Optimization Of Solar -Powered Static wireless Charging Station for Electric Vehicles

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Abstract - The project specifically focuses on the design of a solar-powered electric vehicle charging system, offering a solution to the key issues of fuel dependency and environmental pollution. Electric vehicles have gained global traction and are progressively becoming more prevalent. Beyond their environmental advantages, electric vehicles contribute to cost reduction by substituting electricity for fuel, which is a more economical alternative. This project presents an innovative solution for EV charging, eliminating the need for wires, harnessing solar power to sustain the charging system, and operating without external power supply requirements. The system incorporates components such as a solar panel, battery, transformer, regulator circuitry, copper coils, AC to DC converter, Atmega controller, and LCD display. Through this integration, the system showcases the wireless charging capability for electric vehicles at charging stations. The LCD display provides real-time information on the total cost. In summary, the project demonstrates the viability of a solar-powered wireless charging system for electric vehicles, presenting a forward-looking approach to integration.

***Key Words*:** Electric Vehicle, Wireless power transmission, static wireless charging, Atmega328p controller with LCD, Mutual induction.

1.INTRODUCTION

Wireless power transfer (WPT) is the technology that enables the transmission of electrical energy from a power source to an electrical device without using physical wires or direct electrical contacts. In the context of sustainable electric vehicles (EVs), wireless power transfer means charging an electric vehicle's battery without a physical connection with the vehicle and the charging infrastructure.

The concept of wireless power transfer of sustainable electric vehicles is based on electromagnetic induction theory. It involves two main components: transmitter and receiver. A transmitter, typically installed in charging infrastructure, generates an oscillating magnetic field using a coil of wire. The receiver, installed in the EV, contains a coil of wire tuned to resonate with the frequency of the magnetic field generated by the transmitter. When transmitter and receiver coils are nearby, the oscillating magnetic field induces an alternating current (AC) in the receiver coil through electromagnetic induction. This AC is rectified and converted into direct current (DC) to charge the EV's battery. Wireless power transfer technology for sustainable electric vehicles is rapidly advancing, and it holds tremendous potential for enhancing the user experience and adoption of electric vehicles in the future. Wireless power transfer of electric vehicles offers several advantages. It provides convenience by eliminating the need for physical connections and plug-in charging. It also reduces wear and tear on charging connectors and the risk of electric shock.

2. BLOCK DIAGRAM

System for wirelessly supplying power to an electric vehicle's battery. It is made up of three components: a transmitter to create the AC signal that has to be transmitted, a transmitting and receiving coil to move power wirelessly, and a receiver to change the AC signal into DC voltage so that the electric car's battery may be charged. The method being implemented aims to provide a wireless power supply system prototype to recharge an electric vehicle's battery and prevent energy waste.

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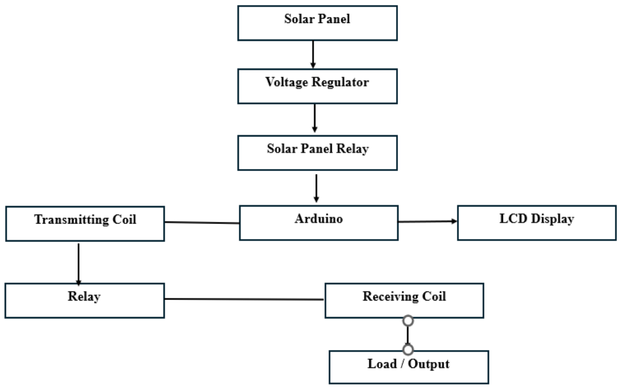

Fig - 1 : Block Diagram

The working principle of a static wireless charging system for electric vehicles is based on the concept of inductive power transfer. The system consists of two primary components: the charging pad (or ground pad) and the receiver pad (or vehicle pad). The charging pad is connected to a power source, such as a power grid or a renewable energy system, and is placed on the ground. The receiver pad is installed on the underside of the electric vehicle, and is positioned directly above the charging pad. When the two pads are in close proximity to each other, the charging pad generates an alternating magnetic field, which induces an alternating current (AC) in the receiver pad. The receiver pad then converts the AC into direct current (DC) to charge the vehicle's battery. The key to the system's efficiency is the use of resonant magnetic coupling, which enables energy transfer over a distance without the need for physical contact or wires. The resonant coupling occurs when the natural frequencies of the two pads are tuned to match each other, allowing for maximum power transfer.

Mutual Inductance formula:

Emf = M (dI1 / dt) OR M = emf/ (dI1 / dt)

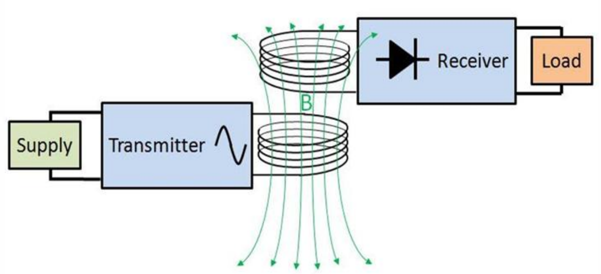

Fig - 2 : Mutual Inductance

3. SCHEMATIC DIAGRAM

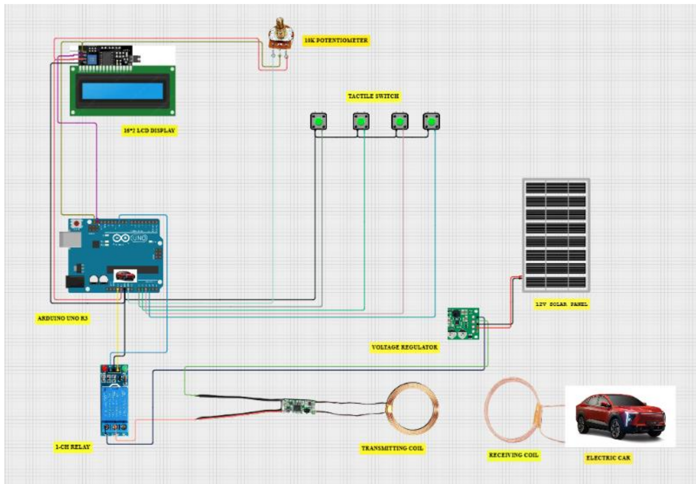

Fig - 3 : Schematic Diagram

- **Arduino UNO R3**: Arduino is an open-source microcontroller platform used for building electronic projects. It consists of a hardware board (e.g., Arduino Uno) and a software development environment (Arduino IDE) The board has digital and analog I/O pins for connecting sensors, actuators, and other components. It is programmed using C/C++, making it easy to develop automation and IoT applications. Widely used by students, hobbyists, and professionals for prototyping and embedded system projects.

- **Tactile switches:** These are small, momentary push-button switches that provide a tactile "click" when pressed. They are commonly used in electronics projects for user input, such as setting timers or controlling devices. These switches are available in different sizes and shapes, typically 4-pin or 2-pin configurations. When pressed, they complete an electrical circuit, sending a signal to a microcontroller like Arduino. Used in applications like remote controls, keypads, automation systems, and embedded projects.

- **LCD Display (16×2):** A 16×2 LCD (Liquid Crystal Display) can display 16 characters per row and has 2 rows. It is commonly used in embedded systems, Arduino projects, and industrial applications for data visualization. The display operates using the Hitachi HD44780 controller, making it compatible with microcontrollers. It can be interfaced using either 4-bit or 8-bit parallel communication. Displays alphanumeric characters and custom symbols, often used for menu navigation, sensor readings, and status updates.

- **1 channel Relay Module:** It is used to control high-voltage electrical devices with a low-voltage microcontroller like Arduino or ESP32.It acts as an electrically operated switch, isolating the low-power control circuit from the high-power load. Operates at 5V or 12V, with a switching capacity of AC (250V/10A) or DC (30V/10A). Typically includes an optocoupler for electrical isolation and an indicator LED to show relay status. Used in home automation, motor control, lighting systems, and industrial applications.

- **Solar Panel 12v:** It is designed to convert sunlight into electrical energy, providing a 12-volt output suitable for charging batteries and powering various devices. These panels are commonly used in off-grid applications, including RVs, boats, and remote cabins.

- **Transmitting Coil:** Generates an alternating magnetic field using AC current. Uses electromagnetic induction for wireless power transfer. Used in wireless chargers, EV charging, medical implants, and industrial automation. No physical connectors, reduces wear & tear, enhances durability, and improves convenience.

- **Receiving Coil:** Captures the magnetic field and converts it into electrical energy.

- **Voltage Regulator:** Maintains a stable output voltage for electronic circuits. Used in Arduino projects, battery charging circuits, microcontrollers, and power supply modules. Prevents voltage fluctuations, protects components, and ensures reliable operation.

4. EXPERIMENTAL RESULTS

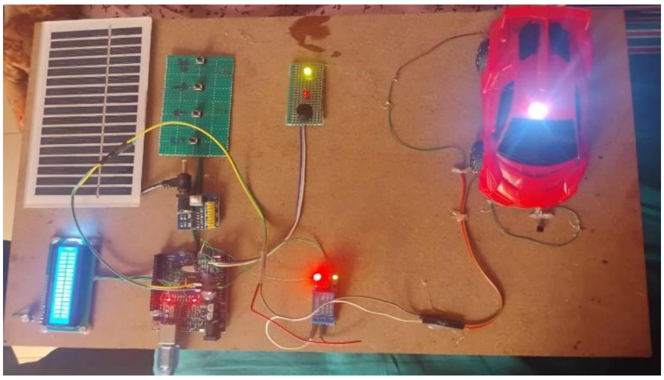

Fig - 4 : Prototype

Steps taken to reach the required outcome: -

- **Solar Power Setup** – A 12V solar panel provides energy for charging.
- Wireless Charging System – A transmitting coil sends power, and a receiving coil collects it.
- **Arduino Control** – Arduino Uno sets the charging time based on user input.
- **User Input & Display** – Tactile switches set the time, and a 16x2 LCD shows the countdown.
- **Automatic Power Cutoff** – A relay disconnects the power once charging time is over.
- **Voltage Regulation** – Voltage regulator modules step down voltage for safe operation.
- **Testing & Implementation** – The system is tested for efficiency and reliability.

5. CONCLUSIONS

- A static wireless charging station for electric vehicles offers several benefits such as convenience, safety, and reduced environmental impact. The system eliminates the need for cables and connectors, making the charging process simpler and more efficient. It also reduces the risk of electrical shock and eliminates the need for manual handling of cables. Furthermore, the use of wireless charging stations for EVs reduces greenhouse gas emissions and improves air quality since EVs produce zero tailpipe emissions. This contributes to a cleaner and healthier environment for all.
- Overall, a static wireless charging system for EVs represents a promising technology for the future of transportation, offering a convenient, efficient, and sustainable way to power electric vehicles. The efficiency of wireless EV charging by magnetic resonance over long distance and we found the efficiency to be 97.2% for a distance of 6cm.

6. FUTURE SCOPE

The future scope for wireless charging stations using timers for electric vehicles (EVs) is vast and promising, as it combines smart technology with sustainability. By integrating timers, these stations can optimize charging schedules, ensuring that vehicles are charged during off-peak hours to reduce grid strain and minimize energy costs. This technology can be further enhanced by linking stations to renewable energy sources such as solar or wind power, using timers to charge vehicles when clean energy is abundant. As smart grids evolve, the timer-based system could automatically adjust charging times based on real-time demand and pricing, ensuring efficient energy distribution. Additionally, the automation of charging cycles with built-in safety features, like auto cutoffs to prevent overcharging, could extend battery life and improve overall efficiency.

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