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Next Generation Wireless Charging: Advanced Technology For Ev Power Trasnfer

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Abstract: Dynamic charging for electric vehicles (EVs) integrates Tesla coils embedded in road surfaces, powered by solar panels and mains electricity. Vehicles equipped with copper coils charge while driving, eliminating the need for traditional charging stations. An ESP module and IR sensor detect vehicles, sending payment links to owner's phones. After payment, a servo motor-driven gate opens for vehicle exit. A 7-segment LED display on the EV indicates charging status. This system offers a seamless, efficient, and sustainable charging experience, reducing range anxiety, saving time, and promoting renewable energy usage, although infrastructure setup and standardization are key challenges.

***Index Terms* -** Wireless Charging, Power Transfer Inductive Charging, Resonant Charging and Mobility.

I. Introduction

The rapid adoption of EVs has Wireless Charging, Power Transfer Inductive Charging, Resonant Charging and Mobility. 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 regenerating 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.
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 framework that can be adapted to larger road networks.

II. LITERATURE SURVEY

Mohammed Rabhi et al, has briefly discuss about the continuing electrification of the automobile industry prompts the development of new technologies such as wireless charging. While the concept has been in use for short time now, WPT applications for EVs have recently picked up traction, and there is a growing research trend in the field. Low Maintenance Costs High Upfront Cost. [1]

Mohammed et al, described the purpose of this study is to examine the advancements in battery technology associated with EVs and the various charging standards applicable to EVs. Additionally, the most common types of automotive batteries are described and compared. Moreover, the application of artificial intelligence (AI) in EVs has been discussed. Finally, the challenges associated with EV battery development, as well as suggestions for improvement, are discussed. According to the study, Lithium-ion batteries are the most common in EVs due to energy density, long lifespan, and cost- effectiveness, despite their temperature sensitivity. [2]

Bhosale.et al, has discussed the rise of EV penetration brings numerous benefits in economic and environmental aspects, but it also presents deployment opportunities and challenges of EV charging stations. The EV users benefit from lower

Fuel and operating expenses compared to ICE vehicles because of higher efficiency of electric motors reaching it as high as 60–70%. The electric vehicles are intermittent load to the grid since the total number of users charging the electric vehicle at different charging station at different time. Moreover, the increasing EV penetration leads to the increase in load requirement on charging stations and will place a heavier load on the grid, necessitating the exploration of alternative resources. So, it significantly effects on power quality of the distribution grid. [3]

Subramanian et al, Studies the Magnetic Resonance-Wireless Power Transfer (MR-WPT) has emerged as a key machineries for charging electric vehicles (EVs) due to its ability to transfer power without physical connectors. Unlike traditional wired charging methods, MR-WPT uses magnetic fields for energy transmission over short to medium distances. This type of wireless charging system offers convenience, flexibility, and enhanced user experience for EV users. [4]

Mohammed Tabaa et al, discuss about Recharging electric vehicles' batteries requires an important amount of time. Since time is an important factor, recent works started focusing more on optimizing the use of recharge within an electric vehicle to make the most of it while avoiding frequent stops at the charging stations. It Reduced the Dependence on Oil in the vehicles. But it requires wider infrastructure for dynamic charging. [5]

Mohammed et al, provides a **holistic review** of both **static** and **dynamic charging inventions** for **battery electric vehicles (BEVs),** addressing their topologies, operation principles, limitations, and future research directions. As global EV adoption surges, efficient, user-friendly, and fast-charging stations are critical for sustainable transportation. [6]

Afshar et al, presents a **comprehensive review of Mobile Charging Stations MCSs** a promising alternative that enhances the adaptability and responsiveness of EV charging systems. The paper categorizes **MCSs** into various types based on design, application, and power source, Deployed via service vans or trucks equipped with batteries or generators to charge EVs at stranded locations. Mobile units that swap drained batteries with charged ones, used primarily in fleet operations. Future-focused methods aiming at autonomous or semi-autonomous mobile charging delivery. [7]

Mohammed et al, presents a detailed overview of the three major **dynamic charging technologies for electric vehicles (EVs) Inductive Power Transfer (IPT), Capacitive Power Transfer (CPT),** and **Magnetic Gear-based Systems (MG).** The study focus on the principles, system design, performance characteristics, and challenges related with each approach, along with a comparative analysis and future research opportunities. [8]

Munir et al, delivers a comprehensive overview of **Inductive Wireless Power Transfer (IWPT)** systems for **Electric Vehicles (EVs),** focusing on key aspects such as **power transfer topologies, power electronics design,** and **control strategies.** The main goal is to identify and classify state-of-the-art approaches while highlighting practical challenges and future research requirements. [9]

Mastoi et al. offer an all-encompassing review of the EV charging landscape, highlighting that **technical progress must align with policy and infrastructure planning** for EV adoption to scale. The paper emphasizes **interdisciplinary coordination,** involving **technologists, urban planners, and regulators,** to build a future-ready EV charging network. [10]

Yadav et al. provide a detailed and well-structured review of dynamic charging systems for EVs, highlighting the interplay of power electronics, control strategies, coil design, and standardization. The study concludes that future systems must integrate **smart grid communication, safety protocols, and scalable designs** to meet the increasing demand for wireless EV charging.

Ahmed et al. provide a detailed and practical analysis of the design and execution of dynamic charging systems for EVs. Their study underscores the need for continued innovation in **resonant coupling**, **compact power electronics**, and **standard-compliant safety mechanisms** to make wireless EV charging more viable and scalable. [12]

III. OBJECTIVES

- To analyze the hardware structure, fundamental circuitry of dynamic wireless charging.
- To arrange the transmitter coil and receiver coil, input and output model of IPT.
- To integrate IR sensor with microcontroller and relay for switching of coils.
- To implement the hardware prototype model of dynamic charging.

IV. METHODOLOGY

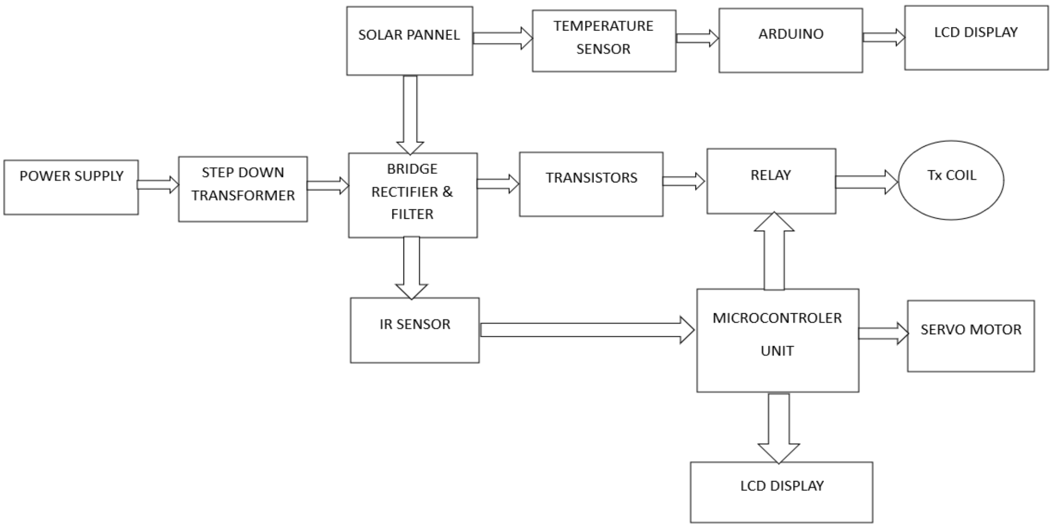


Fig1.Block diagram related to road part

Figure 1 gives info about the power supply transmitting to the receiving coil through different phases. Figure 2 describes about the dynamic power receiving through the receiving coil.

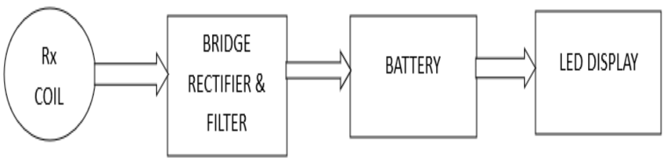


Fig 2. Block diagram related to EV part

Supply is the input and starting point of our implementation. Once supply is connected to the transistor, the transistor will start switching and it will generate the dynamic power with help of copper coil. The number of transmitter copper coil will fix on the road base. An IR sensor detects vehicles exiting the charging lane. The receiver copper coil will be inside the Electric vehicle. This receiving coil will receive the power without any physical connection. In the electric vehicle we are using bridge rectifier and filter for convert this power into pure DC and storing in the battery. We are using LCD display in vehicle to display the battery voltage.

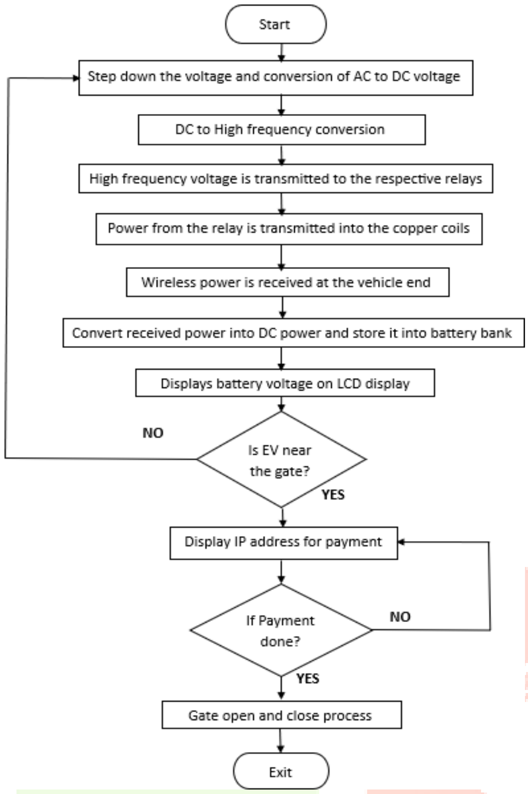


Fig 2. Block diagram related to EV part

Fig 3. Flow chart

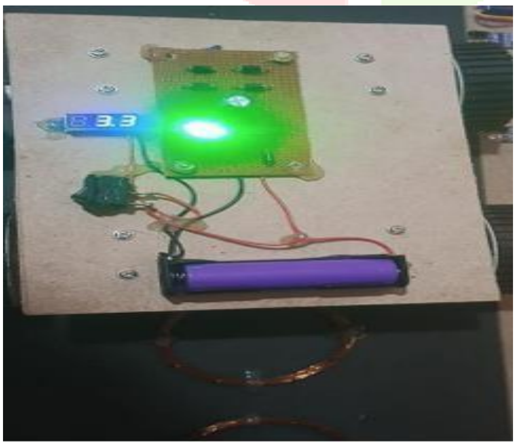


Fig 4(a). Voltage reading before charging

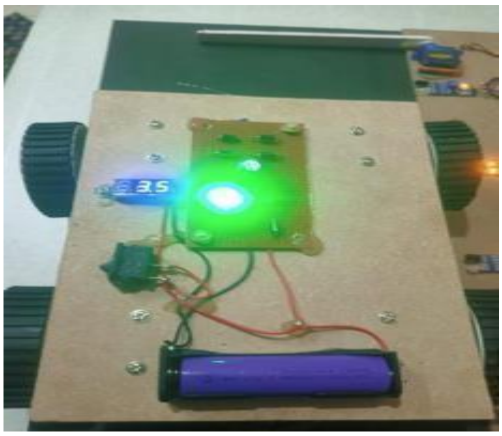
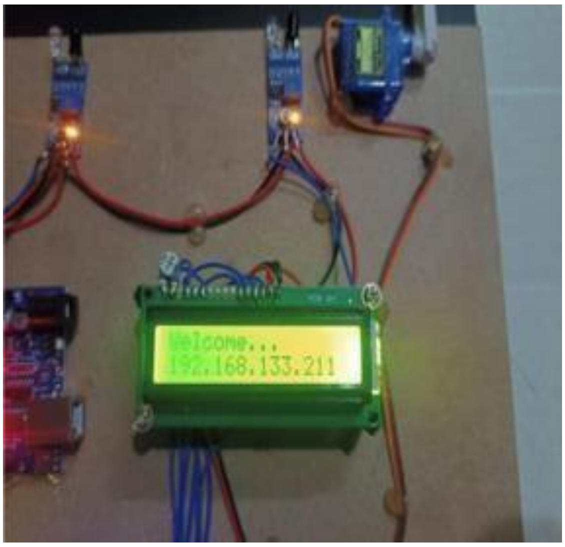
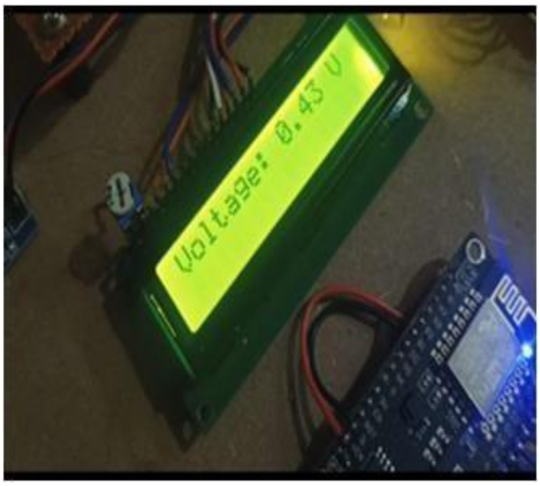


Fig 4(b). Voltage reading after charging

In fig 4(a) we can observe the battery percentage of the EV before shifting on to the EV lane for charging. This EV vehicle consists of a receiving coil which is placed under the vehicle, a led light to indicate the charging and an led display used to display the battery percentage. In fig 4(b) we can observe the battery percentage after charging. The EV is shifted to the EV lane for charging purpose. With the help of transmitting and receiving coils present on the road and the vehicle the battery gets charged.





. Fig 5. IP address for payment is displayed on LCD

Fig 6. Voltage reading of solar panel displayed on LCD.

Fig 7. Car is waiting near the toll gate for payment transaction.

Fig 8. Once the payment is done toll gate opens.

V. APPLICATIONS

- Autonomous and Shared Mobility Services
    - Self-driving and ride-sharing EVs can autonomously charge without human intervention, ensuring continuous operation.
    - Reduces operational costs for fleet services, making EV adoption more viable.
- Public Transportation and Commercial Fleets
    - Wireless charging systems in bus stops, taxi stands, and depots enable efficient energy transfer for electric buses, taxis, and delivery vehicles.
    - Reduces congestion and improves urban mobility.
- Smart Cities and IoT Integration
    - Wireless EV charging can be integrated with smart grids and IoT-enabled systems, optimizing power distribution and energy efficiency.
- Supports bidirectional charging, allowing EVs to act as energy storage units for smart grids.

VI. CONCLUSION

Next-generation wireless charging technology represents a significant advancement in electric vehicle (EV) power transfer, offering improved efficiency, convenience, and scalability. By eliminating the need for physical connectors, wireless charging enhances user experience, reduces maintenance costs, and enables seamless integration into smart transportation systems. Innovations such as dynamic charging, higher power transfer capabilities, and bidirectional energy flow are covering the way for a more sustainable and interconnected EV ecosystem. As research and development continue to push the boundaries of efficiency and cost-effectiveness, wireless EV charging is poised to play a important role in the broadpread adoption of electric mobility, ultimately contributing to a cleaner and more energy-efficient future.

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