Sinhgad Institutes

SINHGAD TECHNICAL EDUCATION SOCIETY'S

SINHGAD INSTITUTE OF TECHNOLOGY

Kusgaon (Bk), Lonavala 410 401

DEPARTMENT OF ELECTRONICS AND TELECOMMUNICATION ENGINEERING

MINI PROJECT REPORT

T.E. E&TC (SEM – II)

AY 2023-24

Prepared By

Dr. P.R.Dike

TEACHING SCHEME

Practical: 2 Hrs. /Week

EXAMINATION SCHEME

Term Work : 25 Marks
Oral : 50 Marks

SAVITRIBAI PHULE
PUNE UNIVERSITY

A MINIPROJECT REPORT ON

"SUN TRACKING SYSTEM USING ARDUINO"

SUBMITIED TO THE SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE IN THE PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE

OF

BACHELOR OF ENGINEERING
(ELECTRONICS AND TELECOMMUNICATION)

BY

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UNDER THE GUIDANCE OF
PROF. P. R. DIKE

Vision and Mission of Institute

VISION

उत्तमपुरुषान् उत्तमाभियंतृन् निर्मातुं कटीबध्दाः वयम्।

We are committed to produce not only good engineers but good human beings, also.

MISSION

Holistic development of students and teachers. We strive to achieve this by imbibing a unique value system, transparent work culture, excellent academic and physical environment conducive to learning, creativity and technology transfer.

Quality Policy

Quality Policy is aimed at achieving excellence in Technical Education with recognition at National & International level. Managements is committed to:

- Provide excellent Infrastructure facilities.
- Employ highly qualified & experienced faculty
- Encourage the faculty for qualifications improvement
- Promote the Industry- Institute Interaction
- Create environment for R & D activities, consultation work and getting Industry- sponsored projects for students
- A special internal Quality Assessment Program has been implemented which monitors all the parameters needed for achieving the goals
- Implementation of the Quality Policy will result in all round development of students relevant to the needs of Industries & will make them competent to face the challenges due to Globalization

Vision and Mission of the Department

VISION

The department of Electronics & Telecommunication is committed to grow on a path of delivering distinctive high quality education, fostering research, creativity and innovation.

MISSION

- The department of Electronics & Telecommunication in partnership with all stake holders will harness Talent, Potential for application based indigenous product development in future.

- ur Endeavour is to provide conductive environment for life skill development of students while exercising effective Learning Strategies

Short Term Goals

- To improve the results of UG classes
- To implement activity plan for overall development of students.
- To establish professional bodies/students forum for life skill development and expose students and faculty to latest business environment.
- To initiate relevant value addition programs and certifications for improving employability.
- To develop Laboratories for meaningful implementation of curriculum and then for Research.
- To encourage continuous up gradation of faculty members through higher education and external interface with other universities.

Long Term Goals

- To practice Project Based Learning (PBL) approach for UG program by creating collaborations with national and International institutions of reputation.
- To create opportunities for students to expose to industry environment through value addition programs and Industry projects for practical training.
- To foster research in the field of Electronics and Telecommunication Engineering for the benefit of society.
- IEEE International conference in the area of Wireless communication.

Program Educational Objectives (PEOs)

PEO1 To develop students to achieve high level of technical expertise with Strong theoretical background and sound practical knowledge

PEO2 To inculcate research environment for enhancement of Academia – Industry collaboration through conference

PEO3 To prepare graduates to be sensitive to ethical, societal and Environmental issues while engaging their professional duties, Entrepreneurship and leadership.

PEO4 To enhance ability of students for providing Engineering solution in a global and societal context

PEO5 Pursue higher education for professional development.

Program Specific Outcomes (PSOs)

PSO1 Get solid foundation in design and development of electronics modules useful to society.

PSO2 Able to handle skills based challenges

List of Program Outcomes (POs)		
PO1	**Engineering Knowledge**	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem Analysis**	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/Development of Solutions**	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct Investigations of Complex Problems:**	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern Tool Usage:**	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The Engineer and Society:**	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
PO7	**Environment and Sustainability:**	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:**	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and Team Work:**	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:**	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project Management and Finance:**	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-Long Learning:**	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

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CERTIFICATE

This is to certify that Mr. Prathmesh Rakesh Palkurtiwar of class TE E&TC Div B Roll No. B41 Examination Seat No./PRN No. T190423074 has completed all the practical work in the Miniproject [304200] satisfactorily, as prescribed by Savitribai Phule Pune University, Punein the academic year 2023 -2024 (Semester I /II)

Course In-charge	Head of Department	Principal
Dr. P.R.Dike	Dr. D.S.Mantri	Dr. M.S.Gaikwad

Date:

Mini Project Title: Soil Moisture Sensor using Arduino

CONTENTS

INTRODUCTION

Sun Tracking System Using Arduino :-

In the quest for sustainable energy solutions, solar power stands out as a promising avenue for renewable energy generation. However, to maximize its efficiency, it's crucial to optimize the capture of sunlight throughout the day. This is where sun tracking systems come into play.

Sun tracking systems ensure that solar panels or photovoltaic cells are aligned optimally with the sun's position, maximizing the absorption of sunlight and consequently enhancing energy output. Among the various methods employed for sun tracking, one popular and accessible approach is through Arduino-based systems.

Arduino, with its user-friendly interface and extensive community support, provides an ideal platform for developing sun tracking systems. By utilizing sensors, motors, and programming logic, an Arduino-based sun tracking system can dynamically adjust the orientation of solar panels to follow the sun's path across the sky.

ABSTRACT

Solar energy is an abundant and renewable resource that can be efficiently harnessed through sun tracking systems. This project presents the design and implementation of a sun tracking system using Arduino microcontrollers. The aim is to enhance the efficiency of solar panels by continuously orienting them towards the sun's position throughout the day.

The sun tracking system utilizes light sensors and servo motors controlled by Arduino to detect the sun's position and adjust the angle of the solar panels accordingly. The methodology involves programming the Arduino to read sensor inputs, calculate the sun's position based on these readings, and drive the servo motors to align the solar panels with the optimal angle for maximum sunlight exposure.

Key features of the sun tracking system include real-time sun position tracking, automatic adjustment of solar panel angles, and efficient utilization of solar energy throughout the day. The project's findings demonstrate improved solar energy generation compared to fixed solar panel installations, validating the effectiveness of the Arduino-based sun tracking mechanism.

In conclusion, the sun tracking system using Arduino offers a practical and cost-effective solution for enhancing solar energy generation efficiency. Future enhancements may involve integrating additional sensors or wireless communication for remote monitoring and control.

SPECIFICATONS

system integrates sensors, motors, and an Arduino microcontroller to achieve this functionality.

Firstly, light sensors such as LDRs (Light Dependent Resistors) or photodiodes are employed to detect the intensity of light. These sensors are crucial as they provide the necessary input to determine the sun's direction relative to the system's position. By measuring the intensity of light from different directions, the Arduino can calculate the sun's position.

Secondly, the Arduino processes this sensor data using appropriate algorithms to determine the optimal orientation of the solar panel towards the sun. These algorithms may involve trigonometric calculations to convert light intensity readings into angular positions relative to the sun.

Thirdly, actuators such as servo motors or stepper motors are used to physically adjust the position of the solar panel based on the calculated sun position. The Arduino sends control signals to these motors to ensure that the solar panel maintains an optimal angle with respect to the sun's movement across the sky.

Additionally, the system may include a real-time clock (RTC) module to keep track of time accurately, enabling precise adjustments throughout the day. This ensures that the solar panel remains aligned with the sun's position as it moves across the sky.

Moreover, the system requires calibration and testing to optimize its accuracy and efficiency. This involves fine-tuning the sensor readings, refining the control algorithms, and ensuring that the mechanical components operate smoothly and reliably.

In summary, a sun tracking system using Arduino is a sophisticated integration of sensors, microcontrollers, and actuators designed to automatically orient solar panels towards the sun, maximizing the efficiency of solar energy collection throughout the day.

WORKING

Working:

Designing a sun tracking system using Arduino involves integrating sensors, actuators, and control logic to ensure solar panels or devices are always facing the sun for maximum energy capture. The process typically begins with selecting appropriate components such as light sensors (LDRs or photodiodes), servo motors, and an Arduino board capable of handling the system's requirements.

Firstly, the light sensors are positioned to detect the direction of maximum sunlight. These sensors provide analog readings proportional to the intensity of light falling on them. By comparing readings from multiple sensors, the Arduino can determine the sun's position relative to the system.

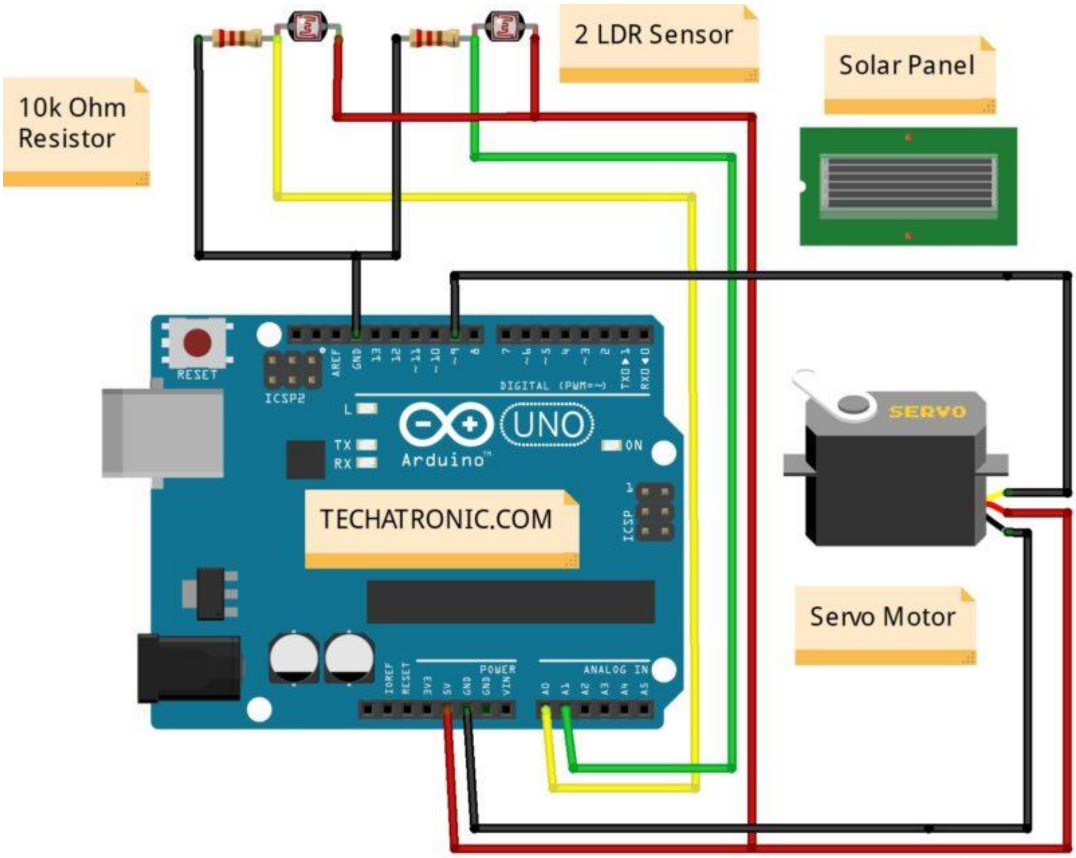
Next, based on these sensor inputs, the Arduino calculates the required orientation adjustment for the solar panels. This involves computing the difference between the current orientation and the optimal orientation towards the sun. The Arduino then sends control signals to servo motors, which mechanically adjust the position of the solar panels to align them with the sun's direction.

To implement this, the Arduino code will include algorithms to process sensor data, compute necessary movements, and generate servo control signals. The code must also account for factors such as time of day, seasonal changes in the sun's path, and potential obstacles that may block sunlight.

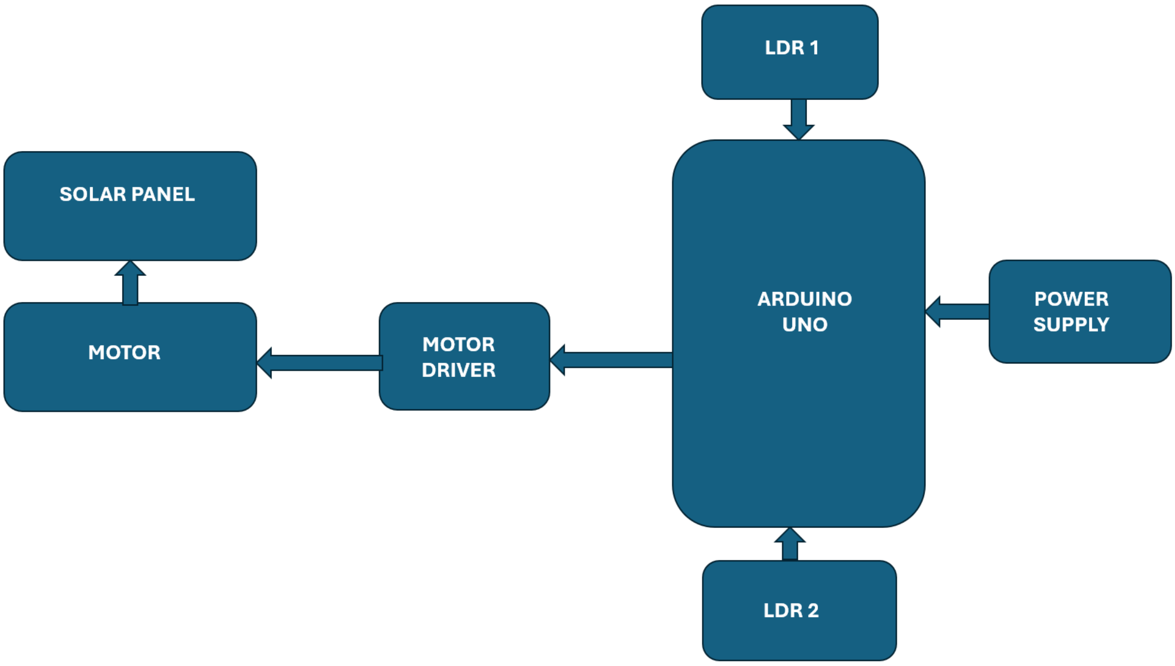
Additionally, considerations like power consumption, mechanical stability, and calibration accuracy are crucial for a reliable sun tracking system. Testing and calibration play vital roles in ensuring the system performs efficiently under different weather conditions and geographical locations.

Overall, developing a sun tracking system using Arduino requires a combination of electronics, programming, and engineering principles to create a robust and effective solution for maximizing solar energy utilization. This project provides an excellent opportunity to explore renewable energy technologies and practical applications of microcontroller-based automation.

CIRCUIT DIAGRAM



BLOCK DIAGRAM



- ❖ The project focuses on the following advancements:

The sun tracking system project using Arduino can incorporate several advancements to enhance its functionality and efficiency:

Improved Sensor Technology: Utilizing advanced light sensors such as precision photodiodes or digital light sensors (e.g., TSL2591) to achieve more accurate and responsive sun tracking. These sensors offer better resolution and sensitivity, enabling the system to detect subtle changes in sunlight intensity and direction.

Algorithm Optimization: Implementing optimized algorithms for sun tracking calculations. This includes sophisticated mathematical models to predict the sun's position based on geographic coordinates, date, and time. Algorithms can be refined to account for atmospheric conditions and seasonal variations, ensuring precise solar panel alignment throughout the year.

Wireless Communication: Integrating wireless communication modules (like Bluetooth or Wi-Fi) with the Arduino to enable remote monitoring and control of the sun tracking system. This allows real-time data visualization and adjustment of system parameters via a smartphone app or web interface.

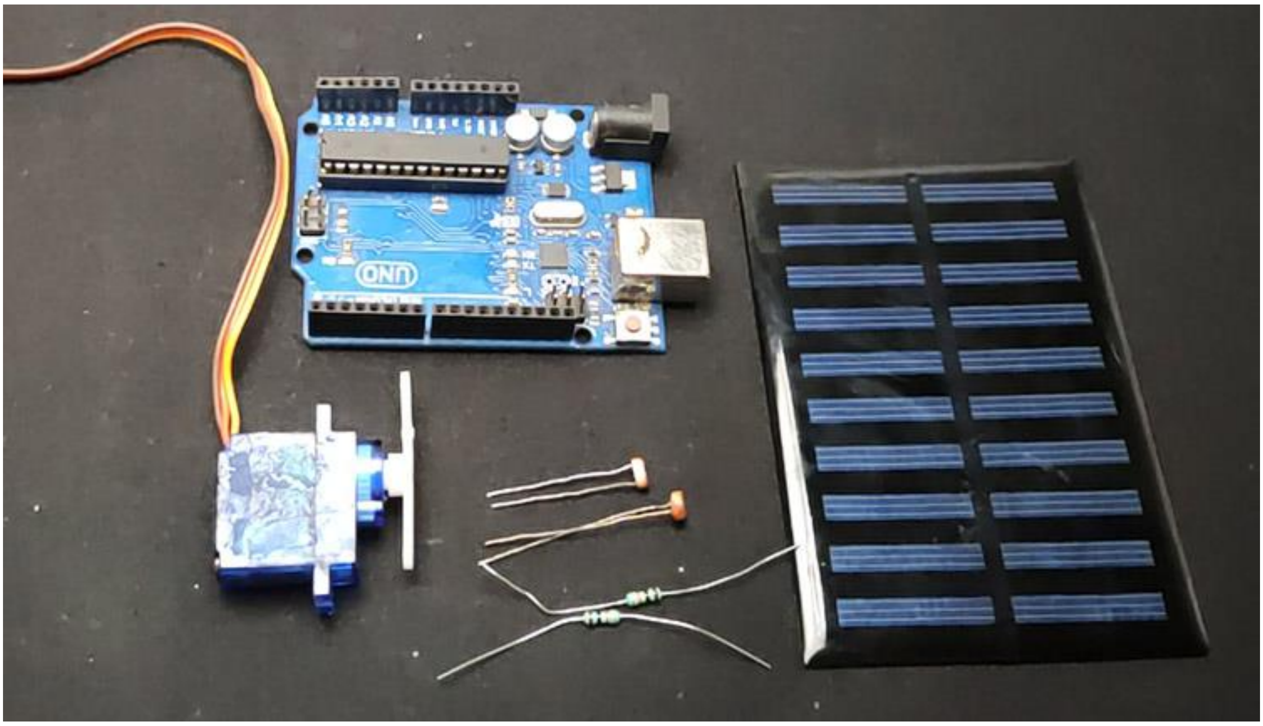
Energy Efficiency and Power Management: Incorporating energy-efficient components and power management techniques to minimize power consumption. For instance, using low-power sensors, optimizing servo motor movements, and implementing sleep modes to conserve energy when the system is idle.

Automated Calibration and Self-Adjustment: Developing automated calibration routines that periodically recalibrate sensor readings and servo motor movements based on environmental feedback. This ensures continuous system accuracy and reduces the need for manual intervention.

Integration of Additional Environmental Sensors: Adding environmental sensors (e.g., temperature, humidity) to the system for comprehensive environmental monitoring. This data can be used to optimize solar panel performance and detect adverse conditions that may affect system operation.

Data Logging and Analysis: Implementing data logging capabilities to record sun tracking performance metrics over time. Collected data can be analyzed to assess system efficiency, identify trends, and facilitate continuous improvement of the sun tracking algorithm.

Modular and Expandable Design: Designing the system with a modular architecture that allows for easy scalability and integration of additional features. This enables future enhancements such as multi-axis sun tracking or integration with other renewable energy systems.



Components Required:

1. LDR sensor
2. Arduino Uno
3. Solar Panel
4. 10k Ohm resistor
5. Jumper wires

Setup:

1. Understanding Sun Tracking Principles:
2. Research and understand the basics of sun tracking. The sun's position changes throughout the day, which can be tracked based on geographical location and time.
3. Circuit Setup:
4. Connect the LDRs to analog input pins on the Arduino to measure light intensity.
5. Connect the servo motors to the digital output pins of the Arduino. You may need to use a motor driver if your motors require more current than the Arduino can supply.
6. Calibration:
7. Calibrate your LDRs to accurately measure the intensity of light.
8. Write a program to read the values from the LDRs and convert them into meaningful data (e.g., position relative to the sun).
9. Calculating Sun Position:
10. Implement an algorithm to calculate the sun's position based on time and location (latitude and longitude). This could involve using existing libraries or formulas for solar position calculation.
11. Control Algorithm:
12. Develop an algorithm that takes input from the LDRs and calculates the necessary servo motor positions to orient the solar panel towards the sun.
13. Programming Arduino:
14. Write the Arduino sketch (program) that reads the LDR values, calculates the sun's position, and controls the servo motors accordingly.
15. Ensure that the Arduino sketch includes the necessary libraries and functions for servo control and sun position calculations.
16. Testing and Calibration:
17. Test your system under different lighting conditions (e.g., throughout the day).
18. Calibrate the system to ensure accurate tracking of the sun's position.

SIMULATION RESULT

Arduino code for Sun tracking system using

Arduino :

```
#include <Servo.h>

// Define LDR pins
int ldr1Pin = A0; // Analog pin for LDR 1
int ldr2Pin = A1; // Analog pin for LDR 2

// Define servo motor
Servo servoMotor;

void setup() {
  // Attach servo motor to pin 9
  servoMotor.attach(9);

  // Initialize serial communication
  Serial.begin(9600);
}

void loop() {
  // Read LDR values
  int ldr1Value = analogRead(ldr1Pin);
  int ldr2Value = analogRead(ldr2Pin);

  // Print LDR values (for debugging)
  Serial.print("LDR 1 Value: ");
  Serial.print(ldr1Value);
  Serial.print(", LDR 2 Value: ");
  Serial.println(ldr2Value);

  // Calculate difference between LDR values
  int diff = ldr1Value - ldr2Value;
```

```
// Adjust servo motor based on difference
if (diff > 10) {
  // Turn servo clockwise if LDR 1 > LDR 2
  servoMotor.write(90); // Adjust angle as needed
} else if (diff < -10) {

  // Turn servo counterclockwise if LDR 1 < LDR 2
  servoMotor.write(0); // Adjust angle as needed
}

// Delay for smooth operation
delay(1000); // Adjust delay time based
```

CONCLUSION

In conclusion, implementing a sun tracking system using Arduino offers a promising solution for maximizing solar energy harvesting efficiency in various applications. Arduino's affordability, flexibility, and ease of use make it an ideal platform for developing custom sun tracking algorithms and integrating with sensors and actuators. By leveraging Arduino Uno's capabilities, individuals and organizations can design and deploy sun tracking systems tailored to specific needs and environmental conditions.

The scalability of Arduino-based sun tracking systems allows for adaptation to different sizes of solar panels or arrays, making them suitable for both small-scale experiments and larger installations. Additionally, Arduino's low power consumption and integration capabilities enable efficient operation using solar energy, further enhancing sustainability and cost-effectiveness.

Moreover, Arduino's extensive online community provides valuable resources, support, and collaboration opportunities for individuals undertaking sun tracking projects. This community-driven ecosystem fosters knowledge sharing, innovation, and continuous improvement in sun tracking technologies.

Overall, sun tracking systems using Arduino offer a compelling combination of affordability, versatility, and educational value, contributing to the advancement of renewable energy technologies and environmental sustainability. As the demand for efficient solar energy solutions continues to grow, Arduino-based sun tracking systems present a promising avenue for harnessing the power of the sun more effectively.

FUTURE SCOPE

The future scope of a sun tracking system using Arduino is promising, with potential applications in various fields including renewable energy, agriculture, and smart infrastructure. Here are some aspects of its future scope:

4.1 Enhanced Solar Energy Harvesting:

Solar tracking systems improve the efficiency of solar panels by orienting them towards the sun throughout the day. This optimization leads to increased energy generation, making solar power more cost-effective and viable for residential and commercial installations.

Future advancements may involve integrating sun tracking systems with energy storage solutions like batteries to enhance the reliability and usability of solar energy.

4.2 Smart Agriculture:

Sun tracking systems can be utilized in agriculture for optimizing crop growth and yield. By adjusting the angle and intensity of sunlight, these systems can create ideal conditions for specific crops, particularly in regions with varying sunlight patterns.

Integrating sun tracking with irrigation systems and greenhouse controls can further enhance agricultural productivity and resource efficiency.

4.3 Remote Sensing and Monitoring:

Sun tracking systems equipped with sensors can provide valuable data on solar radiation patterns and atmospheric conditions. This data can be used for weather forecasting, climate research, and environmental monitoring.

Integration with IoT (Internet of Things) platforms can enable real-time monitoring and control of sun tracking systems, allowing for remote adjustments and performance optimization.

4.4 Smart Infrastructure and Urban Planning:

In urban environments, sun tracking systems can be integrated into smart building designs to optimize natural lighting and reduce energy consumption for lighting and HVAC (Heating, Ventilation, and Air Conditioning) systems.

Future applications may include incorporating sun tracking into smart city infrastructure for optimizing the efficiency of street lighting and public transportation systems.

4.5 Research and Innovation:

Ongoing research in solar tracking technologies aims to develop more efficient and cost-effective systems using advanced materials, sensors, and control algorithms.

Integration of artificial intelligence (AI) and machine learning techniques can further optimize sun tracking systems by analyzing historical data and predicting optimal sun positions.

4.6 Educational and DIY Projects:

Sun tracking projects using Arduino provide valuable hands-on learning experiences in STEM (Science, Technology, Engineering, and Mathematics) education. They encourage innovation and creativity among students and DIY enthusiasts.

Continued development of open-source sun tracking designs and educational resources will facilitate broader adoption and experimentation with these systems.

APPLICATIONS

Developing an application for a sun tracking system using Arduino typically involves designing a setup that utilizes sensors to detect the position of the sun and actuators to adjust the orientation of solar panels or mirrors accordingly. This system is particularly useful for optimizing the efficiency of solar energy harvesting throughout the day.

Firstly, the system would require light sensors, such as photodiodes or LDRs (Light Dependent Resistors), to measure the intensity of sunlight. By placing these sensors in strategic positions, the system can determine the direction from which sunlight is coming. Arduino boards can then process this sensor data to calculate the current position of the sun relative to the setup.

Next, actuators like servo motors or stepper motors are employed to adjust the orientation of solar panels or mirrors based on the calculated sun position. The Arduino board controls these actuators through appropriate motor driver circuits, ensuring precise movement to continuously face the panels or mirrors towards the sun.

To implement this, a basic schematic can include connecting the light sensors to analog input pins of the Arduino, while the actuators (motors) are connected to digital output pins using motor drivers to handle the power requirements. The Arduino code would read sensor values, compute the sun's position, and then control the motors to align the solar device with the sun's current position.

It's essential to consider calibration and accuracy during setup, as factors like sensor calibration and mechanical precision will influence the overall effectiveness of the sun tracking system. Additionally, weatherproofing components may be required for outdoor installations to ensure reliable operation under varying weather conditions

ADVANTAGES & DISADVANTAGES

A sun tracking system using Arduino offers several advantages and disadvantages:

Advantages:

Increased Efficiency: By tracking the sun's position throughout the day, solar panels can be aligned optimally for maximum exposure to sunlight. This boosts energy generation efficiency.
Cost-Effective: Arduino-based systems are relatively inexpensive and can be assembled using readily available components. This makes sun tracking technology more accessible to individuals and small-scale projects.
Customizability: Arduino platforms allow for flexible programming and customization. Users can adjust the tracking algorithm to suit specific geographical locations or energy needs.
Enhanced Performance: Compared to fixed solar panels, sun tracking systems can significantly improve energy output, especially during mornings and evenings when the angle of sunlight changes rapidly.

Disadvantages:

Complexity: Sun tracking systems are more complex than fixed solar installations. They require additional components such as sensors, motors, and a controller, increasing the system's overall complexity.
Maintenance: Moving parts in a sun tracking system can lead to higher maintenance requirements. Regular checks and possible repairs might be necessary to ensure smooth operation.
Power Consumption: The tracking system itself consumes some power to operate, which can offset a portion of the energy gains from improved sunlight capture.
Weather Dependency: Sun tracking systems may be affected by adverse weather conditions like clouds or heavy rain, impacting their performance.

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Participation in project competition

Sr. No.	Name & Place of project competition / Exhibition	Date	Certificate / Prizes won (if any)
1.			
2.			
3.			
4.			

[Attach Xerox copy of certificates]

Paper publication/ Presentation

Sr. No.	Name of the organizing society	Date	Certificate / Prizes won (if any)
1.			
2.			