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Solar Powered Wireless EV Charging Station

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ABSTRACT: The rapid evolution of electric vehicles (EVs) and the global push toward renewable energy have prompted the need for innovative, sustainable charging solutions. This project proposes a Solar Powered Wireless EV Charging Station, combining two cutting-edge technologies—solar energy harvesting and wireless power transfer (WPT)—to deliver a convenient, eco-friendly alternative to traditional plug-in EV chargers.

KEYWORDS: Solar system, Design, Charging station, electricity, Electric Vehicle.

I. INTRODUCTION

As the world accelerates toward clean and sustainable mobility, the need for innovative charging solutions for electric vehicles (EVs) has never been greater. One of the most promising advancements in this domain is the Solar-Powered Wireless EV Charging Station—a next-generation solution that merges renewable energy with cutting-edge wireless charging technology. This system harnesses solar energy through photovoltaic panels to generate clean electricity, which is then used to wirelessly charge electric vehicles via inductive charging pads embedded in the ground or mounted in designated areas. The goal is to offer a seamless, efficient, and eco-friendly charging experience that reduces reliance on the grid and eliminates the hassle of physical connectors. Not only does this approach significantly reduce carbon emissions, but it also enhances convenience, especially for smart cities, urban fleets, and public transportation networks. By integrating solar power with wireless charging, this solution paves the way for a greener, smarter, and more connected future of transportation.

II. LITERATURE REVIEW

1. **Bhatti et al. (2016)** critically reviewed the integration of solar photovoltaic (PV) systems with electric vehicle (EV) charging stations. They compared grid-connected and standalone PV-EV charging systems, highlighting the technical and economic advantages of using solar energy to charge EVs. Their study emphasized the environmental benefits and the potential for reducing greenhouse gas emissions by combining emission-free EVs with low-carbon PV power generation.

2. **Singh et al. (2021)** designed and analyzed a solar-powered EV charging station tailored for Indian cities. Their work considered local solar resources and infrastructure constraints, proposing a system that integrates solar energy with EV charging needs. This study provides a practical approach to implementing solar-powered EV charging solutions in urban settings.
3. **A recent review by Yede et al. (2024)** discussed the advancements in wireless EV charging technologies. They explored various methods of wireless power transfer, including inductive and capacitive coupling, and assessed their efficiency and feasibility for EV applications. The review also highlighted the challenges and future directions in the development of wireless EV charging systems.
4. **A 2025 review by Suraj et al. (2025)** focused on solar-based wireless EV charging systems. The paper examined the integration of solar energy with wireless charging technologies, addressing the benefits and challenges of such systems. It provided insights into the potential for combining renewable energy sources with advanced charging technologies to create sustainable EV charging solutions.

III. PROBLEM DEFINITION

As the adoption of electric vehicles (EVs) increases globally, the demand for accessible, efficient, and sustainable charging infrastructure continues to grow.

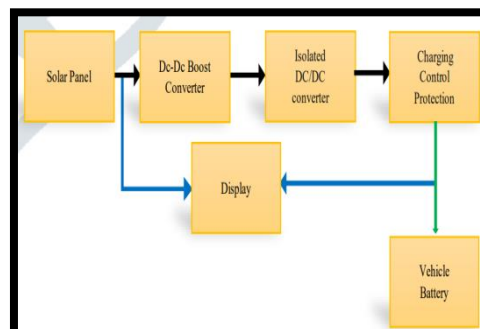
IV. FUTURE SCOPE

This project focuses on the design and development of a solar-powered wireless electric vehicle (EV) charging station, aiming to provide a sustainable, efficient, and user-friendly alternative to conventional EV charging systems. The scope includes integrating solar photovoltaic (PV) panels to harness renewable energy, implementing wireless power transfer (WPT) technology to enable contactless charging, and incorporating energy storage solutions to ensure consistent power availability. The system is intended to eliminate the need for physical connectors, enhance convenience for users, and support the future of autonomous and smart transportation.

V. OBJECTIVE

1. To design and develop a sustainable electric vehicle (EV) charging station powered by solar energy in order to reduce dependency on grid-based electricity and promote the use of renewable energy sources.
2. To implement wireless power transfer (WPT) technology that enables contactless, user-friendly EV charging, eliminating the need for physical cables and connectors.
3. To integrate an energy storage system (battery backup) that allows for uninterrupted EV charging, even during non-sunny periods or power outages.
4. To create a prototype model demonstrating the working principles of solar-based wireless EV charging, showcasing real-time energy conversion and wireless power transmission.

VI. METHODOLOGY



VII. HARDWARE DETAIL

1. SOLAR PANEL

A solar panel, also known as a photovoltaic (PV) panel, is a device that converts sunlight directly into electrical energy using the photovoltaic effect. It is the primary source of power in the Smart Solar Bench system, enabling the bench to operate independently of the conventional electrical grid.

2. BUCK-BOOST CONVERTERS

Wireless charging systems for electric vehicles typically require high power levels, often ranging from tens to hundreds of kilowatts. The LM2596 module is designed for much lower power applications, typically handling up to a few watts to a few dozen watts. It cannot efficiently or safely handle the power levels required for wireless EV charging.

3. WIRELESS CHARGING MODULE

The coil driver generates an alternating current (AC) to create an electromagnetic field. The power output of the coil driver determines the charging speed and efficiency of the wireless charging system.

4. REGULATOR CIRCUIT

The regulator circuit maintains a stable output voltage to ensure that the charging pad or transmitter coil provides the correct voltage for charging the EV battery. This helps prevent overvoltage or under voltage conditions that could damage the battery. Current Limiting.



VIII. FABRICATION PROCESSES

1. Solar Panel Setup

- Procurement: Select high-efficiency solar panels (monocrystalline or polycrystalline) based on the energy requirement of the charging station.
- Installation: Install the solar panels at an optimal angle (typically 30-45 degrees) to maximize solar energy absorption, either on a rooftop or a dedicated ground-mounted structure.

2. Battery Storage Assembly

- Selection of Batteries: Choose high-capacity, durable batteries such as Lithium-ion or Lead-acid batteries. Lithium-ion batteries are preferred due to their higher efficiency and longer lifespan.
- Battery Enclosure: Design a protective enclosure to house the batteries, ensuring it is weatherproof and adequately ventilated.

3. Wireless Power Transfer (WPT) System Fabrication

- Transmitter Coil (Charging Pad):

4. Power Conversion Units

- DC to AC Inverter: Install a power inverter to convert the DC output from the solar panels and batteries into AC power, which is necessary for wireless power transmission.

5. Microcontroller and System Control

- Microcontroller Selection: Choose a microcontroller (such as Arduino, Raspberry Pi, or a similar embedded system) to manage the charging station. This system will monitor charging status, energy flow, and safety features.
- Programming: Write a control program to:

6. Charging Pad Construction

- Base Material: Select materials that are durable and resistant to outdoor weather conditions. The charging pad should be designed for long-term outdoor use with materials such as reinforced concrete, metal, or high-strength plastic.
- Coil Placement: Embed the transmitter coil into the charging pad with careful attention to alignment to maximize the efficiency of the wireless power transfer.

7. Vehicle Receiver Coil Installation

- Integration with Vehicle: Install the receiver coil in the vehicle, ensuring it is aligned with the charging pad when parked. The receiver coil should be mounted in a way that allows it to capture the magnetic field generated by the transmitter coil.

8. Safety and Protection Circuitry

- Over current and Overvoltage Protection: Add protection circuits to prevent excess current and voltage from damaging the system components. This includes fuses, circuit breakers, and surge protection devices.

9. System Integration and Testing

- Assembly: Integrate all the fabricated components (solar panel, battery storage, wireless coils, microcontroller, power conversion units) into a single cohesive unit.

10. Final Adjustments and Calibration

- Alignment Optimization: Fine-tune the alignment between the transmitter and receiver coils to maximize the charging efficiency.

APPLICATIONS

1. Residential Charging
2. Commercial and Office Parking Lots
3. Public Charging Infrastructure
4. Highway Charging Stations / Rest Stops
5. Smart Cities and Urban Mobility Projects

IX. RESULT

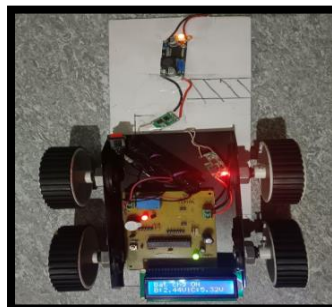
The development and testing of the Solar-Powered Wireless Electric Vehicle Charging Station successfully demonstrated the feasibility of combining renewable energy with wireless power transfer (WPT) technology for EV charging.

Efficient Solar Energy Generation

- The solar panel setup generated sufficient power under standard sunlight conditions (peak sun hours), providing a consistent energy source for EV charging.

Reliable Energy Storage System

- The battery storage system effectively stored excess solar energy and supplied power during cloudy conditions and at night.

**X. CONCLUSION**

The Solar-Powered Wireless Electric Vehicle Charging Station project successfully demonstrates the integration of two innovative and sustainable technologies—solar energy and wireless power transfer—to create an efficient, eco-friendly, and user-convenient solution for EV charging. The system not only reduces dependence on fossil fuels and the electrical grid but also eliminates the need for physical connectors, making it highly suitable for smart cities, public areas, and autonomous vehicles.

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