STATIC WIRELESS CHARGING FOR ELECTRIC VEHICLES USING IOT

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College : SJB Institute of Technology, Bengaluru
Branch : Department of Electronics and Communication Engineering
Guide : Dr. Supreeth H.S.G
Student(s) : Ms. Anshitha B
Ms. Asha R
Ms. Deepika B
Ms. Devika S Nairy

Keywords:

Electric Vehicles (EV), Static Wireless Charging, Wireless Power Transfer (WPT), Inductive Coupling, IoT-enabled Monitoring, Smart Energy Management, ESP32 Microcontroller, Coil Alignment Optimization, Sustainable Transportation.

Introduction:

The increasing adoption of electric vehicles (EVs) requires efficient, safe, and user-friendly charging solutions. Conventional plug-in charging methods face challenges such as mechanical wear, safety risks, and lack of automation. To address these issues, this project proposes an IoT-enabled static wireless charging system using resonant inductive coupling, enabling contactless power transfer between transmitter and receiver coils without physical connections.

The system integrates an ESP32 microcontroller to monitor parameters such as voltage, current, and battery status in real time through a cloud-based platform. This approach enhances safety, convenience, and energy management, making it a cost-effective and scalable solution for smart parking infrastructure and future EV charging systems.

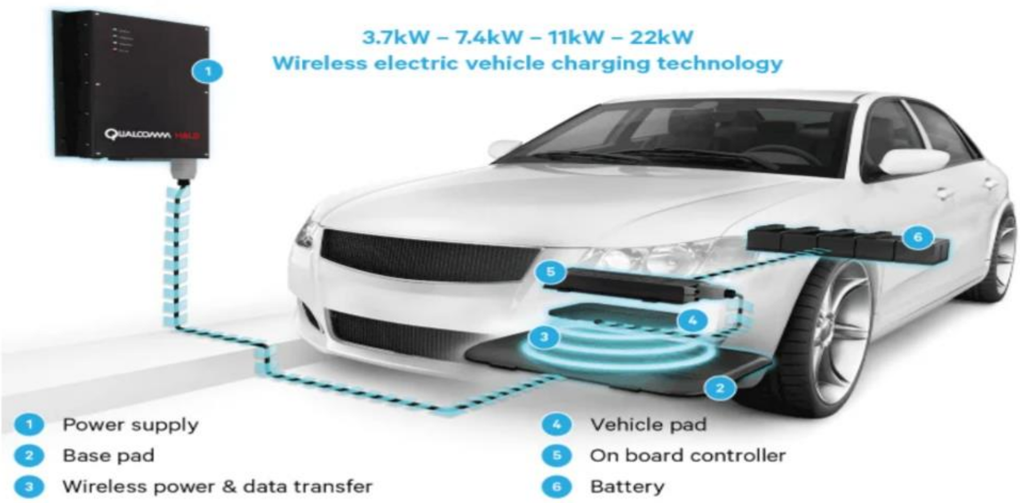

Figure 1: IoT- Enabled Static Wireless charging for Electric Vehicles

Objectives:

1. To provide a convenient and cable-free charging experience for EV users.
2. To enable automatic and reliable power transfer using electromagnetic induction.
3. To integrate real-time monitoring of charging parameters such as battery level, alignment, and power usage through IoT-enabled mobile or web applications.

Methodology:

Electric vehicles are a clean alternative to fuel-based transport, but plug-in charging has issues like cable wear, safety risks, and inconvenience.
This project proposes a static wireless charging system using magnetic induction with IoT monitoring for safe and efficient EV operation.
The following steps are involved in the proposed methodology:

1. AC Power Conversion
2. High-frequency excitation of transmitter coil
3. Wireless inductive power transfer
4. Receiver side rectification and voltage regulation
5. Battery charging and storage
6. IoT monitoring and display of charging performance

The system uses a 230V AC supply stepped down to 12V AC, which is converted to DC using a rectifier and filter capacitor. This DC powers a high-frequency driver circuit that energizes the transmitting coil to create an alternating magnetic field. When the EV prototype is placed above it, the receiving coil captures the magnetic flux and induces an AC voltage for charging.

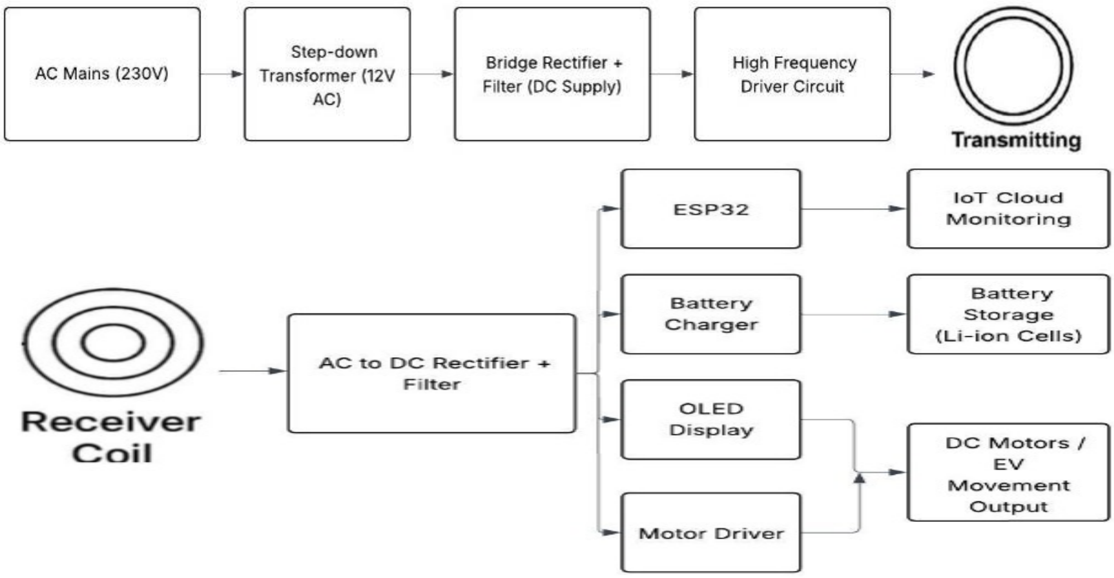

Figure 3: Receiver-Block Diagram

The received AC is rectified to 5V DC to charge Li-ion batteries, and the stored energy drives DC motors via a motor driver for vehicle movement.
An ESP32 monitors key parameters and displays/transmits data via OLED and Blynk, ensuring efficient, safe, and smart EV charging.

Result and Conclusion:

In conclusion, the developed prototype successfully demonstrates efficient wireless power transfer using inductive coupling between the transmitter and receiver coils, validating the feasibility of static wireless charging for electric vehicles. The system effectively converts the induced AC into stable DC for reliable battery charging, while experimental results highlight the importance of proper coil alignment in improving power transfer efficiency. The integration of the ESP32 microcontroller enables real-time monitoring of key parameters such as voltage, current, temperature, and battery status, which are transmitted to a cloud platform for remote access. Additionally, the OLED display provides instant local feedback, ensuring system transparency and reliability. The overall system operates safely and consistently under various conditions, proving its practicality. The prototype also demonstrates effective energy storage using Li-ion batteries and controlled power delivery to the load, ensuring stable system performance. The IoT-based monitoring enhances user interaction by enabling remote supervision and data analysis. The system design ensures minimal energy loss and improved operational safety compared to conventional wired charging methods.

Project Outcomes & Industry Relevance:

The proposed project successfully demonstrates a functional prototype of an IoT-enabled static wireless charging system for electric vehicles, showcasing efficient contactless power transfer using inductive coupling. The system achieves reliable energy conversion, stable battery charging, and real-time monitoring of key parameters such as voltage, current, and temperature through IoT integration. The implementation highlights improved user convenience, enhanced safety by eliminating physical connectors, and reduced mechanical wear compared to conventional charging systems. The developed solution is cost-effective, compact, and scalable, making it suitable for small-scale EV applications and prototype-level validation. From an industry perspective, the project aligns with the growing demand for smart and automated EV charging infrastructure in urban environments. It supports the transition toward sustainable transportation by enabling cleaner and more efficient energy delivery systems. The integration of IoT facilitates remote monitoring, predictive maintenance, and data-driven energy management, which are essential for modern smart grid applications. Furthermore, the concept can be extended to commercial charging stations, smart parking systems, and autonomous vehicle ecosystems, making it highly relevant to future mobility solutions. Overall, the project contributes to advancements in wireless power transfer, embedded systems, and IoT-based smart energy technologies, meeting current industry trends and future technological requirements.

Working Model vs. Simulation/Study:

Working Model

This project is a working model as it involves the design and development of a physical prototype demonstrating real-time wireless power transfer using inductive coupling along with IoT-based monitoring through an ESP32 microcontroller. The system is implemented using actual hardware components such as transmitter and receiver coils, rectifier circuits, battery charging module, and display unit, ensuring practical validation of the concept. It successfully demonstrates energy transfer, battery charging, and real-time parameter monitoring under working conditions. The developed prototype verifies system performance, efficiency, and reliability, making it suitable for real-world EV charging applications and not just theoretical or simulation-based analysis.

Project Outcomes and Learnings:

The project successfully demonstrates an IoT-enabled static wireless charging system for electric vehicles using inductive coupling. It provided a clear understanding of wireless power transfer and energy conversion techniques. Practical experience was gained in working with hardware components such as coils, rectifiers, battery modules, and ESP32. The integration of IoT enabled real-time monitoring and improved system functionality. The project also enhanced skills in circuit design, debugging, and system integration. Challenges such as coil alignment and power efficiency were addressed effectively. Overall, the project strengthened both technical knowledge and hands-on engineering skills.

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Future Scope:

The future scope of this project includes:

1. Implementation of dynamic wireless charging can be explored to enable electric vehicles to charge while in motion, reducing dependency on stationary charging infrastructure and improving overall efficiency. This can significantly enhance user convenience and reduce charging downtime.
2. Power transfer efficiency can be enhanced by optimizing coil design, resonance frequency tuning, and improving alignment techniques to minimize energy losses. Advanced materials and better coupling mechanisms can further improve performance.

3. Integration with renewable energy sources such as solar and wind can be incorporated to develop a sustainable and eco-friendly wireless charging system. This helps in reducing carbon footprint and supports green energy initiatives.
4. The system can be scaled to support higher power levels suitable for real-time electric vehicle applications and commercial charging stations. This makes the system adaptable for practical deployment in industries.
5. Advanced IoT features such as mobile applications, remote control, data analytics, and predictive maintenance can be developed to improve user experience and system reliability. Enhanced security features can also be implemented for safe communication.
6. The project can be extended to integrate with smart grid and smart city infrastructure, enabling efficient energy management, load balancing, and large-scale deployment. This supports future intelligent transportation systems and smart infrastructure development.