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Solar-Powered EV Battery Charging and Payment System

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Abstract: This innovative project is focused on harnessing solar energy efficiently to power electric vehicle (EV) charging stations. It employs a single-axis solar panel tracking system to follow the sun's path and optimize energy capture. The collected solar energy is stored in a high-capacity battery, ensuring uninterrupted charging, even during periods of limited sunlight. Users have the convenience of managing their accounts through a user friendly mobile app, providing real-time cost updates and secure payment options. The EV charging station maximizes the use of stored solar energy for vehicle charging, reducing reliance on the conventional power grid. Additionally, the system incorporates detailed billing and usage history features to enhance transparency and efficiency, ultimately creating an eco-conscious transportation ecosystem that integrates renewable energy and sustainable EV charging.

I. INTRODUCTION

In the wake of climate change concerns and a pressing need to reduce our carbon footprint, sustainable transportation solutions have taken center stage in the modern world. As we navigate an era where environmental responsibility is paramount, the emergence of an innovative project promises to reshape the landscape of electric vehicle (EV) charging. At the heart of this revolution is the efficient harnessing of solar energy to power EV charging stations.

At the heart of the project's functionality is a single-axis solar panel tracking system, a technological marvel that continuously adjusts to follow the sun's path across the sky. This intelligent tracking system ensures that the solar panels are always positioned at the optimal angle to capture the maximum amount of sunlight. It is this relentless pursuit of energy efficiency that sets the project apart. The solar panel tracking system not only maximizes energy capture but also underscores a commitment to ensuring the project's reliability and effectiveness. By meticulously following the sun's trajectory, the system guarantees that the solar panels are constantly exposed to the sun's rays, no matter how it traverses the sky. This unceasing dedication to energy collection is a testament to the project's dedication to delivering consistent and sustainable power for EV charging. One of the primary challenges in harnessing solar energy is maintaining a continuous power supply, especially during periods of low sunlight, cloudy days, or the night. This challenge is expertly addressed by incorporating a high-capacity battery system within the project. The harvested solar energy is efficiently stored in these batteries, creating a robust reserve of power that can be tapped into whenever the sun is not shining brightly.

However, the project's technological innovations extend far beyond the individual user experience. At its core, this initiative seeks to redefine the relationship between renewable energy and the electric vehicle industry. It aims to optimize the use of stored solar energy for vehicle charging. During daylight hours when the sun is at its zenith, excess solar energy is captured and stored in the battery system. This surplus energy can then be directed to charging electric vehicles during both daytime and nighttime hours, significantly reducing the reliance on electricity from the grid. Reducing grid reliance is not just a matter of environmental consciousness; it has profound economic and societal implications. Conventional electricity generation often relies on non-renewable energy sources, resulting in significant greenhouse gas emissions. By harnessing solar energy efficiently, this project actively diminishes the demand for grid electricity, consequently reducing the carbon footprint associated with electric vehicle charging. It represents a pivotal step toward a greener and more sustainable energy ecosystem

II. PROBLEM STATEMENTS

The problem we aim to address is the lack of sustainable and user-friendly electric vehicle (EV) charging solutions. Current systems often rely on non-renewable energy sources and lack transparent payment methods.

Our project seeks to create an efficient, solar-powered EV charging system with a user-friendly payment interface to promote eco-friendly transportation.

III. COMPONENTS

A. Solar Panel

Voltage: 12V Power Output: 10W
Type: Mono crystalline or Polycrystalline
Dimensions: Typical dimensions for a 10W panel could be around 330mm x 260mm x 25mm (L x W x H).

Fig.1 solar panel

B. Battery

Voltage: 12V Capacity: 5Ah (Ampere-hours)
Chemistry: Lead-Acid or Lithium-Ion, depending on your specific requirements.

Fig.2 12V battery Lead acid

C. Light Dependent Resistor (LDR)

Resistance: Typically around 10K ohms in the dark and decreases with increasing light.
Usage: LDRs can be used to measure ambient light levels to adjust solar panel positioning.

Fig. 3 LDR

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D. Servo Motor

Type: Standard hobby servo motor

Torque: 5 kg·cm (kilogram centimeter), which means it can exert a force of 1 kg (kilogram) at a distance of 5 cm from the servo's axis.

Fig.4 Servo Motor

E. ESP32

Microcontroller: ESP32-WROOM-32 is a popular module. Processor: Dual-core Ten silica LX6 microprocessor.

Wireless Connectivity: Wi-Fi and Bluetooth.

Input Voltage: Typically 3.3V. Ensure compatibility with your components.

Fig.5 ESP32 Controller

F. Voltage Sensor

Type: Voltage sensor module.

Range: Ensure it's suitable for measuring 12V. Common voltage sensors have a range of 0-25V or 0-30V.

Fig.6 Voltage sensor

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G. Current Sensor (INA219)

Type: Hall Effect current sensor module.

Range: Choose a current sensor that can handle the maximum expected current of your solar panel (typically around 1A for a 10W panel).

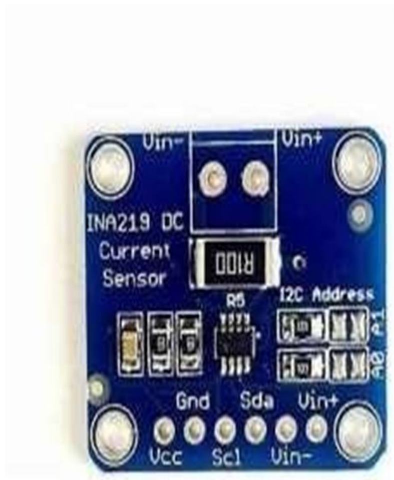

Fig .7 Current Sensor

H. LCD Display

Type: 16x2 or 20x4 character LCD display. Communication: I2C interface for easier connection with ESP32. Resolution: Typically 16 characters per line and 2 lines.

Backlight: LCD displays with an I2C backpack often come with a built-in backlight.

Fig. 8 LCD Display

I. LCD Driver

If you are using an I2C LCD display, it typically comes with an I2C driver module for easy integration with microcontrollers.

Fig. 9 LCD Driver

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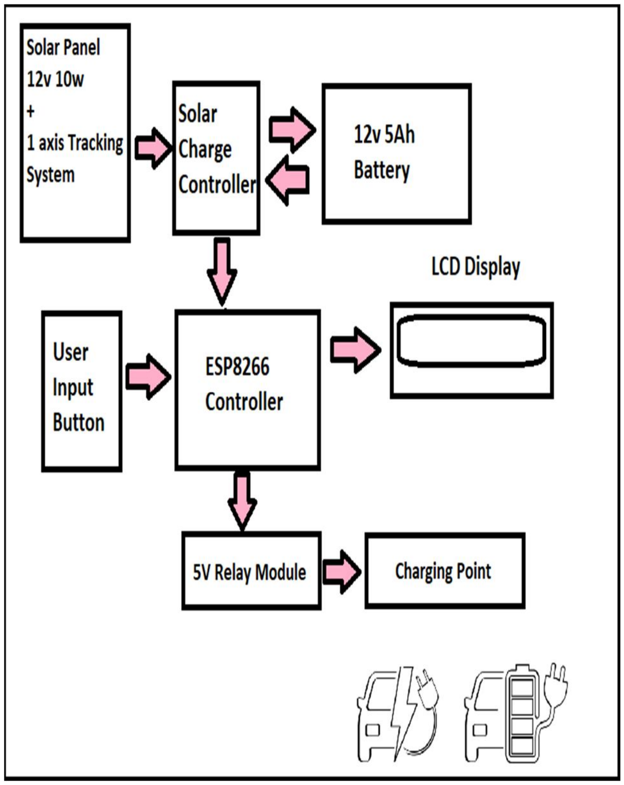
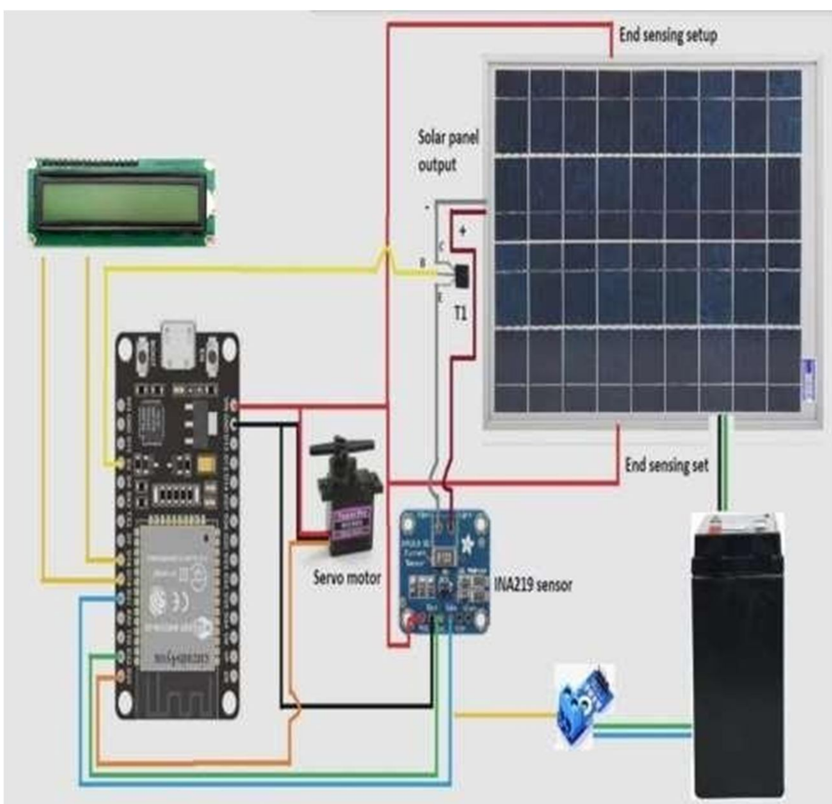
IV. BLOCK DIAGRAM AND CIRCUIT DIAGRAM

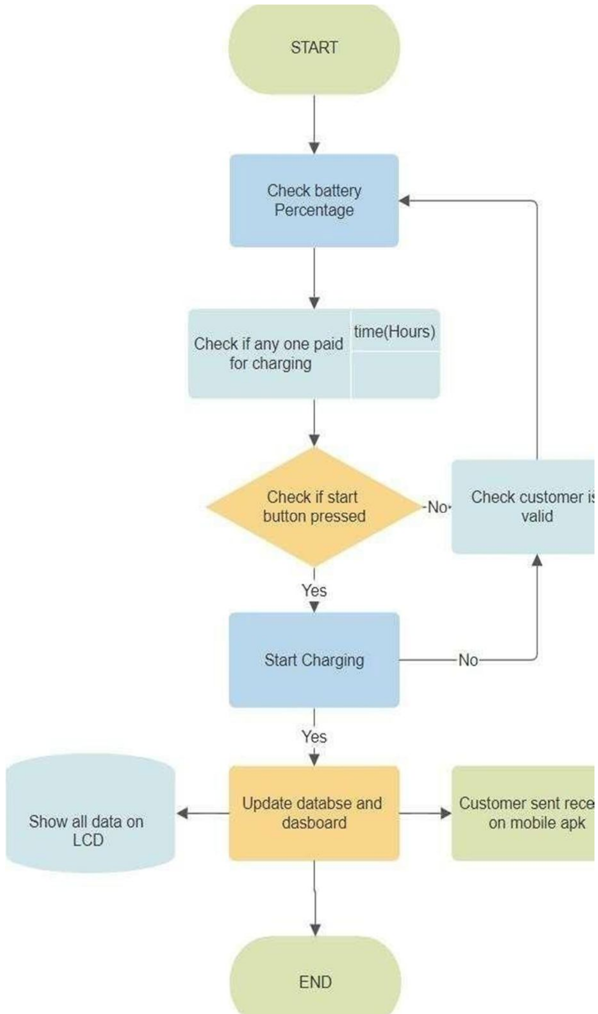


BLOCK DIAGRAM



CIRCUIT DIAGRAM

V. FLOWCHART DESCRIPTION



VI. WORKING

The working principle of this innovative project revolves around harnessing solar energy efficiently to power electric vehicle (EV) charging stations. A single-axis solar panel tracking system follows the sun's path, optimizing energy capture. The harvested solar energy is stored in a high- capacity battery, ensuring uninterrupted charging, even during low sunlight. Users manage their accounts through a user- friendly mobile app, providing real-time cost updates and secure payments. The EV charging station optimizes stored solar energy for vehicle charging, reducing reliance on the grid. Additionally, detailed billing and usage history promote transparency and efficiency, creating an eco-conscious transportation ecosystem that combines renewable energy and sustainable EV charging. Solar panels generate electricity when sunlight falls on them, producing a maximum of approximately 10 watts of power.An LDR (Light Dependent Resistor) is connected to the solar panel to track the intensity of sunlight as feedback for a servo motor, enabling it to align the solar panel with the direction of the sun. Single axis Solar- Powered EV Battery Charging Payment System 15 A voltage sensor is used to monitor the voltage generated by the solar panel and also to track the battery's terminal voltage. The voltage sensor plays a crucial role in determining when the battery is fully charged, allowing the controller to stop charging and thereby preventing overcharging, which safeguards the battery. A current sensor measures the current flowing through the circuit during the charging process, helping us monitor the overall power. consumption. An LCD display is employed to present all relevant parameters and readings, making them easily

VII. PROGRAMMING CODE

A. Code

```
#include <Wire.h>
#include <Servo.h>
#include<Adafruit_ADS1015.h> #include <LiquidCrystal_I2C.h> Servo Motor
LiquidCrystal_I2C lcd(0x27, 16, 2);
Adafruit_ADS1115 ads; // Create an instance of the ADC const int LDR_PIN = A0;
const int BATTERY_VOLTAGE_PIN = A1;
const int SOLAR_VOLTAGE_PIN = 0; // Connect to the appropriate pin on the ADC
const int SOLAR_CURRENT_PIN = 1; // Connect to the appropriate pin on the ADC
const int SERVO_PIN = 9; // Choose the appropriate pin for the servo
void setup()
{ servo.attach(SERVO_PIN); lcd.init();
lcd.backlight(); ads.begin();
// Initialize payment processing service (not included here)
// Connect to Wi-Fi or any necessary communication channels
// Other setup code
}
void loop() {
// Read LDR and control servo
int ldrValue = analogRead(LDR_PIN);
int servoAngle = map(ldrValue, 0, 1023, 0, 180); servo.write(servoAngle);
 // Read battery voltage

IntbatteryVoltage=analogRead(BATTERY_VOLTAGE_ PIN);
// Read solar panel voltage and current floatsolarVoltageads.readADC_SingleEnded(SOLAR_V
OLTAGE_PIN) * 0.0001875; // Adjust the scaling factor
floatsolarCurrentads.readADC_SingleEnded(SOLAR_C URRENT_PIN) * 0.0001875; // Adjust the scaling factor
// Display data on the LCD lcd.clear(); lcd.setCursor(0, 0);
lcd.print("Battery: "); lcd.print(batteryVoltage); lcd.print("V"); lcd.setCursor(0, 1); lcd.print("Solar: "); lcd.print(solarVoltage, 2);
lcd.print("V "); lcd.print(solarCurrent, 2); lcd.print("A");
// Implement payment processing logic here (not included)
// Other functionality, safety measures, and communication can be added delay(1000); // Adjust the delay according to your
project's requirements
}
```

VIII. CONCLUSION

In summary project combining single-axis solar panel tracking, high-capacity EV charging batteries, and a user- friendly mobile app offers a promising solution for sustainable transportation and energy use. Key advantages include improved energy capture, sustainability, user convenience, and cost savings. However, challenges like initial costs,weather dependency, and scalability must be addressed. By focusing on installation, maintenance, and scalability strategies, and promoting environmental and economic benefits, your project can positively impact transportation by reducing carbon emissions and supporting green transportation. It's a noteworthy contribution to cleaner energy solutions and has the potential to become a cornerstone of eco- friendly EV charging infrastructure with ongoing innovation and adaptation.

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