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Wireless Charging Station for Electric Vehicle

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Abstract

To simplify the charging process, lessen reliance on physical connectors, and improve overall user convenience, this article describes the design and execution of an efficient wireless charging station for electric cars (EVs). The system uses the microcontroller to control all the parts that are added to the project, such as LCD, UNO, etc. Safety is a key design; it integrates thermal management and fault detection mechanisms to reduce risks such as overheating, short circuits, and electromagnetic interference. The charging pad is constructed from robust, weather-resistant materials, ensuring reliable operation in both indoor and outdoor environments under varying climatic conditions. The modular nature of the design also supports easy scalability and adaptability to different vehicle types and power requirements. Improving automation through cutting-edge communication technologies like vehicle-to-grid (V2G) systems is one of the main areas of research. Electric vehicles can interact intelligently with the power grid thanks to V2G communication, which enables them to both consume energy for charging and return stored energy to the grid as needed. In addition to managing energy demand and enhancing total energy use, this bidirectional energy flow can assist in stabilizing the grid. Future developments in wireless charging technology will be in high demand as it continues to progress. These include improved automation through vehicle-to-grid (V2G) communication, quicker charging rates, increased power transfer efficiencies, and integration with renewable energy sources like solar and wind. All these advancements will help create an environment for electric mobility that is more intelligent, sustainable, and user-friendly.

Keywords: Wireless charging, electric vehicles, inductive power transfer, power electronics, EV charging, control systems, energy efficiency

INTRODUCTION

The world is adopting electric vehicles (EVs) for transportation. However, conventional plug-in charging methods present challenges in terms of user convenience, maintenance, and safety. Wireless charging technology offers a promising alternative by enabling contactless energy transfer, reducing wear and tear, and enhancing the overall user experience [1, 2].

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This study focuses on the design and implementation of a wireless charging station tailored for EV applications. The system utilizes a microcontroller-based control unit to manage the power flow, ensure efficient energy transmission, and maintain operational safety. It focuses on durability and environmental adaptability, and the charging pad is designed for both indoor and outdoor use.

By addressing key points such as performance, safety, and scalability, this study aims to contribute to the ongoing development of intelligent and sustainable EV charging solutions.

EVs are in demand as sustainable alternatives to traditional transportation. However, conventional plug-in charging methods are inconvenient and prone to wear. Wireless charging offers a more user-friendly solution using contactless power transfer. This study presents a wireless EV charging system featuring a microcontroller-based control unit for efficient power delivery and safety monitoring. The system is designed for reliable use in both indoor and outdoor environments, aiming to enhance convenience, safety, and sustainability.

As the demand for EVs continues to rise, the need for efficient, safe, and user-friendly charging solutions is growing. Traditional plug-in systems are risky; for example, they can overheat, give shocks, and require more time for connection. Wireless charging technology offers a modern solution by enabling contactless power transfer through electromagnetic induction, thereby improving convenience and safety.

This study proposes the design and development of a wireless charging station for EVs, incorporating a microcontroller-based control system to regulate the power flow and monitor critical parameters in real time. The system focuses on high efficiency, fault detection, and thermal management to ensure reliable operation. Charging stations are suitable for various environments, supporting both indoor and outdoor use.

This study aims to provide a good and easy method for wireless EV charging that aligns with the growing emphasis on automation, renewable energy integration, and sustainable transportation infrastructure.

LITERATURE SURVEY

Conventional EV charging systems rely on plug-in systems that, although efficient, have drawbacks such as mechanical wear, inconvenience, and safety risks such as overheating and electrical arcing. Consequently, wireless charging has emerged as a contemporary alternative, with contactless energy transfer via electromagnetic induction, making the process safer and more convenient [3–4].

To solve these problems, many researchers have explored different wireless charging methods. One extensive report entitled "Wireless Charging for Electric Vehicles – A Survey and Complete Guide" explains the fundamental working principles and problems of wireless power transfer (WPT), such as system architectures, coil design, and control strategies. It highlights efficient energy conversion and standardization as key issues to be overcome for the mass adoption of EVs [5, 6].

Inductive charging remains the most practical WPT technique, particularly for static EV charging. However, the exact alignment between the receiver and transmitter coils is very important for effective power transfer. In the review article "A Review on Resonant Inductive Coupling Pad Design for Wireless Electric Vehicle Charging Application," the authors pointed out how judicious pad design enhances coil alignment and magnetic coupling, thereby increasing the efficiency of energy transfer [7, 8].

Dynamic charging has also been a focus, where cars are charged while moving. The paper "Double-Coupling Resonant Network for Dynamic Inductive Power Transfer Systems Used in EV Charging Applications" proposed a system to transfer energy as cars drive over coils embedded on roads. While innovative, such systems are costly and complex and hence are not suitable for mass use [9–10].

In addition, safety and regulatory issues are a concern in wireless systems. The research "Challenges and Barriers of Wireless Charging Technologies for Electric Vehicles" provides limitations such as electromagnetic interference (EMI), heat, and the requirement of sound safety measures. All of these are important for practical implementation, particularly in public infrastructure.

Furthermore, the article "Electric Vehicle Wireless Charging Technology: A State-of-the-Art Review of Magnetic Coupling Systems" explores the feasibility of using magnetic resonance-based charging technology, highlighting its aspect of offering greater efficiency for longer moderate distances. However, it cites a higher degree of complexity involved in tuning the system to resonate in actual use cases.

Our project extends this by suggesting a microcontroller-controlled wireless EV charging station based on resonant inductive coupling and ultrasonic sensing for the detection of EVs. In this system, using sensors and a controller, we can control the vehicle charging. The system is modular, low-cost, and easily deployed both indoors and outdoors to improve safety, user convenience, and adaptability for different EV models.

METHODOLOGY

The methodology adopted for developing the wireless charging station is described below. It involves both hardware integration and the implementation of control logic. The design is based on resonant inductive coupling, in which energy is transferred wirelessly through magnetically coupled coils. The system consists of two primary modules: transmitter and receiver sections.

In this transmitter module, a regulated power supply converts the AC mains to the required DC voltage. This DC is then switched to a high-frequency AC using an oscillator circuit, which is fed into the transmitter coil. A microcontroller unit (such as an Arduino Uno or ESP32) is used to manage the input from the ultrasonic sensor, which detects the presence of an EVs. When the car comes within the range, the power supply is started.

The LCD provides user feedback and shows "Vehicle Detected," "Access Granted," or "Charging."

The receiver module, located on the vehicle side, consists of a receiving coil that captures the magnetic field generated by the transmitter coil. This induced AC is then rectified and filtered to obtain DC power suitable for charging the battery or powering a simulated load. The system was tested in the laboratory with appropriate precautions.

The proposed wireless charging station uses resonant inductive coupling to transfer power wirelessly between the transmitter and receiver coils. An ultrasonic sensor was used to detect the presence of the vehicle. Once the vehicle is detected, a microcontroller is activated to start charging. The transmitter coil generates a magnetic field that is captured by the receiver coil on the EV side and converted into usable DC power. An LCD provided real-time system feedback. The entire setup was tested under laboratory conditions to evaluate its performance, efficiency, and reliability.

This project implements a wireless EVs charging system using resonant inductive coupling. It includes a high-frequency AC power supply connected to a primary coil that generates an oscillating magnetic field. The sensor detects the car. If both conditions are satisfied, the microcontroller activates the relay to initiate charging. A receiver coil placed in the EV captures the magnetic field and converts it into DC power via rectification and filtering. The LCD provided real-time updates on the charging status. All components, including the microcontroller, sensors, and coils, were integrated and tested in a controlled environment to evaluate the system's efficiency, range, and safety. The methodology ensures a contactless, secure, and automated charging experience, as shown in Figure 1.

- *Arduino Uno:* This serves as the central control unit for the charging station. It manages the charging process, monitors sensor data (such as temperature or proximity), and communicates with the EV's onboard systems.
- *ATmega328P:* As the microcontroller on the Arduino Uno, it runs the code and executes control of the charging process, handling data from the sensors, and managing communication protocols, as shown in Figure 2.

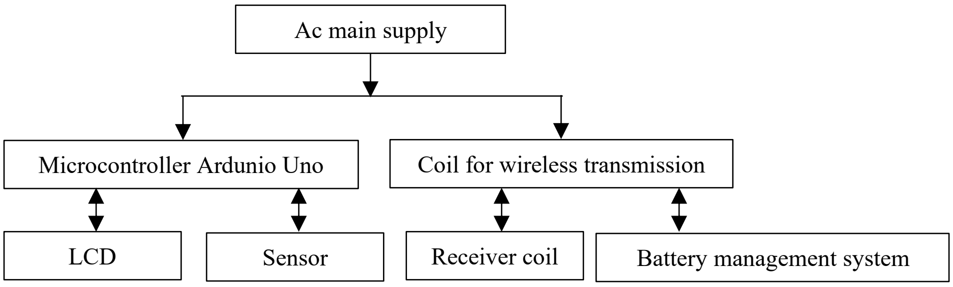

Figure 1. Vehicle detection of LCD.

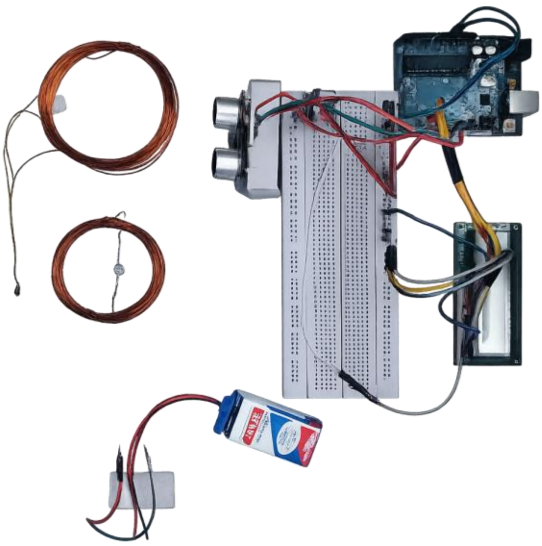

Figure 2. Hardware setup of the wireless EV charging system using transmitter and receiver coils with a microcontroller interface.

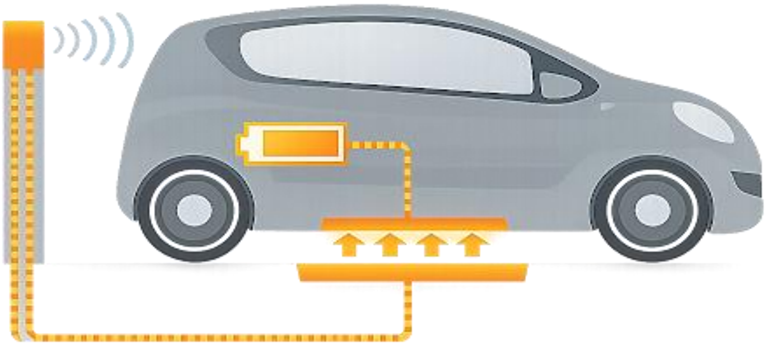

Figure 3. Conceptual illustration of wireless power transfer for electric vehicle charging.

- *Ultrasonic sensor:* This sensor is used for detection, ensuring that the EV is correctly positioned over the charging pad before initiating the wireless charging process. It can also detect obstacles near the charging station for safety purposes.
- *Tesla coil:* It is used for transmitting power; although not directly used for standard EV wireless charging, it demonstrates the principle of wireless energy transfer. In a project context, it can be used for educational purposes or to experiment with high-frequency WPT concepts, as shown in Figure 3.

WIRELESS CHARGING ARCHITECTURE

The image shows a simplified diagram of a wireless charging station for EVs. It begins with a power supply that feeds electrical energy into the inverter. The inverter plays a crucial role, as it transforms the direct current from the power supply into an alternating current suitable for wireless transmission. This AC power is then sent to a transmitting coil that generates a magnetic field. This magnetic field wirelessly transfers energy to a receiver coil mounted on an EVs. The AC power received is then converted back to DC by a rectifier within the vehicle, enabling the charging of the vehicle battery. A control unit oversees the entire process, manages the power flow, and ensures efficient and safe wireless charging of the EVs. This system eliminates the need for physical cables, offering a more convenient charging solution for EV users, as shown in Figure 4.

FLOWCHART

This image presents the key components of an EV charging station.

- *Ultrasonic sensor:* For distance/proximity detection, potentially for vehicle positioning.
- *LCD:* For displaying charging information or status.
- *Power supply:* Provides the necessary electricity.
- *Controller:* Manages the overall charging process.

Essentially, the diagram provides a simplified overview of the essential hardware elements involved in building an EV charging station, as shown in Figure 5.

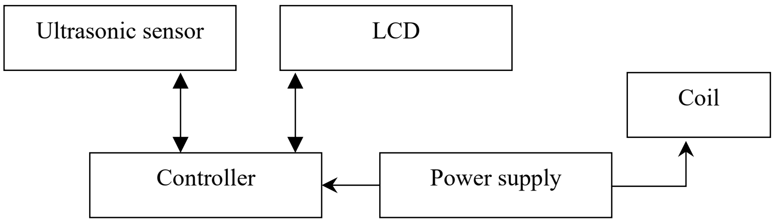

Figure 4. Components of an electric vehicle (EV) charging station.

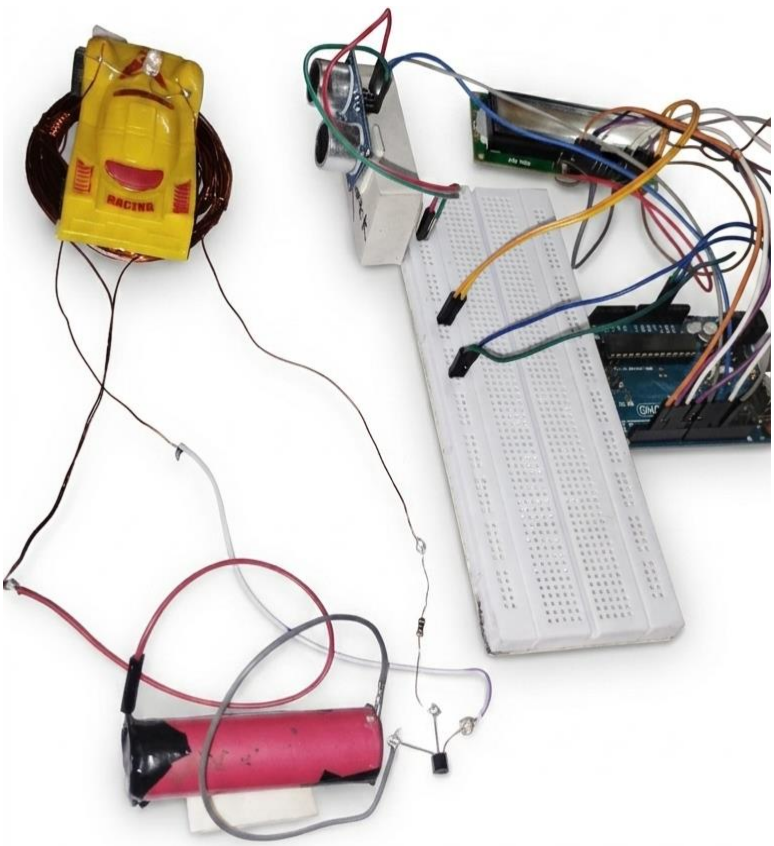

Figure 5. Experimental setup of the wireless power transfer prototype for EV battery charging.

Implementation

The proposed wireless charging station for EVs is based on resonant inductive coupling and includes key hardware and embedded system components to simulate a functional prototype. The system comprises:

- *Transmitter coil and power supply unit:* It converts the AC supply into a high-frequency AC for induction.
- *Ultrasonic sensor:* It detects vehicle presence and triggers charging initiation.
- *Microcontroller unit (Arduino/ESP32):* It can process the sensor input, control the relay, and manage the system logic. It can detect the presence of a vehicle using ultrasonic waves, and accordingly, charging starts and stops.
- *LCD:* It displays the system status, whether it is charging or standing. The output is displayed on the LCD according to the condition.
- *Receiver coil in vehicle module:* It captures the magnetic field and converts it back to electrical energy for charging. Therefore, the vehicle is charged easily, and it is an effective way to charge the vehicle.

The system activates charging when the EV is parked within the correct range of the transmitter coil. The ultrasonic sensor detects the presence of a vehicle, and if authentication is verified (via RFID), the relay switches on the primary coil. The energy was transferred wirelessly to the receiver coil inside the EV, simulating actual power transfer.

SAFETY FEATURES

Overvoltage Protection

Fuses or circuit breakers can be incorporated into the power supply circuit to protect against excessive current draw, which could lead to overheating or fire. A voltage regulator can be used to protect the Arduino and other sensitive components from voltage spikes. Therefore, we used a temperature sensor to measure the temperature. If it exceeds the limit, then change stops to reduce the damage or harm. The display also shows the temperature, so we were aware of overheating.

Misalignment Detection

Here, we used an ultrasonic sensor to check whether proper alignment was performed between the two coils. If there is misalignment, charging does not work properly, and we will understand that there is misalignment.

Power Mode When No Device is Detected

When no car is detected, the sensor does not respond to the controller; therefore, there is no power supply in the coil, and the battery is safe, with no power loss occurring.

RESULT

The prototype was successfully tested under controlled lab conditions.

Key Results Include

- *Effective wireless charging distance:* 5–10 cm between the transmitter and receiver coils. The transmitter coil can transmit energy, and the receiver coil converts the magnetic field into electric energy.
- *Charging efficiency:* A 75% power transfer efficiency was observed at a frequency of 30 kHz. This means that a 25% loss occurs, and 75% of the power is transferred.
- *System response time:* Vehicle detection occurs within 2-3 seconds of charging activation. After the completion of charging, the results are displayed on the LCD.
- *Component synchronization:* All modules (sensor, relay, display, and controller) operated synchronously. All the sensors used in this project were synchronized. The synchronization of sensors with each other is essential for the effective operation of the system.

Table 1. Quantitative results (efficiency, distance, response time).

Performance	Measured result	Description
Charging distance	10–15 cm	Distance between transmitting coil and receiving coil.
Component synchronization	Fully synchronized	Sensor, display, and controller.
Charging efficiency	75% at 30 kHz	Successfully power transmitted.
Response timing	4 to 5 sec	Timing for connecting the coils.

- *User interaction:* The LCD provided real-time feedback, and the RFID module successfully enabled secure access. The LCD shows the current condition. Is the vehicle charged? In addition, is the vehicle connected or not from Table 1.

CONCLUSION

This study demonstrates the feasibility and potential of wireless charging stations as a safe, efficient, and user-friendly method for charging EVs. The implemented prototype confirmed the core functionality of resonant inductive power transfer and real-time system monitoring.

This approach reduces mechanical wear and eliminates the need for manual cable connections, making it ideal for public and autonomous charging applications. Although the prototype worked effectively over short distances, future studies should explore increased efficiency, greater transmission distances, and integration with the Internet of Things for real-time analysis and remote monitoring.

Because wireless charging technology makes charging easy, scalable, and intelligent, it is certain to play a significant role in the general adoption of EVs.

REFERENCES

1. Budhia M, Covic GA, Boys JT. Design and optimization of circular magnetic structures for lumped inductive power transfer systems. IEEE Trans Power Electron. 2011;26(11):3096-3108. doi:10.1109/TPEL.2011.2143730.
2. Kurs A, Karalis A, Moffatt R, Joannopoulos JD, Fisher P, Soljacic M. Wireless power transfer via strongly coupled magnetic resonances. Science. 2007;317(5834):83-86. doi:10.1126/science.1143254. PubMed PMID: 17556549.
3. Li S, Mi CC. Wireless power transfer for electric vehicle applications. IEEE J Emerg Sel Top Power Electron. 2014;3(1):4-17.
4. Zhang W, Mi CC. Compensation topologies of high-power wireless power transfer systems. IEEE Trans Veh Technol. 2016;65(6):4768-4778. doi:10.1109/TVT.2015.2454292.
5. Amjad M, Farooq-i-Azam M, Ni Q, Dong M, Ansari EA. Wireless charging systems for electric vehicles. Renew Sustain Energy Rev. 2022;167:112730. doi:10.1016/j.rser.2022.112730.
6. Aggarwal G, Tripathi A, Sharma HG, Sharma T, Shukla RD. Integrated Technologies in Electrical, Electronics, and Biotechnology Engineering. Boca Raton (FL): Taylor & Francis Group; 2025. doi:10.1201/9781003606208.
7. Fisher TM, Farley KB, Gao Y, Bai H, Ho Tse ZT. Electric vehicle wireless charging technology: a state-of-the-art review of magnetic coupling systems. Wirel Power Transf. 2014;1(2):87-96. doi:10.1017/wpt.2014.8.
8. Gao M, Yang Z, Pang Y, Dai G, Lee C, Choi J, Yang J. Triboelectric nanogenerators for condition monitoring of machines, infrastructure and environment. Interdiscip Mater. 2025;4(5):645-685. doi:10.1002/idm2.70004.
9. SAE International. Wireless power transfer for light-duty plug-in/electric vehicles and alignment methodology. SAE Standard J2954_202010. Revised Oct 2020. Warrendale (PA): SAE International; 2020. Originally issued May 2016. doi:10.4271/J2954_202010.
10. Karthi T, Maheswaran S, Sathesh S, Nivethitha K, Gangadharan B, Santhosh S. Wireless charging technology for an electric vehicle. 2023 14th International Conference on Computing Communication and Networking Technologies (ICCCNT), Delhi, India. 2023. p. 1-6. doi:10.1109/ICCCNT56998.2023.10308173.

