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Mobile Charging using Solar Tracking System

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ABSTRACT

The use of solar energy has gained significant attention due to its ability to provide a sustainable and clean source of power. Solar tracker is a device which is used to collect the solar energy emitted by the sun. Solar tracking system is a device that follows the sun's movement throughout the day to ensure maximum exposure to sunlight.

The system comprises a solar panel, servo motor and rechargeable batteries. The solar panel is used to convert the sun's energy into electrical energy, which is then stored in the rechargeable batteries. This was achieved using an Arduino UNO that controls the position of the solar panel based on the sunlight intensity. The Arduino UNO receives information on the sun's position using two Light dependent Resistors (LDRs), and then adjusts the solar panel accordingly.

The energy stored in the rechargeable batteries is used to charge a mobile. To achieve this, 5V Boost Converter is used. The use of a solar tracking system for mobile charging is a viable option for providing a sustainable and clean source of power. It is an efficient way to charge mobile devices using solar energy, especially in areas where access to electricity is limited.

Key words: Mobile Charging, Solar energy, Sun tracking, Sustainability

1. INTRODUCTION

In recent years, the widespread adoption of mobile devices has revolutionized our lives, enabling constant communication, access to information, and various applications. However, the increasing demand for mobile devices also raises concerns about their power consumption and the environmental impact of traditional charging methods. To address these challenges, alternative and sustainable charging solutions have gained significant attention. One such solution is the utilization of solar energy for mobile charging, coupled with a solar tracking system [1].

Solar energy is an abundant and renewable resource that offers a clean and sustainable alternative to conventional power sources. Solar panels capture sunlight and convert it into electrical energy, making them an ideal choice for charging mobile devices. However, to maximize the efficiency of solar energy conversion, it is crucial to optimize the alignment of the solar panel with the sun's position throughout the day. This is where a solar tracking system plays a vital role.

The objective of this project and paper is to provide a sustainable solution to one of the problems affecting the environment. The paper describes the design, methodology, and performance evaluation of such solar tracking system using LDRs, Arduino, and rechargeable batteries, highlighting its potential as a sustainable solution for mobile charging.

2. LITERATURE SURVEY

Mobiles and other smart devices are always on, draining their batteries. Charging your mobile phone requires a certain amount of time and the right place. Abruptly turning off a mobile phone due to low battery is a major curfew for people rushing to work, markets, schools, universities, offices, train stations, bus stops, etc. It would be great if these people could charge and use their smart devices anytime, anywhere by using renewable energy [2]. So far, some research has been done to solve this problem of providing mobile charging for smart devices. Some of these developments are portable, while others are stable and large charging stations. However, a common feature of these systems is that their power generation is based, in whole or in part, on one or more renewable energy sources such as solar, wind, or hand-cranked generators driven by physical movement. That's it. Most of these are intended for public use, but some are intended for commercial purposes. This article reviews the types/variations of renewable energy sources and system characteristics used to develop portable or stationary mobile charging stations.

Nowadays, smartphones are indispensable in our lives. It is very important that your portable device is always fully charged. Finding a charging socket is not always easy.

Therefore, the use of renewable energy sources such as solar energy can be very helpful in finding hassle-free solutions to the problems faced by consumers due to the shortage of traditional chargers.

This proposed method uses an unconventional energy source to charge the device. The main principle of this project is to convert solar energy into electrical energy. This particular model uses solar energy to generate the voltage needed to charge your phone's battery [3]. A 12V 10W solar panel is used, and the output changes according to the intensity of the incident light. This power is controlled by a control unit and stored in a battery. This battery produces a 12V output voltage that can be used directly to charge the load. By regulating the battery voltage using a voltage regulator, a fixed 9V output is obtained and used to charge the 9V load. This completely eliminates the need to use electricity to solve consumer problems.

Several programs are underway to realize mobile chargers using solar energy. However, the devices we propose should work more efficiently and cost-effectively, allowing us to charge our devices anytime, anywhere. The proposed device is user-friendly, environmentally friendly and inexpensive.

This paper describes a coin-based cell phone charger using a solar tracking system. Mobile phones have become an important source of information for business and personal communications. The need to provide public charging services is essential. Many critics argue that public cell phone charging services are not a lucrative business [4].

Most users can charge their phones at home, in the office, or in the car. Potential customers for mobile phone coin charging services are students and many people who use public transportation, who tend to have low battery power. Suggested locations include hotels, conference centres, leisure centres, shopping malls, internet cafes, universities, airports, train stations, etc [5]. This allows a mobile phone user to reactivate if the battery is low or depleted by simply plugging it in and he charges 1 rupee. It is based on the ATMEL 89S52, a 40-pin microcontroller that counts down the time to 1 minute, and the LCD display shows the actual remaining time. During time measurement, the relay output is cut off and the end of time measurement is executed.

3. EXISTING SYSTEM

Wired chargers are the most common charging methods. They use a cable with a USB to connect the phone to a power source. The cable transfers power from the source to the phone's battery charging it.

4. PROPOSED SYSTEM

Our model is a prototype of the solar tracking system used for mobile charging. The project has a solar panel, servo motor, Arduino UNO, Light Dependent resistors for tracking the sun, rechargeable batteries, and a 5V boost converter. The 2 LDRs on either side of the solar panel help in detecting the intensity of light and the servo motor is used to tilt the solar panel. The power is stored in rechargeable batteries and using the 5V boost converter mobile charging is done [6].

5. HARDWARE COMPONENTS

1. Solar panel (12V 5W)

A 12V solar panel as shown in figure 1 is designed to generate electrical power when exposed to sunlight. The panel typically consists of multiple solar cells connected in series to produce a specific voltage output. When sunlight falls on the solar cells, they generate a direct current (DC) voltage. The actual power generated by a solar panel depends on various factors such as the intensity of sunlight, the angle and orientation of the panel, temperature, shading, and the efficiency of the solar cells. Solar panels are typically rated in terms of their peak power output, which is measured in watts (W).

Figure 1: Solar Panel

2. Rechargeable batteries – 3 (3.7V each)

A rechargeable battery with a voltage rating of 3.7V typically refers to a lithium-ion (Li-ion) battery is shown in figure 2. Li-ion batteries are widely used in various portable electronic devices due to their high energy density, lightweight design, and ability to be recharged multiple times.

Figure 2: Rechargeable Battery

3. 5V boost converter

A 5V boost converter is an electronic circuit or device used to increase a lower input voltage to a higher output voltage, specifically to generate a stable 5V output voltage. The boost converter shown in figure 3 works on the principle of energy storage and transfer. It typically consists of an inductor, a switch (usually a MOSFET), a diode, a capacitor, and a control circuit. It is commonly used in various applications where a higher voltage is required from a lower voltage source, such as in portable electronics, battery-powered devices, and embedded systems.

Figure 3: Boost Converter

4. Arduino UNO

The Arduino UNO shown in figure 4 is a popular microcontroller board that serves as a versatile tool for electronic prototyping. Powered by the ATmega328P microcontroller, it offers 14 digital I/O pins, 6 Analog input pins, and can be easily programmed using the Arduino IDE. With USB connectivity, it allows for seamless code uploading and data transfer. The board can be powered via USB or an external power supply, and its compatibility with expansion boards called "shields" enables the integration of additional functionalities.

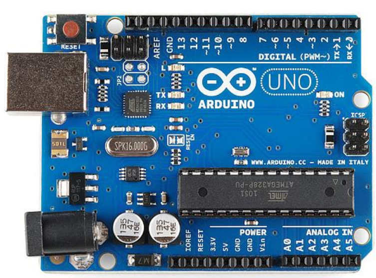

Figure 4: Arduino UNO

5. Servo motor

The MG995 servo motor is a high-torque servo commonly used in robotics is shown in figure 5. It offers a torque output of around 10 kg/cm or higher, with a speed of approximately 0.17 seconds per 60 degrees rotation. Operating within a voltage range of 4.8V to 7.2V, it utilizes a standard PWM control signal for position control. With its three-wire connector (power, ground, and control signal), the MG995 servo motor is suitable for applications like solar panels in sun tracking systems, and pan-tilt mechanisms, where precise and powerful motion control is required.

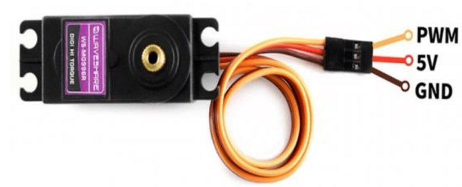

Figure 5: Servo Motor

6. LDR Module

The Light Dependent Resistor (LDR) Sensor Module of 3 Pin (VCC, GND, D0) shown in figure 6 is used to detect the presence of light and measuring the intensity of light. The output of the module goes high in the presence of light and it becomes low in the absence of light. The sensitivity of the signal detection can be adjusted using potentiometer.

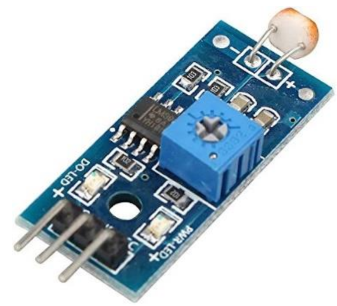

Figure 6: LDR Module

7. 7805 Voltage Regulator

The 7805 voltage regulator shown in figure 7 is an integrated circuit commonly used to provide a stable +5V DC output voltage from an unregulated input voltage source. It has a typical input voltage range of 7V to 35V and can supply up to 1A of current. The IC is equipped with thermal protection and comes in a TO-220 package for easy mounting. It is widely used in electronic circuits to power microcontrollers, digital logic circuits, and other low-power devices, ensuring a reliable and constant voltage supply.

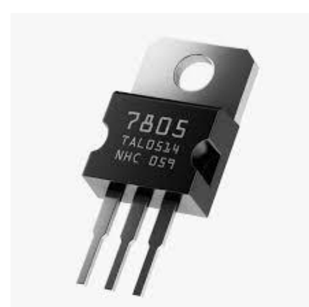

Figure 7: Volatge Regulator

6. SOFTWARE DESCRIPTION

Arduino IDE is a software development platform and the symbol is shown in figure 8, that allows you to program and control Arduino microcontrollers. In the context of tracking the sun using an LDR (Light Dependent Resistor), a solar panel, and a servo motor, Arduino IDE can be used to write the necessary code for the Arduino board. The LDR senses the intensity of light, the Arduino processes this information, and based on the readings, it commands the servo motor to position the solar panel in the direction of the sun, maximizing its exposure and energy generation.

Figure 8: Arduino IDE

7. BLOCK DIAGRAM

Here is the block diagram shown in figure 9,

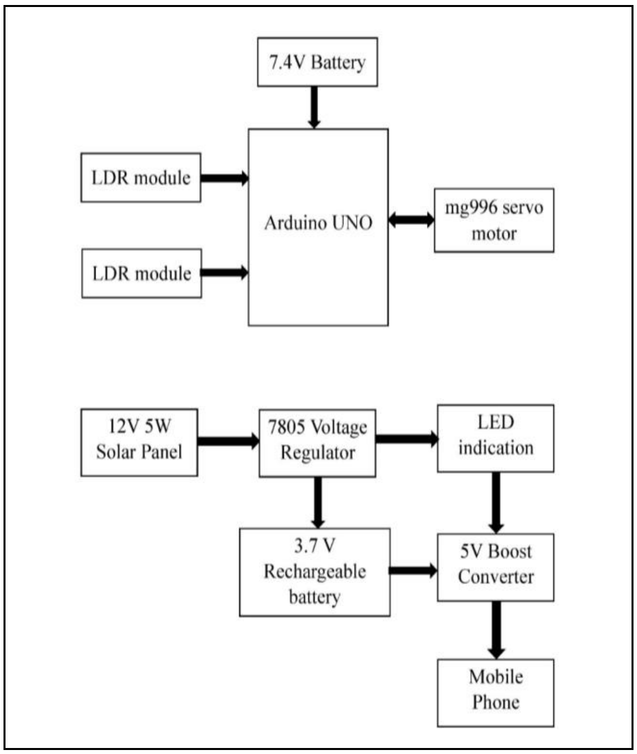

Figure 9: Block diagram of the proposed system

Arduino Connections

1. Connect the Arduino UNO board to the batteries using the barrel jack pin for the power supply.
2. Connect the 3 pins of MG995 servo motor to the Vin, GND, digital input pin (3) of the Arduino uno.
3. Connect input pins of LDR module to analog input pins (A0, A1) of the Arduino Uno. Connect VCC and GND pins of LDR module to ICSP headers.

Solar Panel Connections

1. Connect the positive and negative terminals of the solar panel to the Vin pin, GND of the 5V USB boost converter.
2. Connect the output of the 5V USB boost converter to the positive terminal of the rechargeable battery and negative terminal to common ground.
3. Connect the 5V USB output of the boost converter to the appropriate USB port or charging cable that connects to the mobile phone.

8. METHODOLOGY

System Setup

Connect the solar panel to the solar tracking system, which consists of Arduino Uno, two LDRs, rechargeable batteries, a servo motor, and a 5V USB boost converter. Position the solar panel in an optimal location to receive maximum sunlight throughout the day.

Light Intensity Sensing

Mount the two LDRs (Light Dependent Resistors) at opposite locations on the solar panel as shown in figure 10. Connect the LDRs to analog input pins (A0, A1) on the Arduino Uno. Measure the light intensity using the LDRs and obtain the sensor readings.

Figure 10: System sensing the light

Solar Tracking

A program is written in the Arduino IDE software to analyse the sensor readings from the LDRs. The power is supplied to the Arduino through the batteries. Use the sensor readings to determine the direction in which the solar panel should move for optimal sunlight exposure. Control the servo motor using the Arduino to adjust the position of the solar panel accordingly. Continuously monitor and update the position of the solar panel to track the movement of the sun.

Power Generation and Storage

The solar panel generates electricity from sunlight, which is converted into electrical energy. Connect the solar panel to the

5V USB boost converter to regulate the voltage suitable for charging the mobile phone. And also connect the rechargeable battery to the boost converter to store the solar energy and this energy can be during night to charge the mobile phones.

Mobile Phone Charging

Connect the mobile phone to the output of the 5V USB boost converter and the whole system setup is shown in figure 11. The regulated power from the boost converter charges the mobile phone's battery. Monitor the charging status and control the charging process to ensure the mobile phone is charged safely.

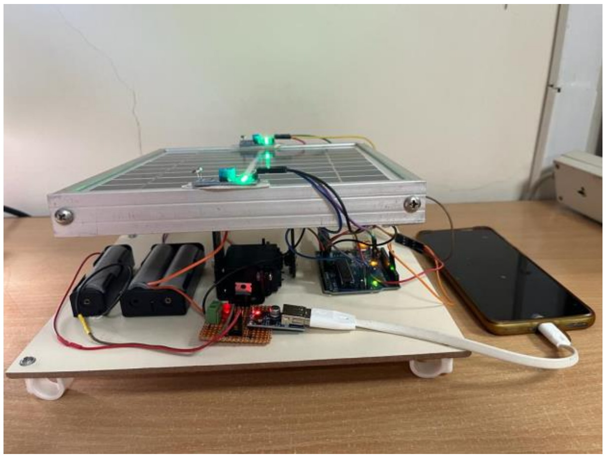

Figure 11: System Setup

System Optimization and Efficiency

Continuously monitor the performance of the solar tracking system and adjust parameters as needed to improve efficiency. Fine-tune the solar tracking algorithm and servo motor movement to optimize sunlight capture. Implement safety measures, such as overcharge protection and voltage regulation, to protect the rechargeable batteries and mobile phone.

9. RESULTS

Mobile Charging Performance - Test Setup

1. Solar tracking system deployed in an outdoor setting.
2. Various mobile devices are charged and observed the timings.
3. Data collected over several days to account for varying weather conditions.

Charging Time Comparison

The following table 1, summarizes the charging times for different mobile devices using the solar tracking system:

1. Battery Capacity Impact - Charging times vary based on the battery capacity of the mobile device. Larger-capacity batteries take longer to charge.
2. Sunlight Condition - Charging times are significantly faster in sunny conditions compared to cloudy conditions due to the increased energy generation from solar panels.
3. Device-Specific - Each mobile device has its charging requirements and efficiency, which affects the charging time.

Table 1: Charging Time Comparison

Mobile	Weather	Percentage charged	Time taken
Mobile A	Sunny	5%	20min
Mobile A	Cloudy	5%	25min
Mobile B	Sunny	8%	25min
Mobile B	Cloudy	8%	30min

4. Solar Tracking Efficiency - The solar tracking system's efficiency in orienting the solar panels towards the sun plays a crucial role in maximizing energy generation and, consequently, reducing charging times.
5. Environmental Factors - Environmental factors, such as dust, dirt, and shading on solar panels, can affect energy generation and, consequently, charging times. Regular maintenance is essential and here is a figure 12 that is showing mobile charging.

Figure 12: Mobile Charging

The results demonstrate the effectiveness of the solar tracking system in charging various mobile devices using solar energy. Charging times vary based on device specifications and environmental conditions. The system's ability to optimize solar panel orientation towards the sun is particularly critical in achieving shorter charging times, especially in sunny conditions.

These results underscore the system's potential to provide sustainable and efficient mobile device charging in various settings, particularly in outdoor or off-grid environments where traditional power sources may be limited or unavailable. Additionally, the data highlights the importance of considering device-specific charging requirements and environmental factors when implementing solar charging solutions.

10. CONCLUSION

In conclusion, mobile charging using a solar tracking system offers sustainable solution for traditional charging. The solar tracking system optimizes the utilization of solar energy by orienting the solar panels towards the sun's position throughout the day. This tracking feature increases the efficiency and effectiveness of the charging process.

Furthermore, a solar tracking system ensures a consistent and reliable power supply for mobile charging. The system's ability to track the sun maximizes the solar panel's exposure to sunlight, resulting in higher energy output. This translates into faster charging times and a more dependable power source for mobile devices.

Mobile charging using a solar tracking system also offers greater flexibility and portability. It allows for charging on the go, making it an ideal solution for outdoor activities, remote locations, and emergency situations where access to traditional power sources may be limited.

11. FUTURE SCOPE

Cloud and Weather Integration

Incorporating weather data into the tracking system can help optimize solar panel positions during cloudy days or inclement weather. By integrating data from weather forecasts or on-site weather sensors, the tracking system can adjust panel angles to capture the most available sunlight.

Remote Monitoring and Control

Enabling remote monitoring and control of the tracking system through the internet or a mobile app can enhance its usability and convenience. Users could check the system's performance, receive notifications, and manually adjust settings as needed.

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