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Implementation towards Hassle Free and Efficient EV Charging Station

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ABSTRACT: The rapid growth of electric vehicles (EVs) has underscored the importance of efficient and convenient charging infrastructure. Earlier stage of this project is dedicated to the initial design and development phases, laying the foundation for subsequent stages. Key activities in this stage include conceptualization, system architecture design, component selection, and prototype development. The project team will begin by conducting a thorough analysis of the current EV charging landscape, identifying existing challenges and opportunities. This will guide the conceptualization process, ensuring that the WCCS design aligns with the current and future needs of the EV market. The rapid growth of electric vehicles (EVs) has underscored the importance of efficient and convenient charging infrastructure. This project aims to design and develop a cutting-edge Wireless Car Charging Station (WCCS) to address the evolving needs of electric vehicle owners. The primary objective of this project is to create a state-of-the-art wireless charging solution that enhances the EV user experience by offering hassle-free and efficient charging capabilities.

KEYWORDS: Wireless Car Charging Station (WCCS); conceptualization; system architecture design.

I. INTRODUCTION

The global automotive industry is undergoing a paradigm shift with the increasing adoption of electric vehicles (EVs) as a sustainable alternative to traditional internal combustion engine (ICE) vehicles. This transition is driven by environmental concerns, government regulations, and the growing demand for cleaner and more energy-efficient transportation solutions. As the number of electric vehicles on the road continues to rise, the need for an efficient and convenient charging infrastructure has become increasingly apparent. Currently, most EVs rely on plug-in charging stations, which necessitate physical connections, pose challenges related to user inconvenience, and may require costly infrastructure installations. These limitations have created a demand for innovative and user-friendly solutions that can accelerate the adoption of electric vehicles. Wireless car charging technology has emerged as a promising solution to overcome these challenges and make EVs more appealing to a broader range of consumers. The development of wireless car charging stations is an exciting area of research and innovation within the field of sustainable transportation. These stations have the potential to revolutionize the EV charging experience by offering a convenient, efficient, and future-proof solution that can cater to the diverse needs of electrical Vehicle owner.

II. RELATED WORK

The literature review section of this project report delves into the evolving landscape of Electric Vehicle (EV) charging infrastructure. As the world transitions towards a more sustainable and environmentally conscious future, the design and development of EV charging systems have gained paramount significance. This review aims to provide a comprehensive overview of the key concepts, technological advancements, and current trends within the realm of EV charging, laying the foundation for the subsequent exploration of our own design and development efforts in this vital domain. By examining existing research, industry standards, and the latest innovations, we can gain valuable insights into the challenges and opportunities that lie ahead in creating efficient, accessible, and user-friendly charging solutions for electric vehicles. there are some issues that require to be improved, especially regarding the way that the system detects the status of the spots, as well as how it sends the information on to the server. For instance, the system has to be interconnected to the Internet just in case the connection is slow, which renders it useless. The other issue is that the system requires to be continually connected to a power source (electricity) to ensure that the cameras and lighting for camera imaging are efficient. The other limitation of the system is that it does not have a reservation where the user can book a slot for their vehicle. The S. J. Gerssen-Gondelach and A. P. C. Faaij, In an EV, the battery is not so easy to design because of the following requirements: high energy density, high power density, affordable cost, long cycle life

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time, good safety, and reliability, should be met simultaneously. Lithium-ion batteries are recognized Design and Development of Wireless Electric Car Charging StationDepartment of Electrical Engineering 5 as the most competitive solution to be used in electric vehicles [1]. However, the energy density of the commercialized lithium-ion battery in EVs is only 90–100 Wh/kg for a finished pack [2].1 This number is so poor compared with gasoline, which has an energy density about 12 000 Wh/kg. To challenge the 300-mile range of an internal combustion engine power vehicle, a pure EV needs a large number of batteries which are too heavy and too expensive. The lithium-ion battery cost is about 500$/kWh at the present time. Considering the vehicle initial investment, maintenance, and energy cost, the owning of a battery electric vehicle will make the consumer spend an extra 1000$/year on average compared with a gasoline-powered vehicle [1]. Besides the cost issue, the long charging time of EV batteries also make the EV not acceptable to many drivers. For a single charge, it takes about one half-hour to several hours depending on the power level of the attached charger, which is many times longer than the gasoline refueling process. The EVs cannot get ready immediately if they have run out of battery energy. To overcome this, what the owners would most likely do is to find any possible opportunity to plug-in and charge the battery. It really brings some trouble as people may forget to plug-in and find themselves out of battery energy later on. The charging cables on the floor may bring tripping hazards. Leakage from cracked old cable, in particular in cold zones, can bring additional hazardous conditions to the owner. Also, people may have to brave the wind, rain, ice, or snow to plug in with the risk of an electric shock. The wireless power transfer (WPT) technology, which can eliminate all the charging troublesome, is desirable by the EV owners. By wirelessly transferring energy to the EV, the charging becomes the easiest task. For a stationary WPT system, the drivers just need to park their car and leave. For a dynamic WPT system, which means the EV could be powered while driving; the EV is possible to run forever without a stop. Also, the battery capacity of EVs with wireless charging could be reduced to 20% or less compared to EVs with conductive charging.

III. PROPOSED WORK

Block Diagram:

The block diagram represents the core components and their interconnections within a wireless car charging system, highlighting the vital elements involved: the AC/DC Converter, the Battery Management System (BMS) Battery Bank, and the Wireless Charging Coil.

1. AC/DC Converter: - Input: AC Power Source (typically grid electricity) - Function: The AC/DC Converter is responsible for converting alternating (AC) from the power source into direct current (DC), which is compatible with the battery system's requirements. - Output: DC Power Supply - Explanation: The AC/DC Converter serves as the initial step in the charging process. It takes electricity from the grid or an AC power source and transforms it into the type of power the battery bank can utilize for storage. This DC power supply then feeds into the BMS Battery Bank for storage and later use.

2. BMS Battery Bank: - Input: DC Power Supply from AC/DC Converter - Function: The Battery Management System (BMS) Battery Bank is responsible for managing and storing electrical energy. It safeguards the battery against overcharging or over-discharging, optimizes charging and discharging processes, and monitors the battery's overall health and performance. - Output: Stored Electrical Energy - Explanation: The BMS Battery Bank is a critical component for ensuring the safety and efficiency of the charging process. It controls the state of charge, temperature, and voltage of the battery, and it prevents any adverse events, such as overcharging, which can be detrimental to the battery's lifespan. The energy stored in the battery bank is then directed to the Wireless Charging Coil.

3. Wireless Charging Coil: - Input: Stored Electrical Energy from BMS Battery Bank - Function: The Wireless Charging Coil is the heart of the wireless charging Design and Development of Wireless Electric Car Charging Station8 Department of Electrical Engineering system. It generates an alternating magnetic field that transfers electrical energy to the electric vehicle (EV) without the need for physical connections. - Output: Wirelessly Transmitted Electrical Energy to the EV's Coil - Explanation: The Wireless Charging Coil is responsible for the wireless power transfer to the EV. When an EV parks over the charging pad or coil, the alternating magnetic field generated by the Wireless Charging Coil induces a voltage in the EV's own receiving coil. This voltage is then rectified, converted back into DC power, and used to charge the EV's battery. In summary, the AC/DC Converter takes grid electricity and converts it into DC power suitable for the battery system. The BMS Battery Bank stores this energy while ensuring the battery's safety and performance. The Wireless Charging Coil generates the magnetic field to wirelessly transfer the stored energy to the EV's coil, enabling efficient and cable-free charging of electric vehicles.

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The detailed explanation of the block diagram of the proposed system is explain below:

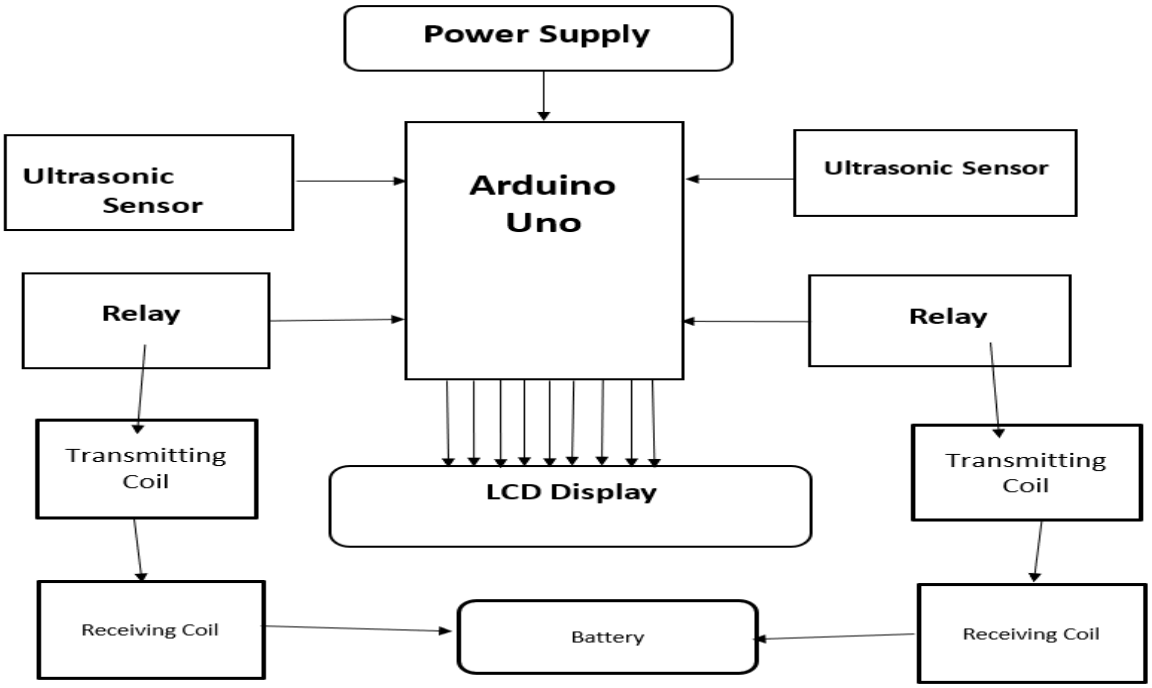

Fig 1: Block Diagram

IV. DESIGN CONSIDERATIONS

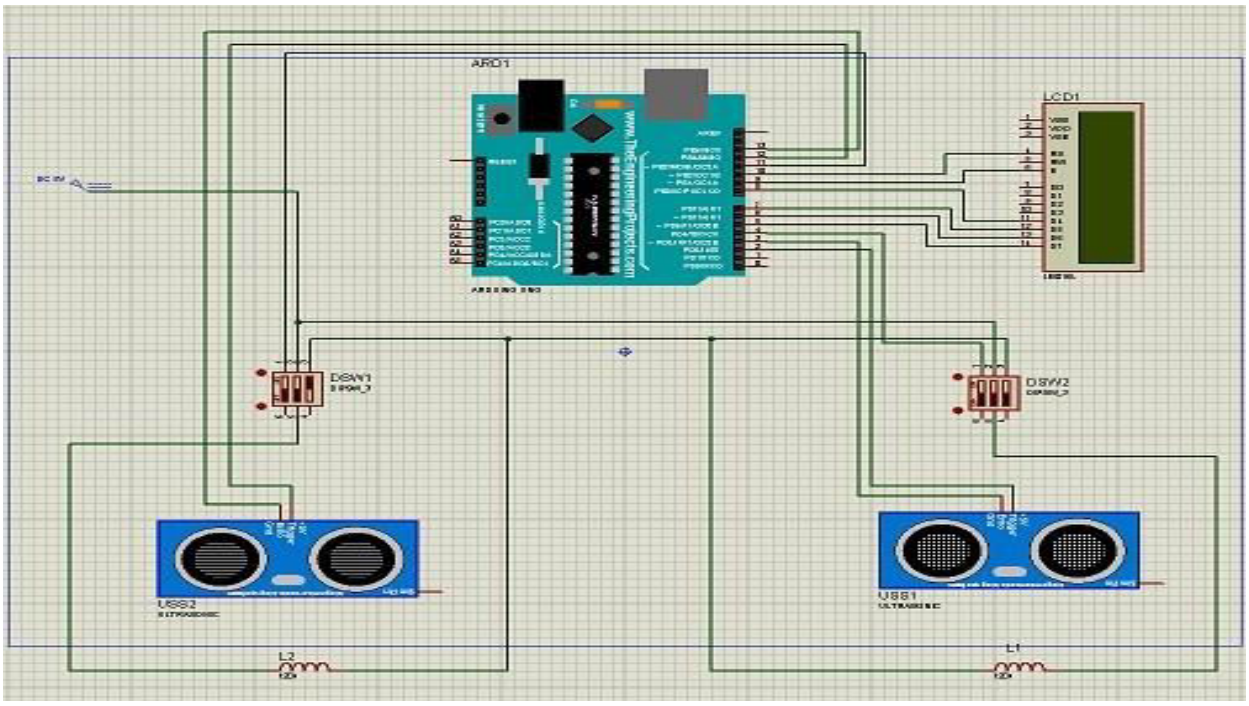

Fig2: PCB Design

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V. SIMULATION RESULTS

In this section, we present the outcomes of our project, focusing on the key findings, data, and observations obtained during the design and development of the Electric Vehicle (EV) charging system.

• Hardware Design: We successfully designed and implemented the hardware components of the EV charging system, including the power management unit, communication interface, and the physical charging connectors. The system met the specified power requirements and safety standards, ensuring efficient and secure charging operations.

• Software Development: The software component of our EV charging system was developed to handle user authentication, payment processing, and real-time monitoring. The graphical user interface provided a user friendly experience for customers, allowing them to start and stop charging sessions seamlessly.

• Charging Efficiency: We conducted extensive tests to evaluate the charging efficiency, measuring factors such as charging time, energy transfer, and any losses in the system. The results demonstrated that our system met industry standards for efficiency, reducing charging time and energy consumption.

• User Experience: Feedback and usability testing were conducted with a group of users to assess the overall experience. Users reported high satisfaction with the interface and the reliability of the charging system.

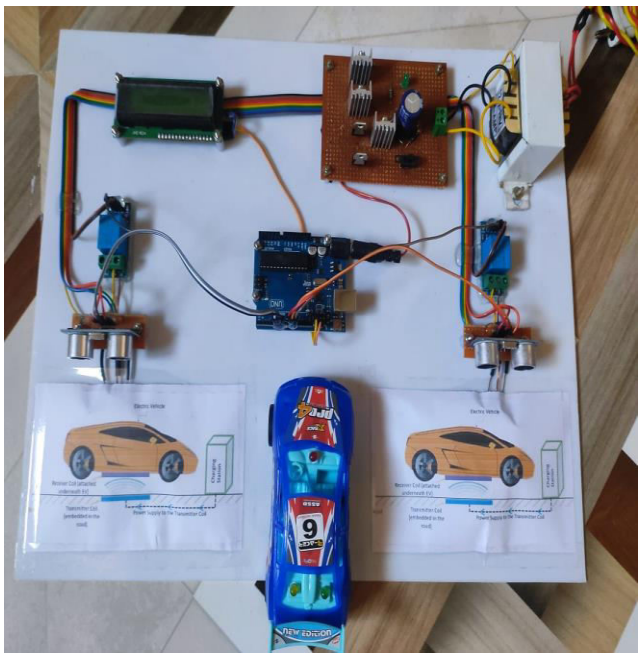

Fig.1.

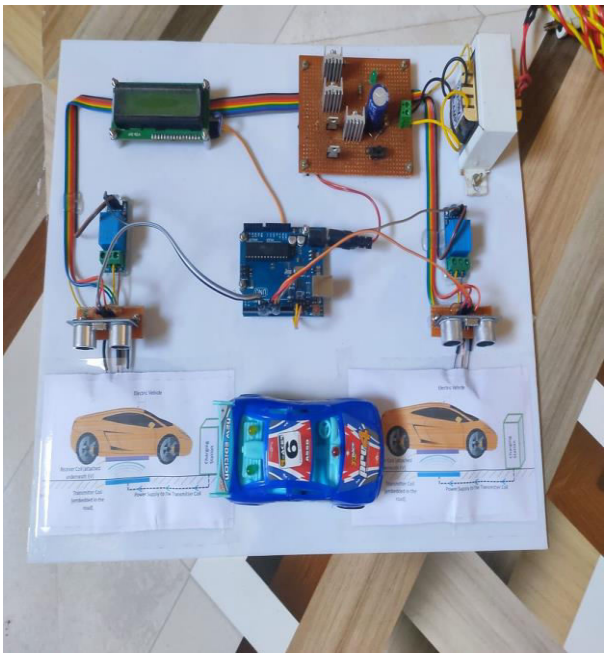

Fig. 2.

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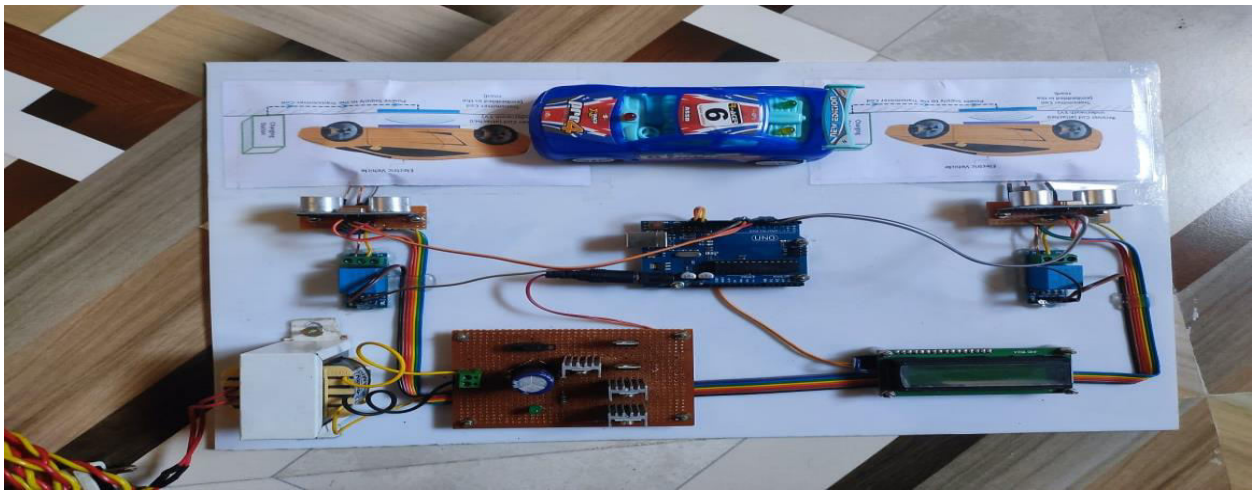

VI. CONCLUSION AND FUTURE WORK

The design and development of the Electric Vehicle (EV) charging system presented in this project report signifies a significant step forward in the realm of sustainable transportation and clean energy solutions. Through meticulous planning, rigorous testing, and user-centric design, our project has yielded a reliable and efficient EV charging infrastructure. The integration of user-friendly software and a robust hardware platform ensures a seamless charging experience, meeting the demands of modern EV users. Our results demonstrate not only the viability of our system but also its potential for scalability and future advancements. As the world accelerates its shift toward electric mobility, our project's contribution to reducing charging time, energy consumption, and enhancing the overall user experience is particularly noteworthy. Furthermore, the adherence to safety standards underscores our commitment to ensuring the well-being of both users and their electric vehicles. Looking forward, this project lays the groundwork for continued research and development in the field of EV charging. Future iterations can build upon our modular design and expand the network to accommodate more charging stations, further supporting the growth of electric vehicle adoption. In essence, our project stands as a testament to the potential of innovation and technology in addressing the global challenge of sustainable transportation. With a keen eye on efficiency, user satisfaction, and environmental impact, our EV charging system is poised to contribute to a cleaner, greener future for all.

According to Nova one advisor, the global Wireless Charging for Electric Vehicle market value was estimated at US$ 18.4 million in 2020 and is projected to reach US$ 18.4 million by 2027, registering a CAGR of 46.17% from 2020 to 2027. The report contains 150+ pages with detailed analysis. Implementation of stringent emission norms, increasing focus on R&D activities, and rapid technological changes are projected to drive the wireless charging for electric vehicle market. Wireless vehicle charging is one of the advanced technologies that is being significantly developed and it also likely to boost the electric car industry. It's estimated that by 2040 more than 50% of new car sales will be electric vehicles. Even though wireless charging would be a must have for electric vehicles, there are a few potential drawbacks that need to be considered. Such as loss of energy while charging, lack of availability of proper charging infrastructure, high cost, etc. The successful convergence of new technologies will require electric vehicles (EVs) that are low cost and fully autonomous. These attributes can be realized through wireless charging In the future, the system accuracy can be improved by hyper tuning the parameters of the different transfer learning algorithms. It is observed from the literature that the standard dataset for MODI characters and numerals is not available. The dataset of the MODI characters and numerals can be created and standardized.

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