SMART INFRASTRUCTURE FOR IN-MOTION EV CHARGING

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Keywords:

Electric Vehicles (EVs), Dynamic Wireless Charging, Inductive Power Transfer (IPT), On-Road Charging Infrastructure, Internet of Things (IoT), NodeMCU ESP8266, Real-Time Monitoring, ThingSpeak Platform, Smart Transportation Systems.

Introduction:

The increasing shift toward electric vehicles demands faster and more convenient charging methods than traditional plug-in systems. Conventional chargers require vehicles to stop, leading to delays, inconvenience, and range anxiety. To address this, our project “Smart Infrastructure for In-Motion EV Charging” demonstrates a wireless charging concept that allows EVs to receive power while moving using inductive energy transfer. The system is supported by an IoT-based monitoring setup using ESP8266 programmed in Embedded C, which provides real-time tracking of temperature, voltage, and battery percentage through the ThingSpeak cloud platform. Our prototype showcases a practical step toward smarter, continuous, and cable-free EV charging.

Objectives:

1. To design and implement an in-motion wireless electric vehicle charging system based on inductive power transfer principles, allowing electric vehicles to receive energy continuously while moving, thereby reducing charging interruptions and dependence on stationary charging stations.
2. To develop an IoT-enabled monitoring and data acquisition framework that captures real-time parameters such as battery voltage and temperature and transmits them to a cloud platform, enabling safe operation, fault detection, and performance visualization of the charging system.
3. To experimentally evaluate the feasibility, stability, and efficiency of dynamic wireless charging, including the effectiveness of segmented coil activation, wireless power transfer during motion, and system response under varying alignment and movement conditions.
4. To simulate the proposed system using appropriate software tools and microcontroller-based implementation (NodeMCU ESP8266) for validation and performance evaluation.

Methodology:

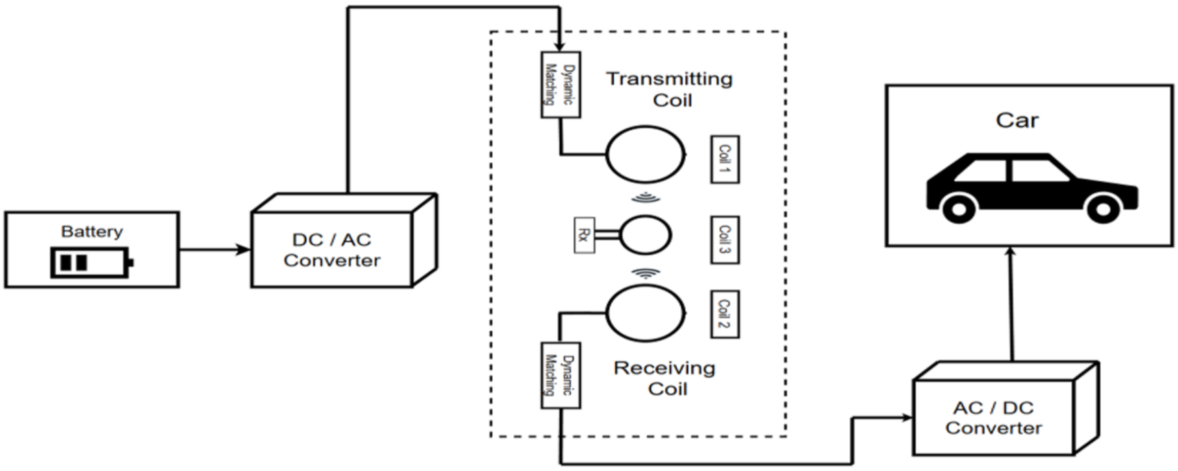

Figure 1: Block Diagram of In Motion Wireless Electric Vehicle Charging System

Transmitter Coil Setup

- Transmitter coils are designed, wound, and placed beneath the roadway section.
- A high-frequency AC supply energizes the coils to generate the alternating magnetic field.
- Coils are arranged sequentially to enable continuous charging as the vehicle moves.

Dynamic Wireless Power Transfer

- As the EV model passes over the energized coils, magnetic coupling induces voltage in the receiver coil.
- Sequential coil activation ensures uninterrupted power transfer along the charging track.

Receiver-Side Power Conditioning

- The induced AC voltage is rectified using a bridge rectifier.
- A regulation circuit smoothens and stabilizes the output for safe battery charging.
- Proper alignment is maintained to improve coupling efficiency during motion.

Sensor Integration for Monitoring 4

- Voltage and temperature sensors are connected on the receiver side.
- These sensors measure power levels and thermal behavior in real time.
- Data is collected and processed by the NodeMCU ESP8266 microcontroller.

IoT-Based Data Transmission

- The NodeMCU uploads sensor readings to the ThingSpeak cloud platform via Wi-Fi.
- A web dashboard visualizes real-time voltage, temperature, and charging patterns.
- Cloud analytics assist in early fault detection and performance assessment.

Prototype Testing and Evaluation

- A moving EV model is tested over the charging track.

- Charging continuity, voltage variations, and thermal stability are recorded.
- LCD output and cloud logs are used to validate the system's performance.

Result and Conclusion:

1. In conclusion, the developed prototype of the Smart Infrastructure for In-Motion EV Charging system successfully demonstrates the concept of dynamic wireless power transfer using inductive coupling. The system was tested under real-time conditions, and the results indicate stable energy transmission between the transmitting and receiving coils.
2. The IoT-based monitoring system using ESP8266 and ThingSpeak effectively recorded and displayed key parameters such as voltage, temperature, and battery percentage. The observed voltage remained stable with minor fluctuations, and the temperature readings stayed within safe operational limits. Additionally, the battery percentage showed a gradual increase, confirming successful charging while the vehicle is in motion.
3. These results validate that the system operates efficiently and provides a reliable solution for continuous EV charging without requiring stationary charging infrastructure. Furthermore, the integration of IoT ensures real-time monitoring and enhances system safety and usability.
4. Overall, the project proves to be a practical, scalable, and innovative approach toward developing smart and sustainable EV charging infrastructure for future applications.

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Future Scope:

The future scope of this project includes:

1. Enhancing the system to support high-power real-world electric vehicles with improved efficiency and faster charging capability.
2. Integrating advanced technologies such as AI and smart sensors for automated power control, fault detection, and optimized energy distribution.
3. Expanding the infrastructure for large-scale implementation on highways and smart cities with multiple vehicle support and improved wireless charging range.