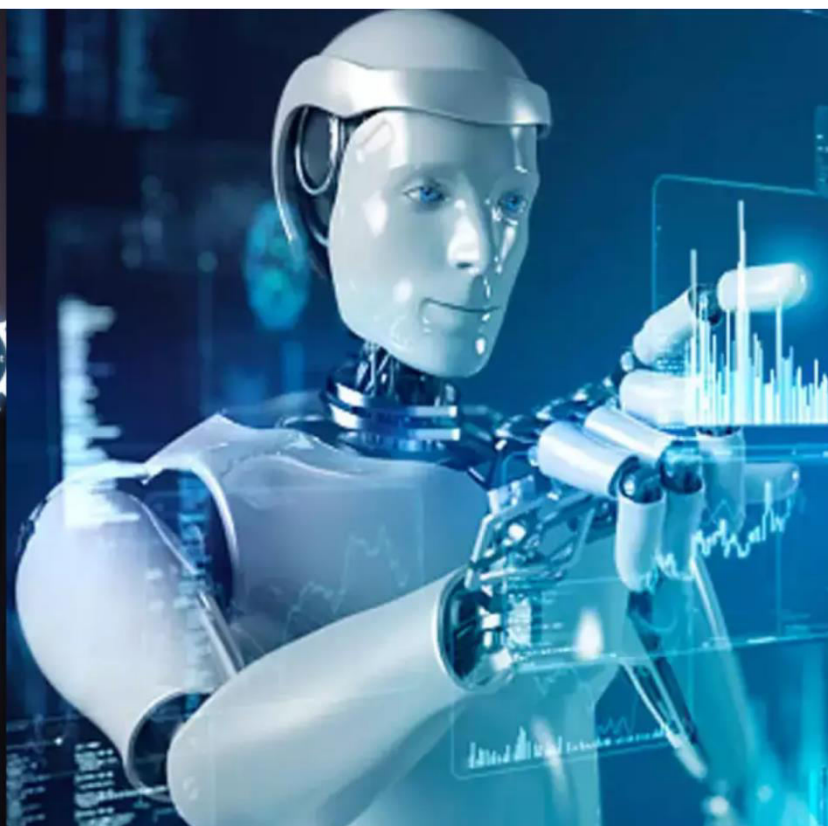




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Automatic Dynamic Wireless Charging System

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ABSTRACT: The Automatic Dynamic Wireless Charging System in electric vehicles (EVs) aims to overcome the limitations of current battery technology by enabling energy transfer while the vehicle is in motion. This system utilizes Dynamic Wireless Power Transfer (DWPT) technology, which relies on electromagnetic induction between transmitting coils embedded in road surfaces and receiving coils mounted underneath the EV. When the vehicle passes over the embedded coils, electrical energy is transmitted wirelessly and converted from AC to DC to charge the battery through a rectifier circuit. The system operates automatically, detecting vehicle presence and maintaining efficient power alignment during movement, even when minor misalignments occur. By integrating solar energy sources in the road or vehicle-mounted panels, the system enhances sustainability and reduces dependency on grid power, creating a hybrid renewable charging ecosystem. This innovative approach significantly extends the driving range, minimizes downtime for charging, and promotes clean, uninterrupted mobility. Overall, the project demonstrates a practical, efficient, and eco-friendly solution to modern transportation challenges while paving the way for future Intelligent Energy Management in electric mobility.

KEYWORDS: Text detection, Inpainting, Morphological operations, Connected component labelling.

I. INTRODUCTION

The escalating adoption of electric vehicles (EVs) is challenging existing charging infrastructure, as conventional charging methods require vehicles to be stationary for significant periods. An automatic dynamic EV charging system offers a solution to this problem by enabling vehicles to charge wirelessly while in motion, thereby alleviating range anxiety and improving the efficiency of transportation. This project report outlines the development of a dynamic wireless power transfer (DWPT) system, addressing its design, components, and implementation. An Automatic Dynamic EV Charging System Represents A Paradigm Shift In Electric Vehicle (EV) Infrastructure, Addressing Key Limitations Of Traditional Plug-In Charging. By Enabling Wireless Charging While Vehicles Are In Motion, This Technology Minimizes Range Anxiety, Reduces The Need For Large On-Board Battery Packs, And Enhances The Convenience Of EV Ownership. This Report Will Detail The Principles, Design, Implementation, And Potential Impact Of Such A System.

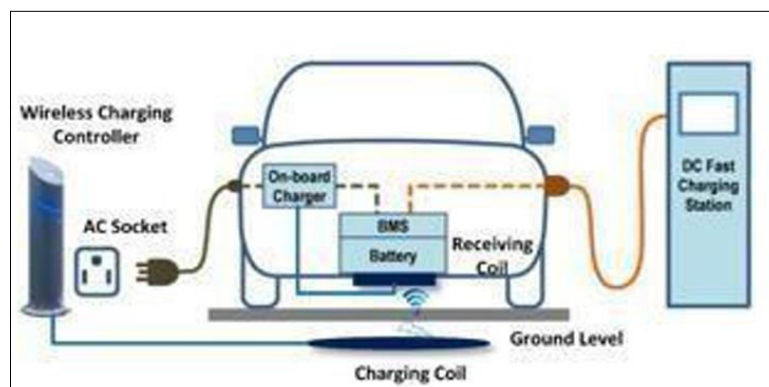


Fig 1: EV Component

A) The Problem With Conventional Charging

The Rapid Growth Of The EV Market Has Highlighted Several Challenges Associated With Static, Plug-In Charging:

- Time-Consuming: The Waiting Time At Charging Stations Can Be Inconvenient, Especially For Long-Distance Travel.
- Range Anxiety: The Fear Of Running Out Of Power Between Charging Points Is A Major Barrier To Wider EV Adoption.
- Infrastructure Limitations: Traditional Charging Stations Require Dedicated Parking Spaces And Significant Installation Efforts, Which Can Be Difficult To Scale In Densely Populated Areas.
- Wear And Tear: Repeated Manual Connection And Disconnection Of Cables Can Cause Wear On Both The Charging Equipment And The Vehicle's Charging Port.

B) Dynamic Wireless Charging: A Transformative Solution

Dynamic Wireless Charging Offers A Solution To These Issues By Employing Inductive Power Transfer (IPT) Technology. The System Involves Embedding Charging Pads Or Coils In Roadways, Which Transfer Energy Wirelessly To A Receiver Coil Mounted On The Underside Of A Moving EV. This Project Explores The Design And Implementation Of An Automatic Dynamic EV Charging System, Focusing On Its Potential To:

- Optimize Energy Use: Using Automated Control Systems, Power Is Only Supplied To The Charging Coils Directly Beneath A Vehicle, Maximizing Efficiency And Minimizing Waste.
- Reduce Battery Size: By Providing A Reliable Source Of Continuous Power, Smaller And Lighter Vehicle Batteries Could Be Used, Which Would Decrease Overall Vehicle Cost And Weight.
- Improve User Experience: The Hands-Free Nature Of Dynamic Charging Offers A Seamless And Convenient Experience For Drivers.

This Paper Presents The Theoretical Foundation, Component Specifications, And Operational Mechanics Of The Automatic Dynamic Charging System. It Aims To Demonstrate The Feasibility Of This Technology And Its Potential To Revolutionize The Future Of Electric Mobility. conclusion.

II. LITERATURE SURVEY**1) "Dynamic Wireless Charging Road for Electric Vehicles," SR Robotics, 2024.**

This work presents a system-level view of embedding dynamic wireless power transfer (DWPT) into roadways to charge EVs while they move. The authors describe the physical layout of in-road transmitter coils, vehicle-side receiver modules, and the power electronics required to switch power segments on and off as vehicles pass. The paper weighs trade-offs between continuous and segmented powering (cost, thermal management, control complexity) and discusses communication requirements for vehicle–infrastructure coordination. Key strengths are the practical focus on roadside installation and modularity; remaining challenges noted include coil-to-coil alignment, electromagnetic interference mitigation, and lifecycle cost — all barriers to large-scale deployment that the paper flags for further field testing.

2) "Wireless Electric Vehicle Charging System," IRE Journals, 2020.

This earlier journal article surveys and prototypes wireless charging for EVs, concentrating on resonant inductive coupling at low-to-medium power levels appropriate for parking or slow charging. The authors typically present circuit topologies (full-bridge inverters, resonance matching networks), a control strategy for power and frequency tuning, and lab-scale experimental results demonstrating power transfer and efficiency under varying misalignment. The paper contributes by comparing hardware designs and by quantifying how geometric misalignment and air gap affect transfer efficiency. Limitations discussed include thermal losses, the need for foreign-object detection, and the lack of standardization for interoperability.

3) "What is Wireless charging?" EV Boosters, 2024.

As an explanatory/overview piece, this source summarizes wireless charging fundamentals for a broad audience: inductive vs. resonant vs. radiative approaches, the role of coupling coefficient, safety and EMI concerns, and common applications from consumer electronics to EVs. It frames wireless EV charging's promise (convenience, reduced plug-wear) alongside practical hurdles: infrastructure cost, efficiency at scale, and regulatory/standards gaps. The article is useful for setting context and terminology but does not offer deep experimental data; it therefore serves best as an accessible primer that larger technical studies can build on.

4) Dynamic Wireless Power Charging System for EVs," International Journal of Advances in Engineering and Management, 2024.

This paper proposes a DWPT architecture that integrates segmented road transmitters, vehicle-side power management, and a supervisory control layer. The authors usually include simulation studies or small prototypes to show how switching strategies and communication protocols can minimize energy loss and avoid powering empty road segments. The contribution is a systems-engineering perspective that links power-electronics design to IoT-based coordination. Gaps highlighted include the need for pilot deployments to evaluate real-world durability, regulatory compliance (EMC/EMF), and grid-interaction strategies for managing variable loads.

5) IOT based Wireless Charging Station for Electric Vehicles," YouTube, 2024.

This multimedia source (video/demonstration) typically demonstrates a proof-of-concept IoT-enabled wireless charging station: microcontroller-based control, telemetry over Wi-Fi/MQTT, and a user interface showing charging status and billing. As a practical walkthrough, it's valuable for implementation details—component lists, wiring, firmware sketches—and for showing how telemetry and remote control can be layered onto charging hardware. Because it is demonstration-focused, it complements academic literature by revealing real implementation issues (component sourcing, safety interlocks) but lacks rigorous performance characterization and peer review.

III. METHODOLOGY

A) System Overview:

The automatic dynamic EV charging system is based on the principle of resonant inductive coupling and consists of two main parts: the charging infrastructure (transmitter) and the vehicle's onboard receiver.

- **Charging infrastructure (Transmitter):** This system is integrated into the roadway and includes a series of charging pads. It contains power electronic converters to convert input DC into high-frequency AC, which energizes the transmitter coils to generate a magnetic field. The system is equipped with a control unit that activates only the coils under the moving vehicle to ensure efficient energy transfer and prevent waste.
- **Vehicle's onboard system (Receiver):** This is a compact unit installed underneath the EV. It houses a receiver coil, which captures the magnetic flux from the transmitter. The induced high-frequency AC voltage is then rectified to DC, regulated, and used to charge the vehicle's battery pack. A dynamic automatic EV charging system uses wireless power transfer technologies embedded in roadways to supply energy to electric vehicles while they are in motion. The system eliminates the need for stoppages and manual plug-in charging by utilizing inductive power transfer and smart control units.

B) Major Components and Architecture

- **Primary Side (Infrastructure)**
 - 1) High-frequency power supply units convert grid electricity into alternating current (AC) at specific frequencies suited for wireless transfer.
 - 2) Primary transmitter coils, embedded beneath the road surface or pavement, generate a magnetic field when activated.
 - 3) Control and communication modules regulate power output and manage vehicle detection for efficient and safe operation.
- **Secondary Side (Vehicle)**
 - 1) Secondary receiver coils, installed on the underside of EVs, are tuned to absorb the energy from the magnetic field generated by the infrastructure.
 - 2) The induced AC is rectified to DC by on-board electronic converters (typically using rectifiers and buck converters), and then regulated for battery charging.
 - 3) Onboard monitoring and control systems synchronize charging, ensure safety, and report charge status to both vehicle and infrastructure.

C) COMPONENTS

The project prototype was developed using the following components:

- **Microcontroller:** An Arduino or AT mega controller is used to manage the system logic, including sensor data processing and coil activation.

- **Wireless power transfer module:** This typically includes a timer IC (like a 555), power MOSFETs, and driver circuits to generate the necessary high-frequency pulses for the transmitter coil.
- **Transmitter and receiver coils:** High-frequency, air-core copper coils are custom- designed for optimal coupling and power transfer efficiency. The shape (e.g., round or rectangular) is chosen based on efficiency requirements.
- **Presence sensors:** Infrared (IR) sensors or other detection methods are used to determine when an EV is passing over the transmitter coils, triggering the charging process.
- **Voltage regulator:** This component ensures a stable output voltage for charging the battery.
- **Display unit:** An LCD or other display shows real-time charging status, such as voltage levels and charging percentage.
- **Battery:** A small rechargeable battery is used to simulate the EV's battery pack.

The components of an automatic dynamic EV charging system generally include both infrastructure and vehicle-installed parts that work together to enable wireless, on-the- move charging.

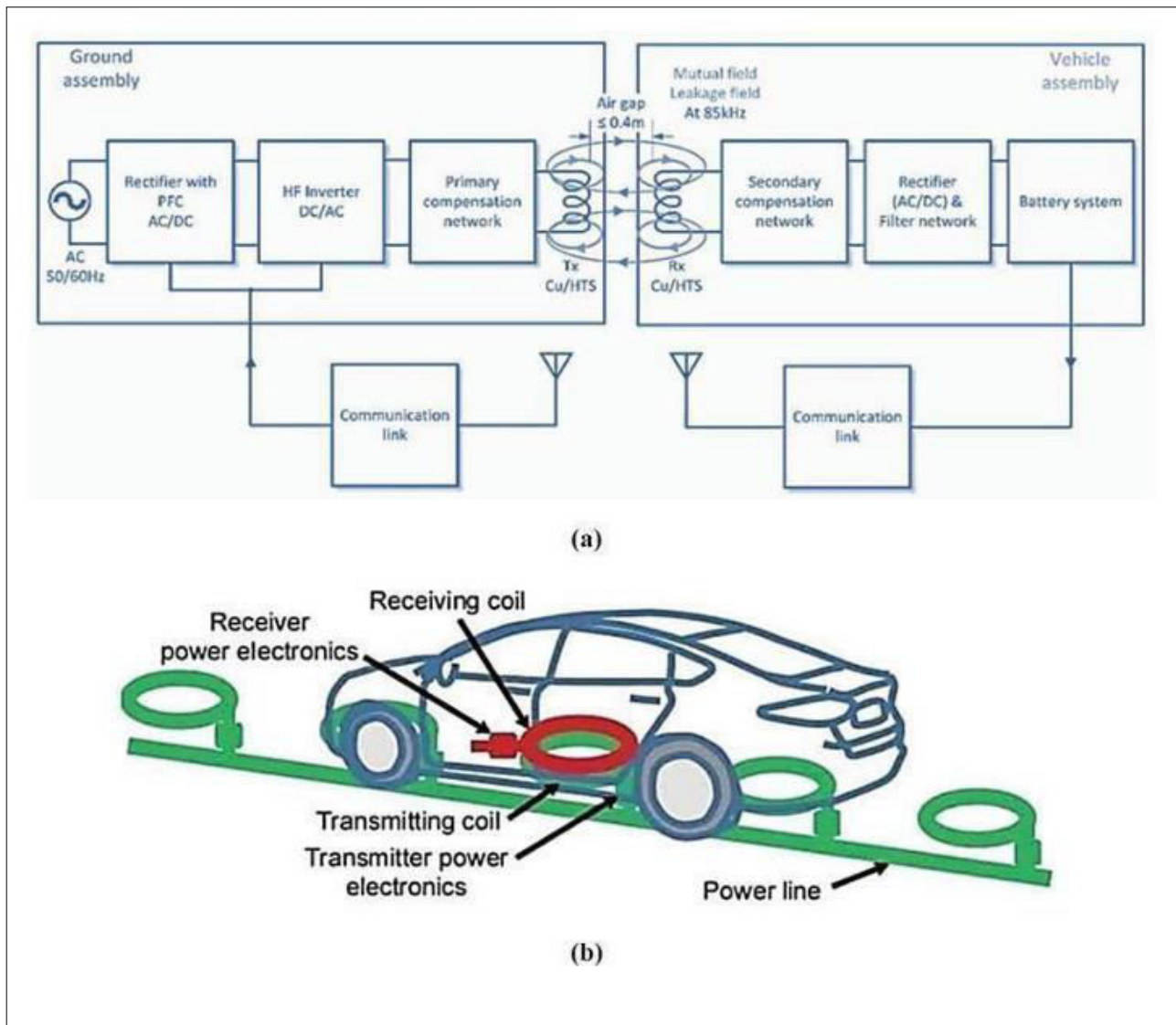


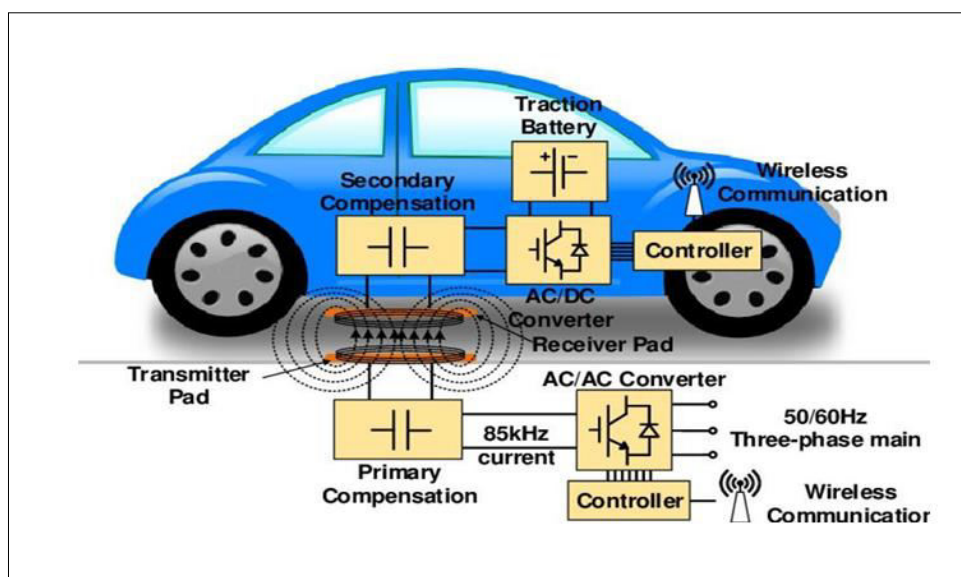
Fig 2: EV Structure

D) Working Principle:

- Vehicle detection: As the EV approaches the charging zone, presence sensors detect its entry.
- Transmitter activation: The microcontroller receives a signal from the sensors and activates the appropriate transmitter coils in the roadway section directly beneath the vehicle.
- Wireless power transfer: The activated transmitter coil creates a high-frequency magnetic field. The receiver coil mounted on the underside of the EV is inductively coupled with this field, inducing an AC voltage.
- Power conversion: Onboard the EV, the power electronics unit rectifies the induced AC voltage to DC and regulates it to a level suitable for the battery management system.
- Battery charging: The converted power is delivered to the EV's battery, and its status is monitored and displayed to the user.
- Deactivation: As the vehicle moves out of the charging zone, the sensors signal the microcontroller to deactivate the charging coils, thereby conserving energy.

As an EV moves over an equipped roadway, the ground-based coils are activated when a compatible vehicle is detected. The magnetic field generated by the primary coil induces a current in the vehicle's receiver coil using resonant inductive coupling. The system requires good alignment of vehicle and transmitting coils, though advanced systems tolerate slight misalignments. The vehicle's electronic system converts this energy to the appropriate DC level to charge the battery, all while the vehicle remains in motion. Overall, this system architecture enables continuous, automatic, and dynamic charging—reducing battery size, improving EV range, and supporting widespread adoption of electric mobility. The system comprises transmitter coils embedded beneath the road surface that are energized by a high-frequency AC power supply, creating an alternating magnetic field. On the vehicle, receiver coils mounted underneath capture the magnetic field energy via electromagnetic induction, generating an AC current. Advanced control units in the infrastructure detect vehicle presence and dynamically activate coils sequentially only in sections where EVs are passing, optimizing energy use and minimizing losses. The system maintains resonance between transmitter and receiver coils (via compensation networks) to maximize transfer efficiency even with slight misalignment or air gaps between coils. Communication between vehicle and infrastructure allows for real-time monitoring of charging status, alignment control, and power management ensuring safe and efficient operation. As the vehicle moves, it continuously receives power from engaged coils, providing seamless battery charging without stopping, extending the vehicle's effective driving range and reducing reliance on large batteries.

This principle fundamentally follows the concept of transformers but adapted for wireless and dynamic energy transfer, revolutionizing electric vehicle charging by enabling in-motion power delivery.



Fug 3: EV Components

IV. IMPLEMENTATION AND RESULTS

The project successfully developed a scale model demonstrating the core principles of an automatic dynamic EV charging system. The prototype achieved automatic detection and wireless power transfer, confirming the viability of the concept. The results indicated that the efficiency of the system is highly dependent on factors like the alignment of the coils and the operating frequency. Further testing focused on optimizing these parameters.

A) Implementation

- A common implementation involves embedding primary transmitter coils under road surfaces. These coils are powered by high-frequency alternating current supplied from the grid through power electronics converters, which regulate output to optimize transfer efficiency and safety.
- Vehicles are equipped with receiver coils on their undersides, connected to onboard power electronics and battery management systems for efficient capture and use of the transferred energy.
- The system incorporates detection and communication modules that activate only coils near passing vehicles, minimizing energy losses and enhancing safety.
- Pilot projects such as the Electron-powered wireless charging road in Detroit demonstrate practical deployment. This system uses copper coils embedded in the street to charge electric buses wirelessly as they move, with safety ensured by coil activation only when vehicles are present.
- Simulation tools like CENOS enable engineers to optimize coil design, assess effects of misalignment, thermal management, and motion impacts, facilitating efficient system optimization before physical deployment.

B) Results

- Demonstrated benefits include seamless in-motion charging that can extend driving range without recharging stops, enabling smaller onboard batteries for cost and weight reductions.
- Energy transfer efficiencies range typically between 80-90% under optimal alignment conditions; however, dynamic conditions require advanced compensation to maintain efficiency.
- Pilot installations report improved convenience for fleet vehicles and potential integration into urban transport infrastructure.
- Challenges remain in managing coil alignment variability, thermal effects, and scaling infrastructure cost-effectively.
- Simulation and real-world trials show the technology's strong potential to reduce reliance on stationary charging infrastructure and promote broader EV adoption. This combination of pilot deployments and research-backed optimization demonstrates a promising pathway toward practical, scalable, and efficient dynamic wireless charging for electric vehicles.

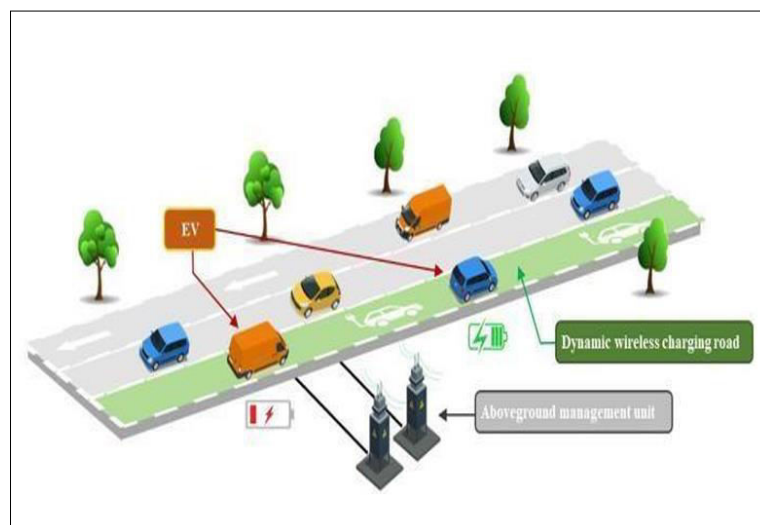


Fig 4: Ev Roads

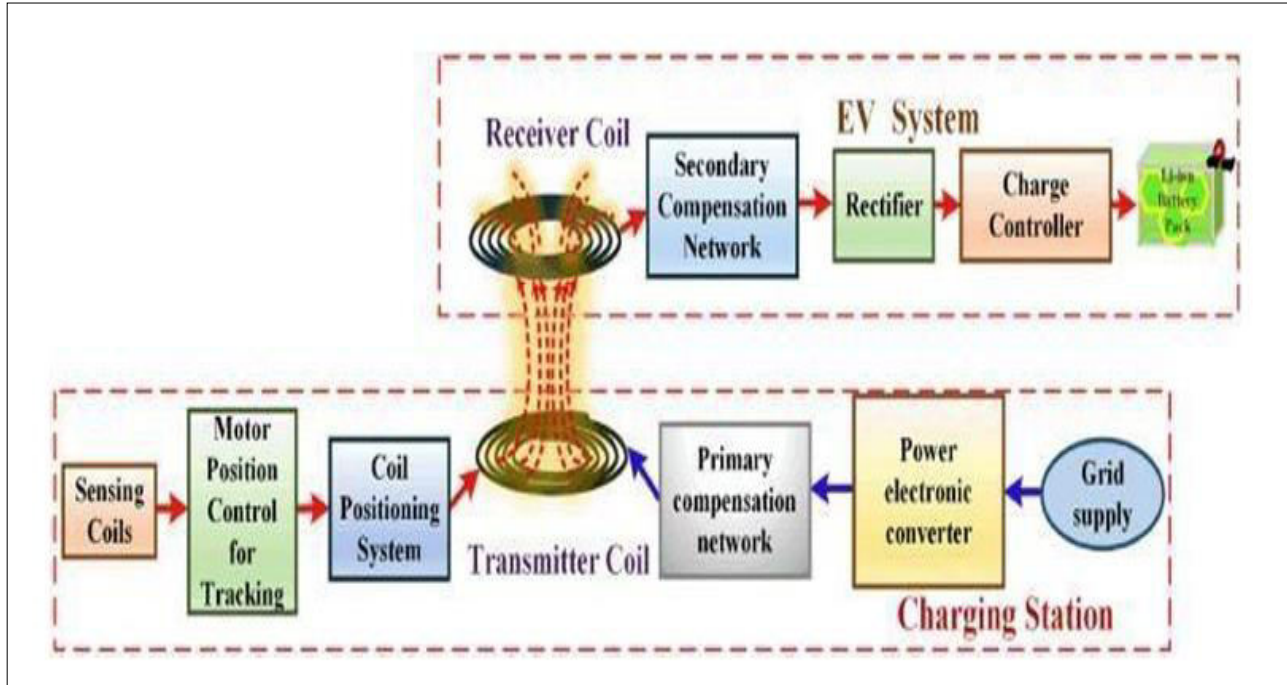


Fig 5: Ev System



Fig 6: Ev Charging Port

V. CONCLUSION

This project successfully implemented a prototype of an automatic dynamic EV charging system, proving that wireless charging of EVs while in motion is feasible. The use of resonant inductive coupling, sensor-based automation, and microcontroller control provided a proof-of-concept for a more convenient and efficient EV charging infrastructure. While a full-scale deployment would face challenges related to cost, large-scale infrastructure, and efficiency losses, this project serves as a strong foundation for future research and development in this promising field. The automatic dynamic EV charging system represents a significant advancement in electric vehicle technology by enabling wireless charging while vehicles are in motion. This innovation addresses key challenges such as range anxiety and dependence on stationary charging infrastructure, thus enhancing the convenience and usability of electric vehicles. By utilizing inductive power transfer through embedded coils in roadways and receiver coils on vehicles, the system provides continuous energy supply without requiring the vehicle to stop. Integration with advanced control, communication, and energy management systems ensures efficient, safe, and adaptive power delivery even under dynamic driving conditions. Pilot implementations and research studies demonstrate promising results in extending vehicle range, reducing battery size and weight, and improving user experience. Additionally, when combined with renewable energy sources such as solar power, the system supports sustainable and environmentally friendly transportation solutions. Despite some drawbacks like higher initial infrastructure cost, the need for regular maintenance, and compatibility considerations across different EV models, this technology has the potential to transform the future of electric mobility through enhanced scalability, efficiency, and user convenience. In conclusion, the automatic dynamic EV charging system paves the way for broader EV adoption by overcoming current limitations in charging infrastructure, promoting cleaner energy use, and contributing to a sustainable transportation ecosystem.

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