BI-DIRECTIONAL WIRELESS CHARGING SYSTEM FOR EV

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ABSTRACT

Contactless power-transfer system for electric vehicles is a futuristic technology aimed at simplifying and enhancing the charging process by integrating charging systems into the roads. This project utilizes Tesla coils made of copper coils embedded in the road surface, powered by solar panels and mains electricity. An ESP module connected to an IR sensor detects vehicles exiting the charging lane, notifying owners with payment links via mobile phones. Upon successful payment, a servo motor-driven gate opens, allowing the vehicle to proceed. The EV model is equipped with a copper coil for charging and a 7-segment LED display to indicate charging status while moving on the road. This innovation minimizes reliance on fixed charging infrastructure, offering a seamless, efficient, and sustainable charging experience.

1. INTRODUCTION

The rapid increasing shift toward electric mobility has brought the challenge of efficient and accessible charging infrastructure to the forefront. Conventional charging methods require substantial space, time, and manual intervention. Wireless charging roads provide a novel approach, enabling vehicles to charge as they move. By integrating Tesla coil technology and renewable energy sources like solar panels, this system aims to make EV charging more user-friendly and environmentally sustainable. The system also integrates a digital payment and notification mechanism, ensuring a seamless experience for vehicle owners. To achieve international climate goals and mitigate greenhouse gas emissions, the widespread adoption of Electric Vehicles (EVs) is imperative. Beyond their environmental benefits, EVs are increasingly recognized as valuable distributed energy resources (DERs) within smart grids, providing critical services such as peak shaving, frequency regulation, and voltage support, This paradigm shifts positions EVs not merely as transportation tools but as integral components of modern energy systems.

Eg1: As per Yogesh Parmar, Amit Patel, Jayant Shah, “Review paper on Wireless Po wer Transmission”, International Journal of Scientific Research Engineering & Technology .

Eg 2: It is reported that reviews different techniques of wireless power transmission, explains how each method works, compares their benefits and limitations, and highlights the potential applications in future technologies like electric vehicles, space energy, and consumer electronics.

1.1 System Overview

The project focuses on developing a wireless charging infrastructure for EVs, catering to both urban and highway scenarios. Its scope includes, **Infrastructure Development**: Designing roads embedded with Tesla coils powered by solar and mains electricity, **Vehicle Integration**: Equipping EVs with receiver coils and charging status indicators, **Automation**: Incorporating sensors and ESP modules for vehicle detection, payment processing, and gate control, **Scalability**: Creating a scalable structure suitable for expansion across wider roadway system.

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1.2 Research Motivation

This project is driven by the need to reduce dependence on traditional charging points, lower vehicle idle time, and promote cleaner energy practices the need to reduce dependency on conventional charging stations, minimize vehicle downtime, and promote sustainable energy use. With EV adoption on the rise, wireless charging roads can revolutionize the industry by providing an uninterrupted charging experience, fostering convenience, and encouraging the transition to cleaner energy sources.

2. METHODOLOGY

Infrastructure Design: Tesla coils embedded in road surfaces are connected to an energy input derived from photovoltaic pannels and mains electricity , **Vehicle Integration**: EVs are equipped with receiver copper coils for wireless charging and a 7-segment LED display for status indication.**Automation**:IR sensors detect vehicles exiting the charging lane.ESP modules notify vehicle owners with payment links and control the gate via a servo motor.**Payment Mechanism**: Vehicle owners receive a mobile notification with a payment link. Upon successful payment, the gate opens.**Testing and Validation**: The system is tested for charging efficiency, vehicle detection accuracy, and payment processing.

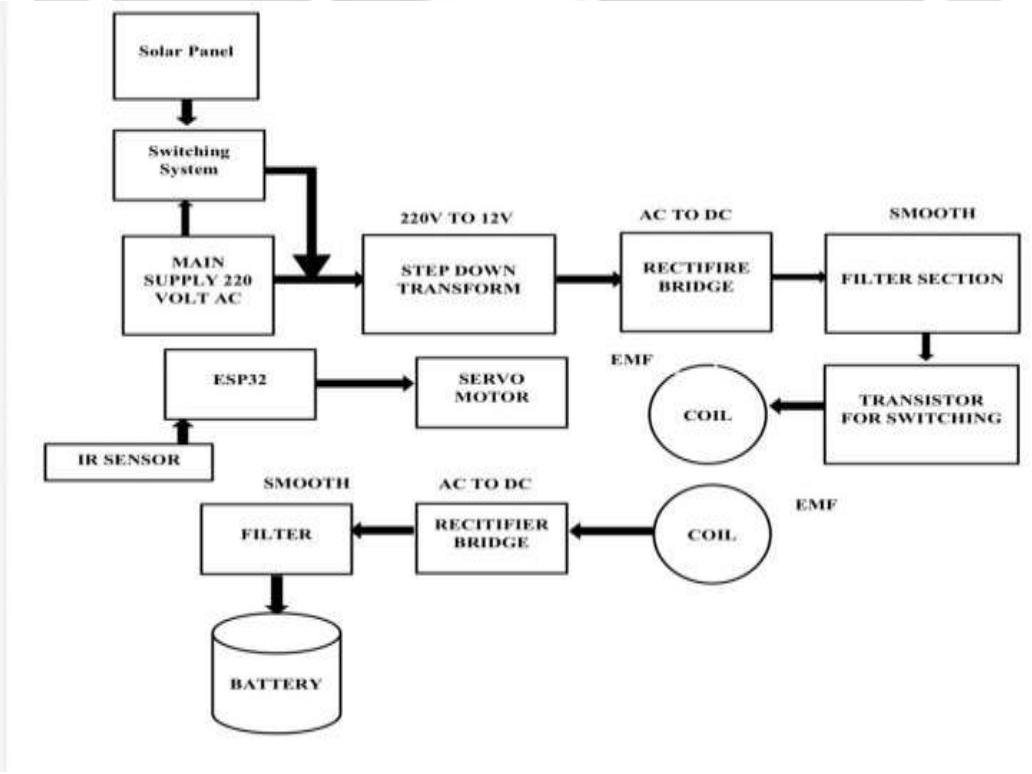

Chart -1 System Components and Interconnections:

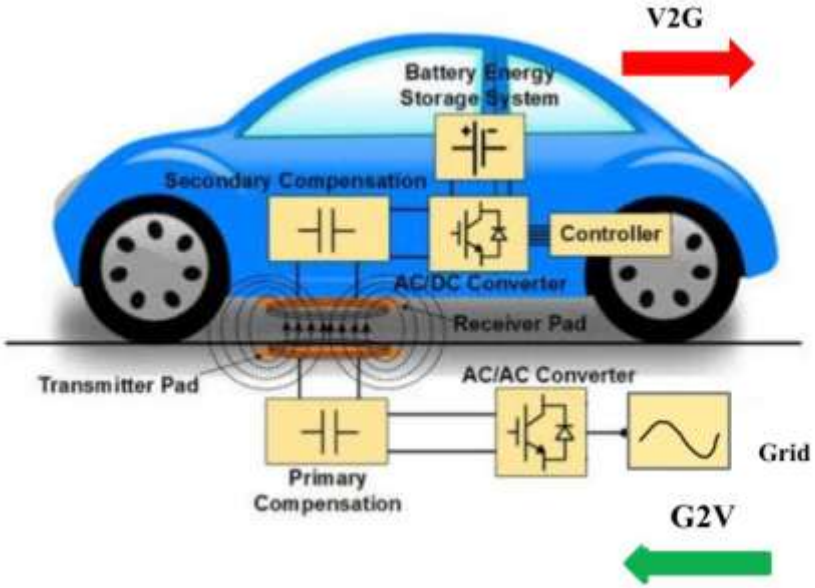

Fig -1: Schematic diagram of wireless EV charging system

2.1 Hardware Implementation

The hardware consists of the Esp32 microcontroller, IR Sensor, LED 7 segement Display, solar panel, servo motor, battery of 4V, copper coils, jumper wires, transistors, capacitors, resistors, diodes, step down transformer and some leds etc.

Table -1: Components Description

Component	Model / Type	Function	Power Requirement
Microcontroller	Esp32	Wifi Connectivity	5v
Power Supply	Ac Supply	Provides Energy	12v
Sensor	Ir Sensor	Obstacle Detection	3-5v
Motor	Servo Motor	Move To Precise Angle	4.8-6v
Display	Led 7 Segment	To Display Number	5v

2.2 Software Implementation

The Arduino IDE is used to write and upload the embedded program that runs on the Arduino microcontroller. The code written in C/C++ controls all connected sensors and modules, processes the input data, and sends the required output signals. Using the IDE's built-in libraries and serial communication features, the microcontroller data is efficiently transmitted to the server or displayed for debugging. A web interface is built using the flask framework in python that interacts with the Arduino system. Flask handles the routing, backend logic, and communication between the hardware and the user interface. Through Flask's lightweight structure, a RESTful API or web dashboard is created to display sensor data, receive commands from the user, and control the system remotely.

3. RESULTS AND DISCUSSION

Efficient Wireless Charging: Vehicles received power effectively from Tesla coils embedded in the road.Accurate Detection: The IR sensor reliably identified vehicles exiting the charging lane.Seamless Automation: Notifications and payment processing were smooth, with the gate opening post-payment without delays.Renewable Energy Utilization: Solar panels effectively powered the system during sunny conditions, reducing mains electricity usage

Chart -2: Final Outcome of The Project

3.1 Future Scope

Increased Efficiency: enhancing the transfer efficiency between Tesla coils and vehicle receivers.Dynamic Charging: Supporting continuous charging for moving vehicles at higher speeds.AI Integration: Predicting traffic patterns to optimize energy usage on charging roads.Global Implementation: Adapting the system for diverse climates and road conditions.

AI integration serves as the intelligent backbone of the entire system. Artificial intelligence to understand traffic patterns, predict peak usage times, and allocate energy dynamically across the charging road network. By forecasting congestion, AI can pre-activate certain segments while powering down others to minimize waste. Machine learning models can also monitor system health, predict maintenance needs, and optimize energy routing to avoid overloads. This level of coordination improves efficiency, supports grid stability, and ensures that the infrastructure responds adaptively to real-world driving behavior.

4. CONCLUSIONS

This contactless charging system for EVs demonstrates a scalable and sustainable solution for modern transportation challenges. By integrating Tesla coil technology, renewable energy, and automated payment systems, it enhances the convenience and adoption of EVs while promoting environmental sustainability.

5. ACKNOWLEDGEMENT

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6. REFERENCES

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