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WIRELESS EV CHARGING STATION

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Abstract: Wireless EV charging stations use inductive power transfer (IPT) for contactless charging, offering convenience, scalability, and reduced maintenance, while addressing challenges like efficiency and safety to support sustainable EV adoption

Keywords: wireless electric vehicle charging, Static Wireless Charging, Smart Charging Systems, Green Energy Charging.

I. INTRODUCTION

The rapid growth of electric vehicles (EVs) as a sustainable alternative to traditional internal combustion engine vehicles has necessitated advancements in charging technologies. While conventional plug-in charging methods have been widely adopted, they often pose challenges related to user convenience, wear-and-tear of physical connectors, and integration with autonomous vehicle systems. Wireless electric vehicle (EV) charging, utilizing technologies such as inductive power transfer (IPT) and magnetic resonance coupling, has emerged as a promising solution to overcome these limitations.

Wireless EV charging offers several advantages, including hands-free operation, reduced maintenance costs, and the potential for dynamic charging while vehicles are in motion. These benefits position wireless charging as a critical enabler for future EV adoption and autonomous mobility ecosystems. However, significant challenges remain, including efficiency losses, infrastructure development, and standardization across different vehicle platforms

II. LITERATURE PAPER

In 2024, Zahraa Niema Kama , Hawraa Neama Jasim. proposed A Survey of Wireless Charging Methods and Optimization Techniques of Electric Vehicles. Advancements in EV technology have improved performance and range, increasing their presence on the road. Companies like BMW, Tesla, and Mercedes-Benz are developing wireless charging models, enabling dynamic charging while driving and reducing battery capacity needs. This paper examines EV charging technologies, focusing on wireless power transfer (WPT) systems, their benefits, drawbacks, and applications. It reviews charging methods by efficiency, power level, range, and energy medium, emphasizing the importance of magnetic coupler design on power transfer and efficiency

In 2022, Mattew Eagon,Setayesh Fakhimi , George Lyu ,Audrey Yang ,Brian Lin ,William F. Northrop proposed Model-Based Framework to Optimize Charger Station Deployment for Battery Electric Vehicles. The proposed framework optimizes BEV charging station placement by simulating vehicle-specific traffic patterns and identifying high-demand areas. Using mixed integer programming (MIP), it meets key constraints like wait times and route viability. Applied to Class 8 trucks, it shows flexibility and potential for scalable charging infrastructure, supporting increased BEV adoption.

In 2022, Muhammad Amjad, Muhammad Farroq-i-Azam, Qiang Ni, Mianxiong Dong , Ejaz Ahmad Ansari. Wireless charging system for electric vehicles. proposed Wireless power transmission offers a user-friendly and efficient alternative to wired EV charging, eliminating hazards and reducing maintenance while addressing range anxiety. Inductive power transfer, a mutual coupling technique, is the most effective method. This review covers different charging modes, key system components, and battery types, which influence system performance.

In 2020, Matthew J. Eagon,William F. Northrop. Formal methods approach to the charging facility location problem for battery electric vehicles. proposed This method optimizes charging station placement to meet the growing demand for fast-charging infrastructure. By incorporating energy-efficient paths and charge-time delays, it effectively ranks potential locations based on average charging time cost. Simulations confirm the approach's capability to support efficient infrastructure planning for BEVs

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In 2016, Zicheng Bi , Tianze Kan, Chunting Chris Mi, Gregory A. Keoleian . A review of wireless power transfer for electric Vehicles: Prospects to enhance sustainable mobility .proposed This study introduces an optimization model for placing charging stations to balance investment costs and user convenience. Using historical EV route data and solving a MILP problem, the model identifies optimal locations, demonstrated through a case study in Istanbul. The approach effectively handles varying data sizes, aiding efficient infrastructure planning to support the growing EV demand.

III. METHODOLOGY

A. BLOCK DIAGRAM

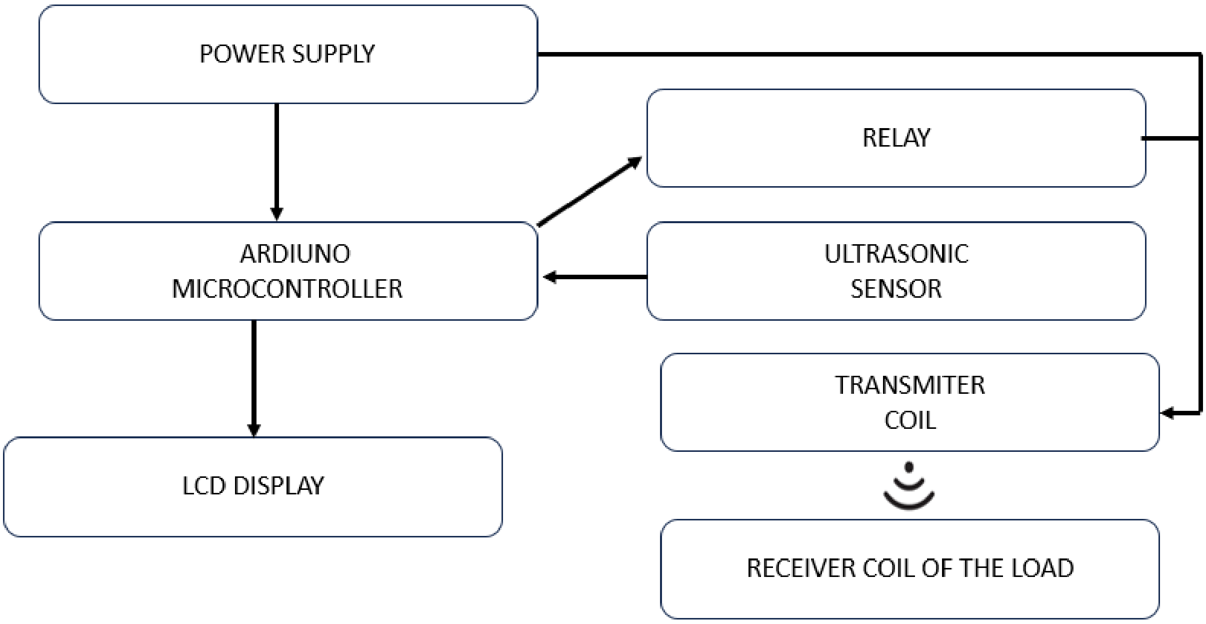

Figure 1 The block diagram of the proposed system consists of six components: Power Supply, Ardiuno microcontroller, LCD display, relay, ultrasonic sensor, transmitter coil, receiver coil of the load. These modules have been procured individually,and a prototype has been developed using them. The specific functions of each component within the overall system will be detailed in the subsequent sections. In summary, Wireless EV charging offers convenient, hands-free operation and supports sustainable transportation, despite challenges like cost and efficiency.

B. WORKING

A wireless EV charging station using a power supply, Arduino microcontroller, LCD display, relay, ultrasonic sensor, transmitter coil, and receiver coil operates seamlessly to enable hands-free charging. The system is powered by an external power source, which provides energy to the transmitter coil via a control circuit. At the core of the system, the Arduino microcontroller acts as the brain, managing the operation of all components. It processes inputs from the ultrasonic sensor to detect the proximity and alignment of the vehicle with the charging pad. Proper alignment ensures efficient inductive power transfer between the transmitter and receiver coils.

When the vehicle is correctly positioned, the Arduino triggers the relay, allowing power to flow to the transmitter coil. The coil generates an alternating magnetic field that is captured by the receiver coil integrated into the vehicle. The receiver coil converts the magnetic energy back into electrical energy, which is used to charge the vehicle's battery. This process occurs without any physical connection, relying entirely on the principle of inductive coupling.

The relay plays a critical role in the system by ensuring that power is only supplied to the transmitter coil when the vehicle is correctly aligned, preventing energy loss and ensuring safety. The LCD display provides real-time feedback to the user, showing system status, alignment confirmation, charging progress, and any errors.

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Together, these components form a cohesive and efficient wireless EV charging system, demonstrating the practicality of contactless energy transfer for modern electric vehicles.

C. FLOW CHART

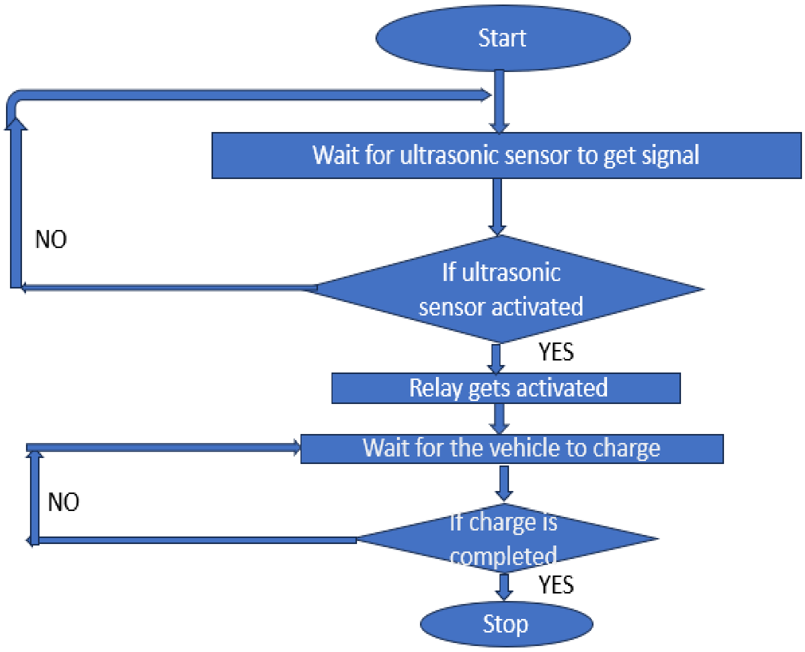

Figure: Flow chart

IV. CONCLUSION

Wireless EV charging represents a transformative step in the evolution of electric vehicle infrastructure, offering unparalleled convenience, reduced maintenance, and integration with autonomous and smart mobility systems. Through the adoption of inductive power transfer and resonant technologies, it addresses many limitations of conventional plug-in charging methods.

While significant advancements have been made in efficiency, scalability, and standardization, challenges such as energy losses, infrastructure deployment, and cost remain critical barriers to widespread adoption. Continued research and collaboration among industries, governments, and researchers are essential to overcome these challenges and unlock the full potential of wireless charging technology.

As EV adoption accelerates globally, wireless charging has the potential to play a pivotal role in supporting sustainable transportation, enabling seamless user experiences, and paving the way for a future of autonomous and dynamic charging solutions.

V. APPLICATONS

1.Public Infrastructure
2. Residential Areas
3. Workplaces and Commercial Buildings
4. Dynamic Charging
5. Fleet and Logistics
6. Special Use Cases
7. Smart Cities
8. Event Venues

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