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Solar Wireless Electric Vehicle Charging System

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Abstract: This project outlines the design and implementation of a solar-powered electric vehicle charging station that addresses the dual challenges of high gasoline prices and harmful emissions. The number of countries adopting electric vehicles continues to rise, as they not only promote environmental sustainability but also significantly lower transportation costs by substituting expensive fuels with more affordable electricity. In this context, developing an electric vehicle charging infrastructure offers an innovative and effective solution. This system enables electric vehicles to charge while in motion, eliminating the need for stationary charging stops. Powered entirely by solar energy, it requires no additional power supply. The system incorporates solar panels, batteries, transformers, regulator circuits, copper coils, AC/DC converters, Atmega328P controllers, and LCD displays. This technology demonstrates the feasibility of an on-road solar-powered wireless charging system for electric vehicles.
Keywords: Wireless charging technology, Electric vehicle, Solar energy, Transmission and reception coils.

I. INTRODUCTION

Electric vehicles (EVs) are transforming the transportation landscape and are projected to take a leading role in the automobile market in the near future. To maintain the integrity of the power grid, effectively managing the charging processes of these vehicles is essential. However, widespread adoption of EVs could pose challenges due to the substantial energy stored in their batteries. The interaction of electric vehicles with smart grid technology will be pivotal in promoting grid independence. As carbon emissions decrease and the dependence on fossil fuels rises, electric vehicles are becoming increasingly competitive with traditional internal combustion engine vehicles.

Despite these benefits, the adoption of electric vehicles has been limited, largely due to their high upfront costs. Additionally, there is a shortage of fast-charging stations and a limited selection of fully electric models. Electric vehicles can be classified into two categories: fully electric and hybrid. In addition to their lower operational costs and reduced environmental impact, EVs rely little or not at all on fossil fuels. With improvements in charging station efficiency, electric vehicles are poised to become the dominant mode of transportation in the future.

Recent tests of portable electric car chargers powered by renewable energy have demonstrated potential for significantly reducing charging times. Wireless charging solutions are an appealing option for those seeking convenient methods to power their vehicles.

Rising fossil fuel prices and decreasing CO2 emissions are making electric vehicles more financially attractive compared to conventional vehicles. However, barriers such as high initial costs, inadequate fast-charging infrastructure, and a scarcity of fully electric options continue to hinder widespread adoption. Electric vehicles can be powered entirely or partially by electricity.

With fewer moving parts and a lower environmental footprint, electric vehicles typically incur lower operating costs than gasoline vehicles. Our project incorporates solar panels, batteries, transformers, control circuits, copper coils, AC-DC converters, ATM controllers, and LCD displays to create an integrated charging system. This innovative approach enables electric vehicles to charge while driving, thereby reducing the need for charging stops. A charge controller facilitates the connection between the battery and the solar panel, allowing direct current to be stored in the battery.

II. OBJECTIVES

The primary objective of this project is to facilitate wireless energy transfer through inductive coupling between transmitting and receiving coils for the purpose of charging the vehicle's battery. This innovative approach allows the vehicle to travel greater distances at efficient speeds, while also reducing power consumption at charging stations.

III. APPROACH

This project utilizes a solar panel that generates up to 12 volts when exposed to sunlight. The output voltage is directed to a bridge rectifier to ensure stability. In optimal sunlight conditions, light-dependent resistors (LDRs) maintain high resistance, functioning as insulators for the direct current flowing to the coil. In contrast, in low-light situations, the LDRs act as a low-resistance pathway, allowing current to flow from the grid or battery to the transmitting coil, thereby charging and storing energy in the battery.

A wireless transmitter linked to the battery creates a magnetic field around the coil. To facilitate this transmission, the transmitter circuit converts direct current into alternating current, generating the necessary magnetic field. A voltage sensor connected to the battery provides real-time monitoring of both the battery and solar power voltage, with an Arduino UNO and a 16x2 LCD displaying this information.

The receiving coil generates its own magnetic field, producing voltage in alternating current. This AC is converted back to direct current, stabilizing the voltage for the car battery, which stores the energy. An LED display indicates the remaining battery power.

The system is composed of solar panels, batteries, transformers, regulator circuits, copper coils, AC-DC converters, Atmega microcontrollers, and LCD displays, creating a comprehensive wireless charging solution. This configuration demonstrates how an electric vehicle can be charged while driving, eliminating the need to stop at charging stations. The solar panel powers the battery through a charge controller, enabling effective storage of direct current.

For electricity transmission, the direct current is transformed into alternating current using a transformer, followed by regulation through a circuit. The copper coils, designed for wireless energy transfer, operate with this alternating current. A corresponding copper coil is positioned beneath the electric vehicle, allowing energy to transfer from the transmitter coil to the vehicle's coil as it passes over. Importantly, the energy induced in this coil remains in direct current, which is then converted back using an AC-DC conversion circuit. The Atmega microcontroller measures the input voltage and displays it on the LCD.

In summary, this system illustrates a solar-powered wireless charging solution for electric vehicles, enabling on-the-go charging capabilities.

IV. LITERATURE REVIEW

A articlel solar wireless charging system for electric vehicles based on inductive power transfer is presented by Chen, Y., Zhang, and Jiang in their article titled "A Novel Solar Wireless Charging System for Electric Vehicles Based on Inductive Power Transfer" (2021). In this paper, published in the IEEE Transactions on Vehicular Technology, the authors describe the system’s architecture, control methods, and performance evaluation. By utilizing inductive power transfer technology, the authors demonstrate the system's efficiency and practicality. Their research makes a notable contribution to the growing field of wireless EV charging systems, particularly those powered by solar energy. The system's design, control strategies, and performance assessments highlight the feasibility and effectiveness of this innovative solar wireless charging solution for electric vehicles.

In the book titled "Wireless Power Transfer for Electric Vehicles and Mobile Devices," edited by Salous, S., Gavrilovska, L., Matolak, D. W., and Sousa, E. (2020), a comprehensive examination of wireless power transfer technologies is provided. The book covers various aspects of wireless power transmission, including solar-powered charging systems for electric vehicles. It delves into topics such as electromagnetic theory, system design, implementation, and potential advancements in the field. This book is an excellent resource for both scholars and professionals interested in the emerging technology of wireless power transfer. It offers in-depth coverage of the theory, design, and implementation of these systems, with a specific focus on solar-based systems and future trends.

In 2018, Tan, K., Wang, Q., and Wang, X. published an article in the International Journal of Electrical Power & Energy Systems, titled "Solar-powered wireless charging system for electric vehicles: design and implementation." In this work, the authors describe the development of a solar-powered wireless EV charging system. They provide insights into the system design, control algorithms, and share experimental results to showcase the efficiency and potential of their proposed system. This study advances the understanding of solar-powered EV infrastructure, demonstrating its practicality and usefulness in real-world applications.

Although not specifically focused on solar wireless EV charging systems, Gubbi, J., Buyya, R., Marusic, and Palaniswami discuss the Internet of Things (IoT) in their 2013 article, "Internet of Things (IoT): A vision, architectural elements, and future directions" in the journal Future Generation Computer Systems. The article explores the role of IoT and its potential impact on several applications, including the integration of smart grid technology and EV charging systems. As EVs become more integrated with smart grids, understanding IoT and its influence on electric vehicle charging systems becomes essential. This paper offers a broader perspective on IoT and its implications for applications such as smart grids and EV charging, even though it is not solely focused on solar wireless systems.

V. METHODOLOGY AND MODELING

A solar wireless electric vehicle charging system is a sustainable way to charge electric vehicles (EVs) by using solar energy and wireless technology. This system begins with solar panels, which are installed to capture sunlight and convert it into electrical energy. Solar panels generate Direct Current (DC) electricity, which can either be used immediately to charge the vehicle or stored in a battery for later use, such as at night or when the sun isn't shining.

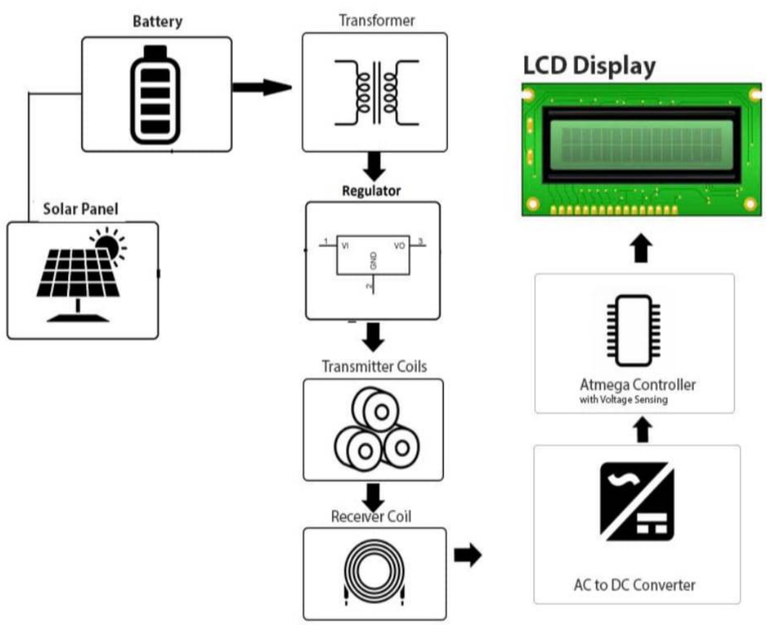
To ensure the solar panels produce the maximum possible energy, a controller called a Maximum Power Point Tracking (MPPT) system is used. This controller adjusts the power output of the panels to match environmental conditions like sunlight intensity and temperature.

The next step is power conditioning, where the electricity from the solar panels is regulated and adjusted. Since the voltage and current from solar panels can vary, a converter is used to ensure the power is at the correct level for wireless transmission. If alternating current (AC) is required, an inverter is used to change the direct current (DC) to alternating current. This is important because the wireless charging system typically operates using AC.

The key part of the system is wireless power transfer, which allows the vehicle to charge without plugging in. This is done using two coils – one coil is placed in the charging pad on the ground, and the other is installed in the car. When electricity flows through the coil in the charging pad, it creates a magnetic field. This field transfers energy wirelessly to the coil in the car. Once the energy is received, it is converted back into DC power to charge the vehicle's battery.

The car’s battery stores the energy, which can then be used to power the vehicle's electric motor. To ensure the battery is charged safely and efficiently, a Battery Management System (BMS) monitors the charging process, preventing overcharging or overheating. Throughout the process, a control system ensures everything runs smoothly. The control system manages the power flow, checks the status of the system, and provides feedback to the user, such as showing how much energy is being transferred or how full the battery is.

This combination of solar power and wireless charging creates an environmentally friendly, convenient way to charge electric vehicles without relying on traditional power grids or physical charging cables. By utilizing clean solar energy and eliminating the hassle of cords, it offers a modern solution to meet the growing demand for sustainable transportation.



Block Diagram: Solar Wireless Electric Vehicle Charging System

VI. RESULT ANALYSIS

This project advances research on electric vehicle charging stations powered by renewable energy and highlights the potential for sustainable and eco-friendly transportation solutions. Grid-connected EV charging stations present a compelling option for charging infrastructure in areas where solar energy is readily available, leading to reductions in carbon emissions, lower energy costs, and enhanced energy resilience, among other advantages.

Ongoing research and development in this field could pave the way for the widespread implementation of renewable energy-based charging stations, significantly contributing to the shift toward sustainable transportation systems.

VII. ADVANTAGES

1) Solar wireless charging relies entirely on renewable energy, reducing the need for fossil fuels and cutting down harmful emissions. This helps in lowering the carbon footprint of electric vehicles and promotes cleaner, more sustainable energy consumption.
2) One of the main barriers to EV adoption is the need for frequent charging stops. With solar wireless charging, vehicles can charge while driving or parked, eliminating the hassle of finding a charging station or waiting for the car to power up. This offers a seamless experience for EV users.
3) Traditional charging stations require a complex network of power grids, cables, and maintenance. Solar wireless systems can be integrated into existing roadways and parking lots, reducing the need for additional infrastructure and making the charging process more accessible in both urban and rural areas.
4) By leveraging solar energy, these systems reduce reliance on conventional power grids and can function even in off-grid locations. This is especially valuable in areas where building traditional charging stations may not be feasible or cost-effective.

VIII. ACKNOWLEDGMENT

We would like to express our heartfelt gratitude to everyone who contributed to the development of the solar wireless electric vehicle charging system. Special thanks go to the engineers, researchers, and innovators whose work in solar energy and wireless charging made this project possible. We also appreciate the support and resources provided by industry partners and institutions. Finally, we acknowledge the global push for cleaner energy and electric mobility, which continues to inspire advancements in sustainable transportation solutions.

IX. SCOPE OF PROJECT

The solar wireless electric vehicle project aims to create a sustainable, on-the-go charging solution by harnessing solar energy to power electric vehicles (EVs) without relying on traditional charging stations. The project focuses on designing and implementing wireless charging systems that can be integrated into roadways and parking lots, allowing EVs to charge while driving or parked. It includes developing efficient power transfer systems, testing performance in real-world conditions, and evaluating the environmental benefits, particularly in reducing carbon emissions and fossil fuel dependence. Ultimately, the project seeks to offer a scalable, eco-friendly solution that accelerates EV adoption and supports a cleaner transportation infrastructure.

X. CONCLUSION

Electric vehicles are poised to shape the future of transportation by enhancing the efficiency of charging stations. As the demand for EVs grows, addressing a critical obstacle to their adoption—the insufficient availability of public charging stations—becomes increasingly important. This study highlights the potential of portable electric car chargers that harness renewable energy to accelerate the charging process. We propose an innovative service tailored for long-distance travelers with electric vehicles, incorporating hybrid drive systems into charging stations. However, a significant gap remains in accessible charging infrastructure for EV drivers on highways. In this context, wireless electric car chargers represent the most effective solution for recharging electric vehicles.

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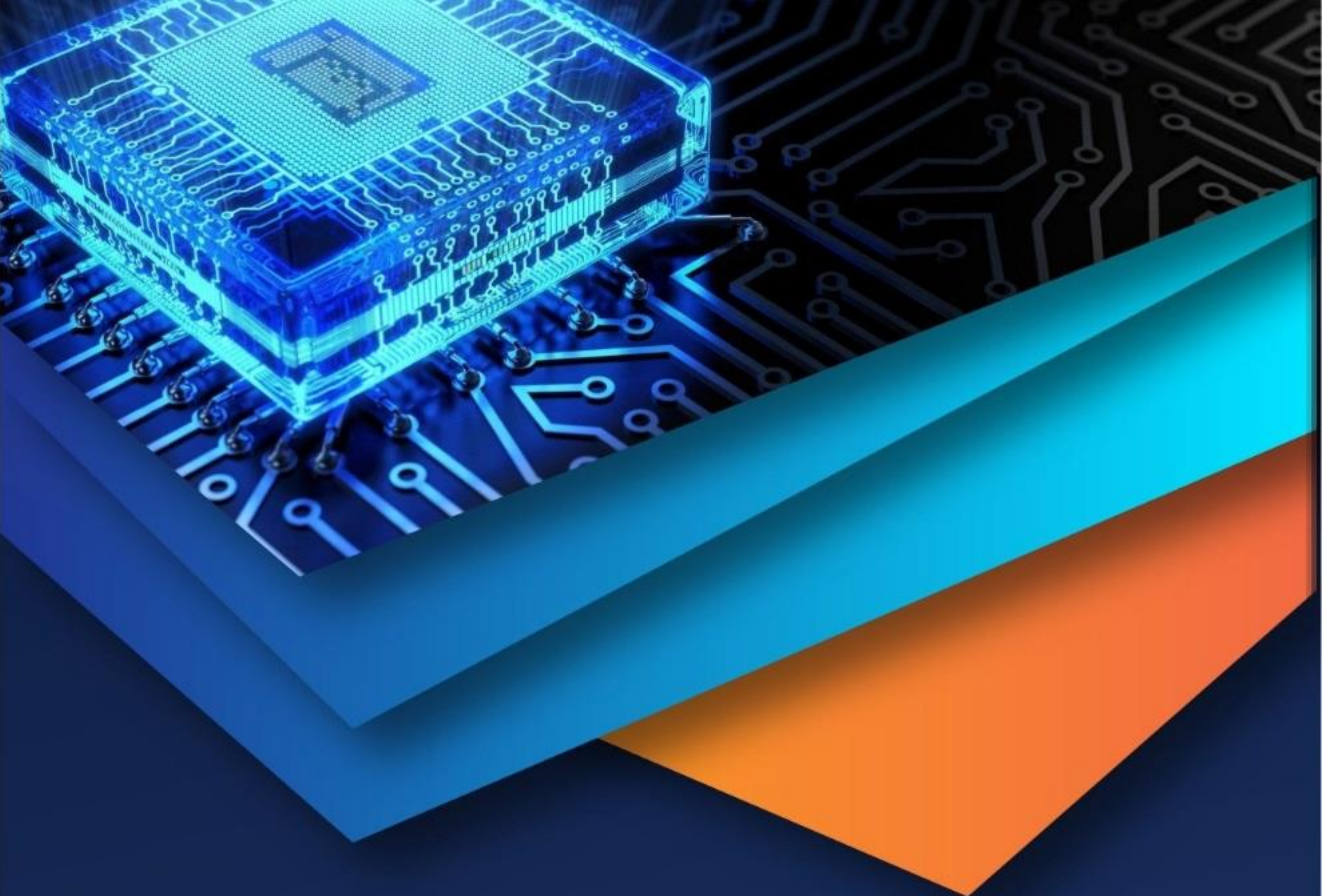

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