Non-Conventional Energy Source Based Wireless Charging Station

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ABSTRACT - Globally, automotive usage is increasing daily. The increase in automotive utilization generates concerns about traffic congestion, environmental effects, and traditional energy consumption. The reliance on conventional energy is a major concern. Governments push for electric vehicles (EVs) to reduce dependency on traditional energy sources. To reduce conventional energy usage the global emphasis is on unconventional energy charging stations instead of conventional electric charging stations, characterized by enhanced efficiency in charging techniques, diminished labour demands, and lowered maintenance requirements. This research introduces a novel solar-powered wireless charging station incorporating an RFID card. The user verifies their identification with the RFID card, thereby obtaining access to the charging station. This wireless charging technique employs inductive charging to transfer energy without physical connections. This charging method eliminates maintenance concerns related to the vehicle's connector and prevents short circuits caused by cable failure. Moreover, users can safely prevent electrical shock while connecting the cable to the vehicle, which constitutes another notable advantage. This RFID-based solar-powered wireless charging station allows for remote monitoring of the vehicle's charging level.

KEYWORDS: Solar Energy, Wireless Power Transfer, Electric Vehicle Charging, Inductive Coupling, Renewable Energy.

I. INTRODUCTION

Electric vehicles have a lower cost of ownership compared to equivalent conventional gas vehicles while also helping to reduce environmental footprint. Apart from environmental benefits, electric vehicles have also proven helpful in reducing cost of travel by replacing fuel by electricity which is way cheaper. Wireless electric vehicle charging system (WEVCS) technology operates on the principles of magnetic inductance and magnetic resonance. Comparing plug-in electric vehicles with wireless charging, WCS brings more advantage in simplicity, reliability, and user friendliness. In this wireless charging technology several works are done in which B. Lathaa, Mohammed Mujahid Irfan in 2024 [1] discussed about wireless charging technology for electrical vehicles they discussed one receiver and two receiver's dynamics charging technology.

Wenjie Chen: Zhitao Liu, in 2024, [2] To improve the battery service life and ensure charging safety, a wireless charger should provide a representative charging process with constant current (CC) and constant voltage (CV) outputs. Usually, different kinds of compensation topology are combined into a hybrid or reconfigurable circuit to meet the changing requirements. the impacts of internal coil resistors and variations in the coil self-inductors on system performance (such as zero voltage switching (ZVS) and output charging current) are investigated. A simple parameter tuning method for robust ZVS is put forward to obtain a higher charging performance.

Naoui Mohamed, FlahAymen 'in 2021[3] study discusses the wireless recharge solutions and tests the system's effectiveness under various external and internal conditions. Moreover, the Maxwell tool is used in this research to provide a complete examination of the coils' position, size, number, and magnetic flux evolution when the coils are translated.

The effectiveness of wireless charging depends on coil design, compensation techniques, and the air gap between the coils. However, coil misalignment, improper compensation topologies, and magnetic materials reduce the efficacy.

A frequency control strategy is proposed for accurate CC charging and improving the system's robustness against gap and misalignment variations. Gnanasekaran Sasikumar, A. Sivasangari in 2021, [4]the design and development of a solar charging system for electric vehicles using a charge controller is discussed. Implementation of the proposed system will

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reduce the electricity cost and charging and discharging losses. Upon studying and analyzing the works mentioned previously, several gaps have been identified. From that major one, the integration of unconventional sources of energy into existing conventional charging stations, together with wireless charging technology that includes proper authentication, is necessary.

Ref.	Title	Key Findings	Technology Used	Year
5]	Review on Future Wireless Charging Methods	Comparison of various wireless charging technologies	Magnetic resonance & inductive coupling	2023
[6]	Solar Wireless EV Charging System	Implementation of solar-powered wireless charging	Solar PV + Wireless Transfer	2024
[7]	Advancements in Wireless Charging for EVs	Review of efficiency improvements in WPT systems	Inductive & capacitive coupling	2018
[8]	Wireless Charging Market Analysis	Market feasibility for large-scale adoption	Dynamic charging infrastructure	2017
[9]	Comparative Review of Wireless EV Charging	Efficiency comparison between existing solutions	Electromagnetic resonance	2017
[10]	Technology Challenges in Wireless EV Charging	Technical barriers for wireless charging adoption	High-frequency magnetic coupling	2015
[11]	Future Trends in Wireless Charging	Wireless power transfer developments	Inductive & resonant coupling	2018
[12]	Battery Management in EV Wireless Charging	Optimization of energy usage in wireless EV charging	Battery energy management systems	2017
[13]	Comparison of Wireless Charging Technologies	Comparative analysis of charging methods	Solar-powered inductive charging	2018

Table 1: Literature Review on Solar Wireless Charging Stations for electrical vehicles

II. OBJECTIVE

Modelling a solar-based wireless charging station for electric vehicles, this incorporates a smart authentication system for accessing the charging station through RFID technology.

III. PROPOSED SOLAR BASED WIRELESS CHARGING SYSTEM

This suggested approach working, integrates solar energy generation with wireless power transmission for the charging of electric cars. The solar panels collect sunlight and transform it into electrical energy. Batteries retain the accumulated solar energy, facilitating charging even under overcast situations and at night. It operates based on electromagnetic induction and charges the vehicle wirelessly. The primary advantages of this project are its eco-friendliness, convenience, scalability, and reduction of grid dependency.

METHODOLOGY:

Step1: **source of energy charging station and utilization through solar power.**

The charging station derives its power from solar panels. Solar energy charges the battery. The primary wireless charging system (comprising the Arduino and other linked devices) operates on direct current (DC) power, which is sourced by the battery system. The comprehensive operational mechanisms of the wireless charging system are dependent upon the Arduino board, which gathers data regarding the vehicle, battery status, and charging status of the car battery, all monitored by an Arduino-based wireless charging system.

Step 2: Vehicle identification and authentication

Vehicle identification is done by using RFID card (Radio Frequency Identification card). RFID reader input is available in Arduino uno, which reads the data from a RFID card and identifies the user/device data on RFID card. If the data is matched, it will allow the vehicle to the charging point, if not again scan the RFID card.

Step 3: **Position of the vehicle on charging pad (vehicle position setter)**

- To wirelessly charge the vehicle, it must be parked in a specific location at the charging station to align the frequencies of the transmitter and receiver. The vehicle must be parked in a specific location at the charging station. To find the best spot for charging a vehicle using infrared sensors (Retro reflective photoelectric IR sensors), it relies on two main things: bouncing infrared light to check for correct alignment and measuring how long it takes for the infrared signals to come back, which helps determine the right distance for proper charging alignment.
- If the car is not in the correct position, the IR sensor indicates this by a buzzer sound, signifying that access

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to charging is restricted until the vehicle is properly aligned for charging.

Step 4: charging the vehicle

- Once the vehicle is positioned correctly, the Arduino transmits a signal to enable the wireless charging station, namely the driver module.
- In the charging station, a transmitter coil is energized by the driver module, while the vehicle is equipped with a receiving coil.
- Electromagnetic energy flows from the transmitter coil to the receiving coil through mutual induction. The vehicle initiates charging in this manner.

Step 5: vehicle Charging Process Monitoring

- Vehicle battery charging status is indicated in LCD display.
- LCD display also shows charging status, authentication result, battery percentage, charging status of the car battery, time estimation to complete charging of the battery etc.
- If the charging is not started even if the vehicle is in the correct position, first we need to check transmitter-receiver coil and then will check the battery unit of the charging station and vehicle.

HARDWARE SELECTION:

Solar based wireless charging station requires different hadware components which shown in figure one

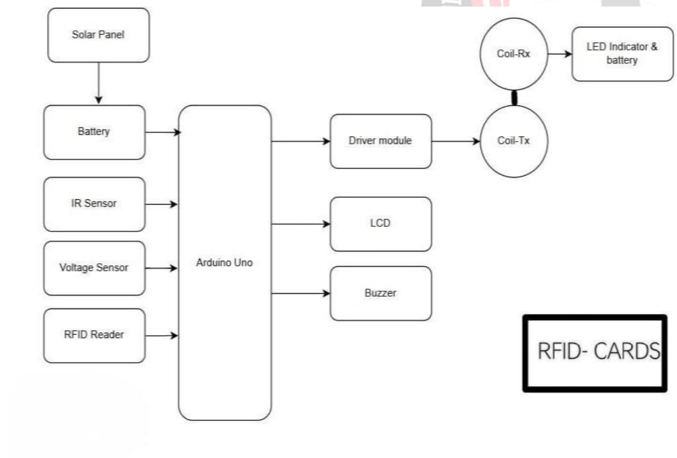

Figure 1: Block diagram for solar based wireless charging station

- **Solar Panel (10w):** The power is supplied to the entire equipment through the Solar panel.
- **RFID for User Authentication**: RFID Module: When a user arrives at the charging station, they use an RFID card for authentication. The RFID module reads the card and verifies the user's credentials, allowing them access to the charging system.
- **IR sensor for Vehicle Position Detection:** IR Sensor: An infrared sensor is used to detect whether the vehicle is properly aligned with the charging station. Correct positioning is crucial for optimal wireless power transfer. If the vehicle is not properly parked, the charging process does not begin, preventing energy loss and ensuring safety.
- **Arduino UNO using for Charging Process Initiation**: Relay Module: Once the RFID authentication is successful and the IR sensor confirms correct vehicle alignment, the microcontroller activates the relay module, which powers the wireless charging coil. This coil generates an electromagnetic field that transmits power wirelessly to the receiver coil installed in the EV.
- **LCD display for Real-Time Monitoring**: During the charging process, an LCD display shows real-time information such as the station's voltage, charging status, and other relevant data. This helps the user monitor the charging progress and ensures transparency.

IV. RESULT

The operational model of the solar-powered wireless charging station is shown in Figure 2 and has undergone testing. Initially, charge the battery with regular electricity, and then connect the solar panel to provide energy to the battery. In the traditional approach, charging time is less than that of solar energy sources; yet the efficiency indices exhibit minimal variation.

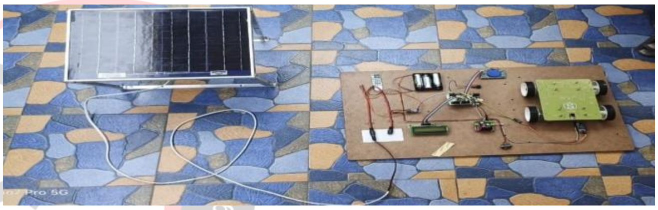

Figure 2: working prototype model of solar base wireless charging station

The power supply is sourced via a solar panel and the switch depicted in figure 3. Upon the electric vehicle's arrival at the charging station, authentication procedures commence via RFID, as seen in figures 3.1,3.1 a.

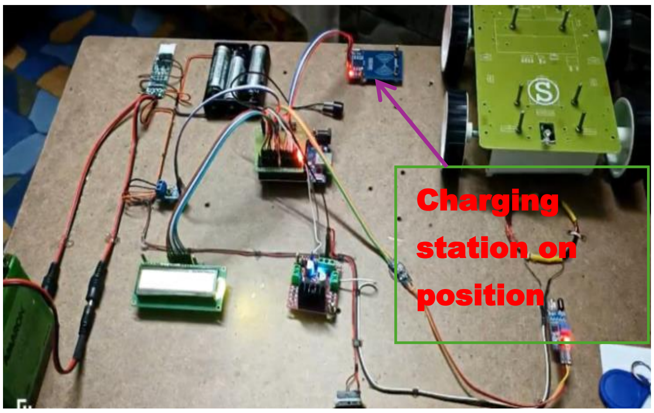

Figure 3: Solar power-based charging system on position

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Figure 3.1: Scan card prompt (battery voltage)

Figure 3.1 a: RFID-card scanning

Upon finalizing customer authentication, a parking alert will be issued, as illustrated in figure 4. The vehicle then arrives at the charging position, where the receiving coil is located at the charging station and the transmitting coil is situated at the vehicle's bottom, as depicted in figure 4.1. The two coils must be synchronized; only then is vehicle charging feasible. The vehicle's correct position at the charging point will be verified using the IR sensor seen in Figure 4.2.

Figure 4: Parking alert prompt

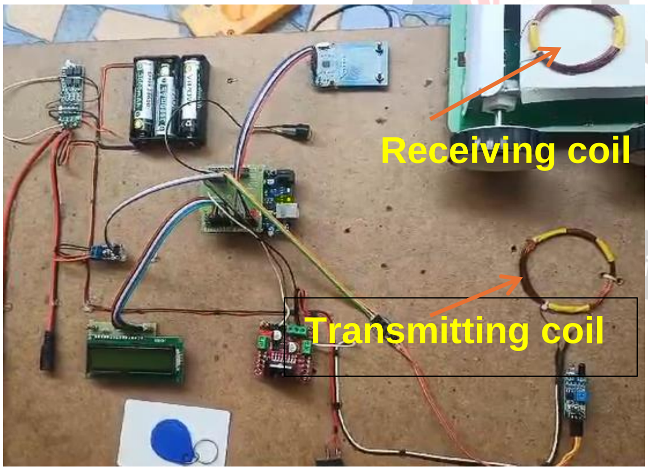

Figure 4.1: Transmitting coil and receiving coil setup

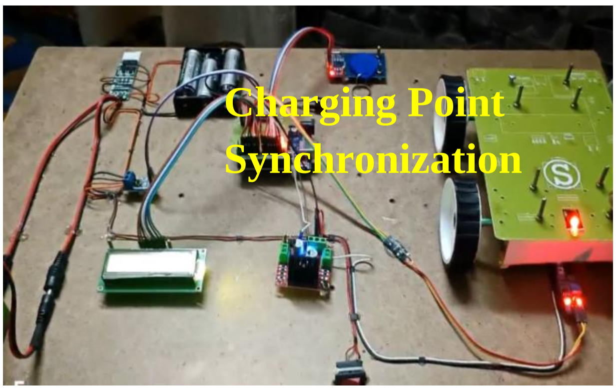

Figure 4.2: IR sensor detects the correct charging position for vehicle

If synchronization is not executed successfully, the IR sensor will transmit a signal to the buzzer. The buzzer emits an alert sound until the vehicle attains its correct position for charging.

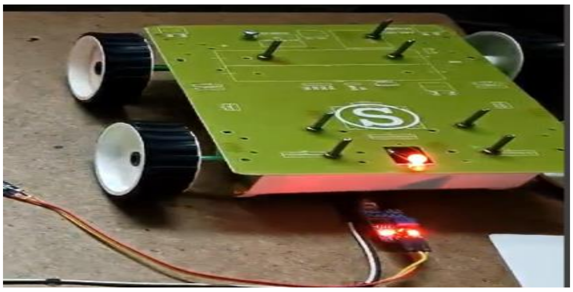

Figure 5: Vehicle while charging

Figure 5.1: Vehicle battery charging status

The vehicle's LED light will illuminate during the charging process, as depicted in Figure 5. The vehicle's charging duration and battery status are depicted in Figure 5.1.

V. CONCLUSION

The prototype of the solar-powered wireless charging station has been successfully created and tested for operation. Though solar energy charging for the electric vehicle has been completed, because solar energy is intermittent, the charging station requires a battery backup. The system runs on an Arduino Uno and includes features such as RFID for user authentication, an IR sensor for precise vehicle alignment at the charging point, a voltage sensor for monitoring safe operational voltage levels, and transmitter and receiver coils for electromagnetic energy transfer without a physical connection. This experiment reveals the possibility of wireless charging using solar energy, which could help reduce pollution in the future while also being less expensive and low maintenance. The successful testing of the prototype confirms the potential of solar-powered wireless charging infrastructure, leading to additional advances.

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