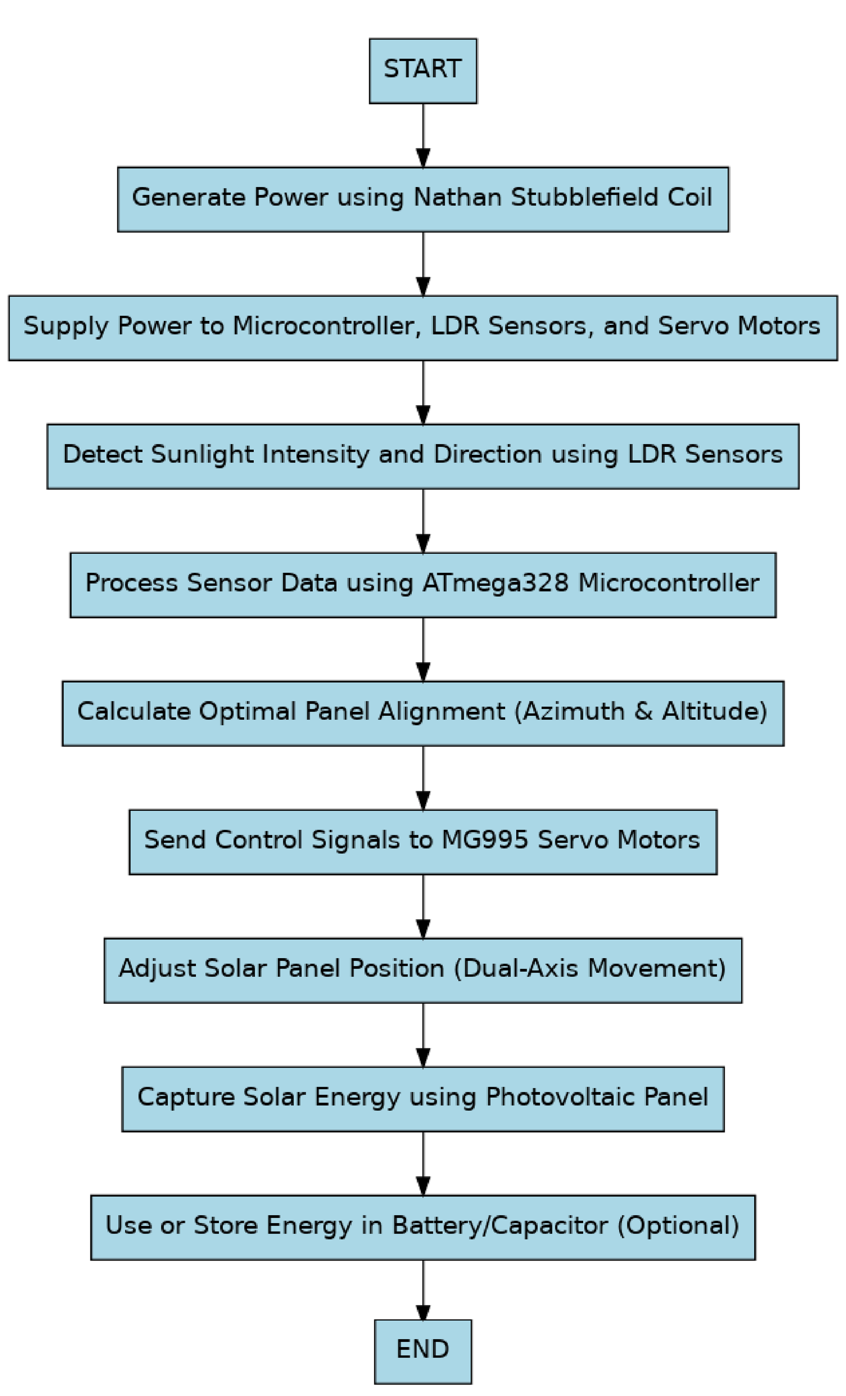
1. Power Generation:
A Nathan Stubblefield coil, buried in soil, generates a continuous electric current through galvanic reactions, powering the entire system autonomously.

2. Sunlight Detection:
LDR sensors (LM393-based) mounted on the solar panel detect the intensity and direction of sunlight in real time.

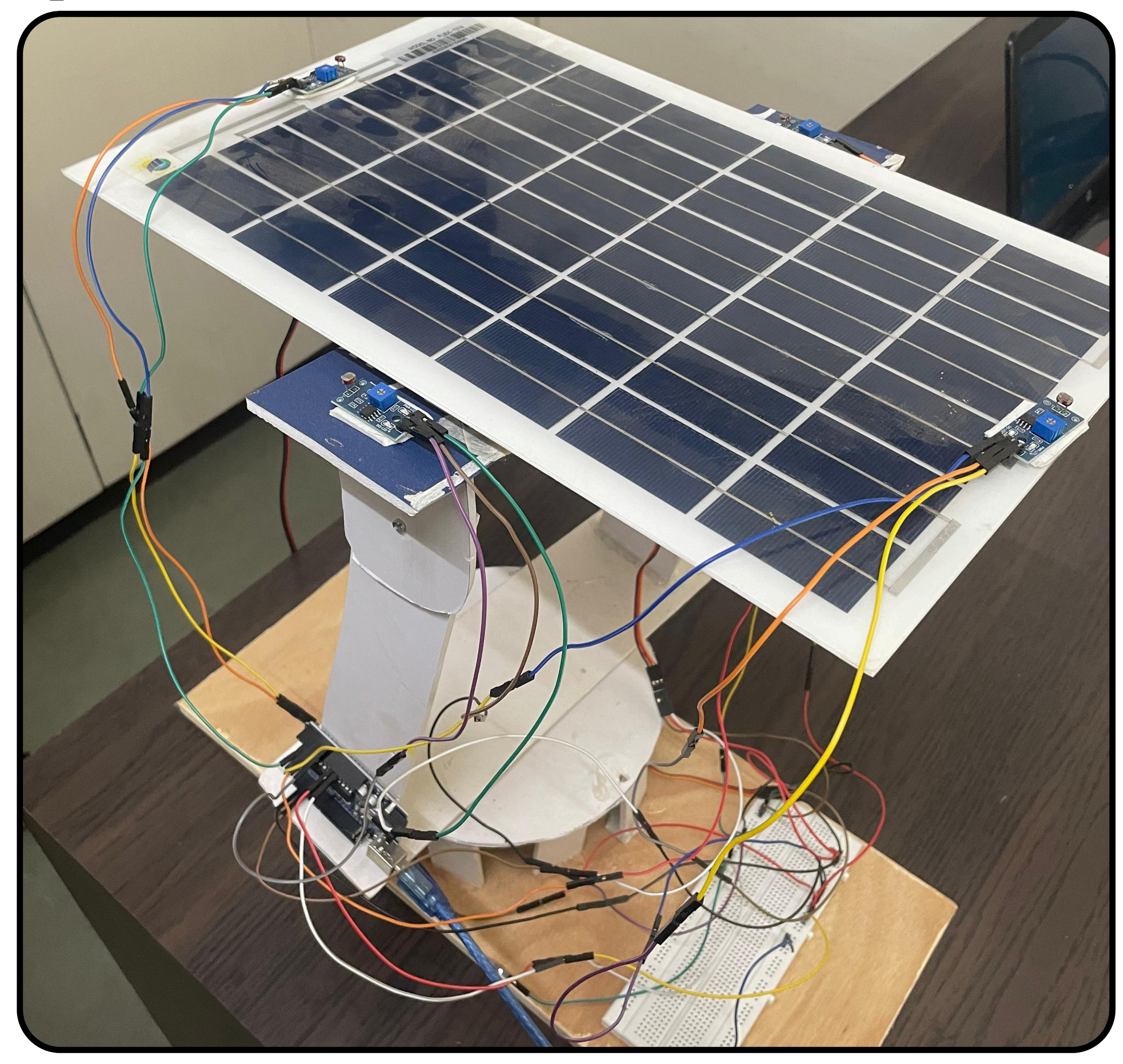
3. Control System:
An ATmega328 micro-controller processes sensor data to calculate the sun's position and determine the optimal alignment of the panel.

4. Panel Adjustment:
MG995 servo motors adjust the solar panel along both horizontal (azimuth) and vertical (altitude) axes to maintain perpendicular alignment with the sun.

5. Energy Harvesting and Storage:
The aligned solar panel converts sunlight into electrical energy, which is either used directly or stored in a battery/capacitor for uninterrupted operation during low-light conditions.



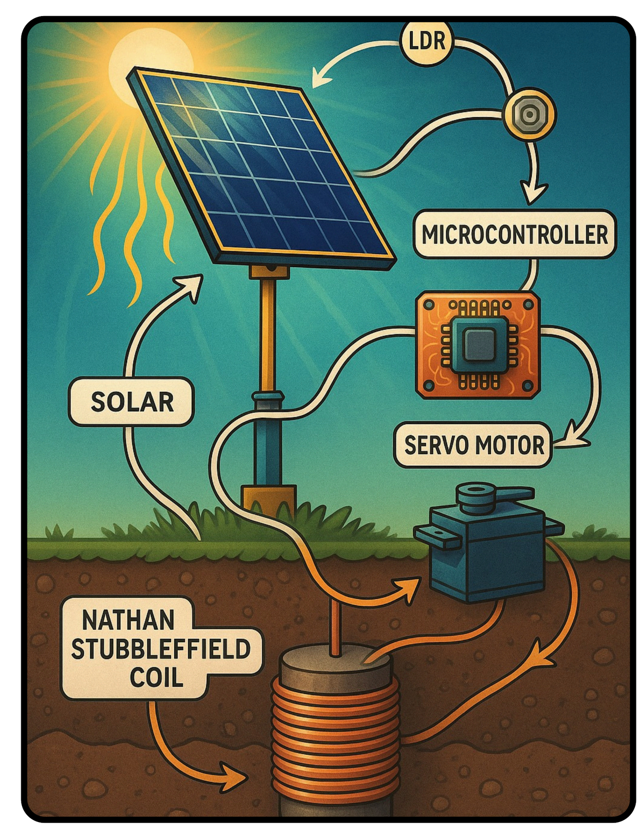
Hardware Implementation:



Innovation :

The most innovative aspect is the self-powered bidirectional tracking mechanism using the Nathan Stubblefield coil, eliminating the need for external power sources or batteries. This unique integration of energy harvesting, autonomous tracking, and efficient power management enhances solar efficiency, making it highly sustainable and ideal for smart city applications.

Its battery-free design also significantly reduces maintenance and environmental impact, offering a scalable solution for resilient, off-grid solar infrastructure.



Sustainable Development Goals:

SDG 7: Affordable and Clean Energy
Promotes decentralized, renewable, and autonomous solar power solutions-especially critical for off-grid and remote areas providing access to affordable, reliable, sustainable, and modern energy for all

7 AFFORDABLE AND CLEAN ENERGY

SDG 9: Industry, Innovation, and Infrastructure
Introduces a novel energy harvesting method using the Nathan Stubblefield coil, fostering innovation in sustainable technology.

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

SDG 11: Sustainable Cities and Communities
Enables smart, low-maintenance solar infrastructure for urban and rural applications like streetlights, EV stations, and off-grid setups.

11 SUSTAINABLE CITIES AND COMMUNITIES

SDG 13: Climate Action
Reduces carbon emissions by maximizing solar energy efficiency and eliminating dependence on fossil-fuel-based power systems.

13 CLIMATE ACTION

Applications:

Solar Farms
Enhances large-scale solar energy production through autonomous, dual-axis tracking without external power, reducing operational costs and increasing energy yield.

EV Charging Systems
Powers off-grid or semi-grid EV charging stations with precise sun-tracking, making them more efficient and sustainable for urban and rural deployment.

Agricultural Irrigation Systems
Provides a reliable, battery-free solar power source for automated irrigation in farms, especially in remote or drought-prone regions.