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Review on Design and Development of an Efficient Wireless Charging Station for Electric Vehicles

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Abstract - Wireless Power transmit (WPT) systems use wireless technology to transmit electricity from a source to a load. WPTs provide advantages over wired systems in industrial applications, including no exposed wires, easy charging, and reliable power transfer in harsh environments. Some firms are focusing on developing and improving various topologies for using WPTs to charge EV batteries. Wireless power transfer (WPT) involves inductive connection between two coils, known as the transmitter and reception coil. EV charging involves burying transmitter coils on the road and placing receiver coils inside the car. Inductive WPT of the resonant kind is often utilized for medium-high power transfer applications such as EV charging because to its higher efficiency.

This thesis discusses a WPT system for charging the on-board batteries of an electric city vehicle, which serves as a case study. The electric city car is powered by four series-connected 12V, 100A·h VRLA batteries and two in-wheel motors in the rear wheels, each capable of producing 4 kW of peak power. The study was done in three steps, starting with an overview of wired EV battery chargers and charging procedures. During the second step, the WPT system for the study case was designed. In the third step, a prototype of the WPT system was created and tested.

Key Words: Charging Methodologies, Environmental Conditions, Inductive Coupling, Electric City-car, Industrial Applications, Wireless Power Transfer (WPT), Electric Vehicle (EV),

1. INTRODUCTION

Growing concern about reducing harmful emissions from transportation has resulted in the introduction of cars powered by Batteries, fuel cells, and other cleaner energy sources can be used instead of internal combustion engine (ICE)-powered cars. Compared to ICE cars, electric vehicles (EVs) are still in the early stages of development in terms of autonomy. Academic and industry researchers are working to enhance their overall performance. To improve vehicle autonomy, ideas include developing better energy density batteries, using super capacitors to absorb current peaks during acceleration and regeneration, and installing rapid chargers, charging while on the go, etc. On-board batteries may be recharged using conductive battery chargers at home or at stations/parking lots. In general, two types of conductive battery chargers are used: on-board and off-board.

On-board chargers can be used to charge from a power source at home or at charging stations during the day. Off-board chargers, similar to petrol stations, can handle high power levels and provide quick charging. Most battery chargers are unidirectional, meaning they solely transfer electricity from the grid to the battery. This simplifies the circuitry and reduces grid connectivity and battery deterioration.

Fig-1: Model of Wireless power transfer (WPT)

Some battery chargers can control power in both directions and provide grid benefits including peak power shaving and reactive power adjustment. These chargers are known as bidirectional battery chargers

(BBCs). An electric car can be charged either conductive (or wired) or wirelessly. Wired charging employs a connecting mechanism between the electric supply and the charge input of the car.

2. LITERATURE REVIEW

1) Customers adopt electric vehicles because of their utility. The specs need a suitable parking and charging facility. The proposed model integrates these two systems, resulting in an effective conclusion. This article discusses how to create a parking place availability and payment schedule management system. Parking systems cannot yet accommodate all types of automobiles. Parking and an electric vehicle charging station are essential. In the proposed approach, a charging station may be reserved by Smartphone. The system manages all connected processes depending on data such as vehicle arrival time and battery life. The system then oversees all related operations. Key players include the lot manager, client manager, automobile manager, and map manager. The Java Platform Enterprise Edition (JavaEE) is being used. Think about the concept of security. This requires a User ID, which is also used for billing purposes.
2) The suggested concept replaces parking garages' original WSN and RFID systems with ZigBee technology. RFID technology is widely used for vehicle check-in and check-out because to its speed and security. The proposed system is separated into two sections: monitoring and control. The control segment includes display devices, processing and sensor components. Information and management hubs come first, then sensor nodes and LED displays. The system's key component is the last information and management centre. The device's hardware includes an LCD display, reflection sensors, and ARM7/LCP2148-controlled ZigBee modules for communication. The programs utilized include Flash Magic, Express PCB, and Keil Micro Vision.
3) This method is built on a realistic parking pattern that emphasizes individual parking places. The study compares two types of electric vehicles based on their mobility. Electric cars are divided into two categories: regular and irregular. Electric cars require adequate charging time. This study proposes a PLRS system for tracking vehicle arrival and departure times, EV battery levels, and distance travelled. The machine then creates its own timetable for EV charging. This mechanism operates throughout the day and night. This technology boosts parking lot income and recharges more electric automobiles. To recharge EVs depending on their parking patterns, the suggested system uses a two-layered PLRS mechanism. Our smart parking solution is cloud-based and IoT-based.

4) An on-site IoT module was created for the suggested smart parking solution. IoT is one of the most feasible concepts for a smart city. This Internet of Things (IoT) model is used to monitor and report on parking spot availability. It features a Smartphone app that alerts customers when parking spaces are available. This Smartphone app allows users to book a parking place. Parking systems utilize ultrasonic, passive infrared (PIR), and infrared sensors. The Raspberry Pi serves as the processing unit for cloud and sensor communication. The mobile application connects users to the system.

5) The suggested system consists of an ESP8266-01 Wi-Fi module, an Arduino Uno, an ultrasonic sensor, a mobile app, and a cloud server named Thing Speak. This parking platform uses the Internet of Things to connect and analyze real-time data. This technology generates data automatically and parks intelligently. The ultrasonic sensor detects available space. A Wi-Fi network interface-equipped Arduino module is linked to the sensor. An Arduino Uno connects to the internet and sends data to a cloud server. To utilize the Android app, users must first install it on their Smartphone as it is managed by software.

3. Body of Paper

Wireless charging stations for electric vehicles are evaluated based on efficiency, safety, and dependability. Although wireless charging stations have lesser charging efficiency than regular plug-in chargers, their convenience and ease of use make them a viable choice for EV owners. Wireless charging stations must priorities safety and dependability. IoT-enabled devices offer real-time input on the charging process to ensure this. To achieve optimal performance and uptime, wireless charging stations must be designed and deployed with reliability in mind.

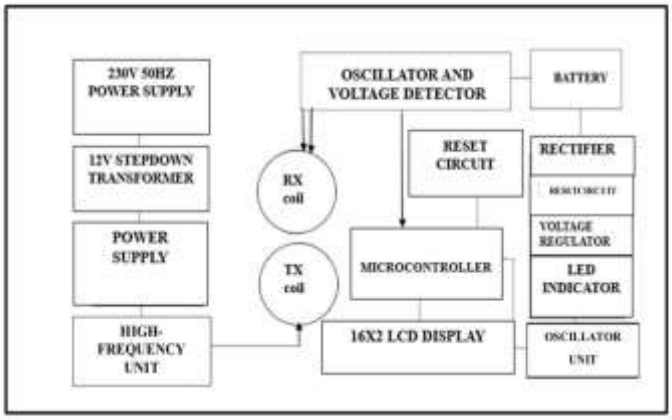

Fig -2: Proposed Block Diagram

The proposed approach for wireless charging of electric vehicles begins with designing and configuring the charging equipment. During this step, the EV charging setup's power requirements and standards are defined, and a suitable Wireless Power Transfer (WPT) technology is chosen based on efficiency, power levels, and compatibility with the EV. To optimize power transmission efficiency and distance, transmitter and receiver coils are carefully selected based on size, shape, and material considerations. The WPT system's resonance frequency is optimized for efficiency and minimal electromagnetic interference. The system's performance is simulated and analyzed using modeling tools to evaluate its behavior under different settings, including load fluctuations and environmental variables.

Wireless charging systems must meet safety and regulatory criteria, including electromagnetic compatibility (EMC) and interference (EMI). After developing a prototype, the wireless charging system is thoroughly tested to ensure its performance, efficiency, and dependability. The system's interface with current EV infrastructure, including charging stations and car charging connections, is handled. The wireless charging technology is iteratively optimized and fine-tuned based on testing results and user input to improve efficiency and enjoyment. Deploying the wireless charging system in real-world circumstances enables evaluation of its efficacy, usability, and scalability, leading to wider use of this technology for electric vehicles.

The process for deploying wireless charging for electric cars (EVs) consists of many major components. To design an EV charging system, first determine its power needs and specifications. Then, choose an efficient and compatible Wireless Power Transfer (WPT) technology. Components such as transmitter and receiver coils are carefully selected and optimized to ensure optimal power transfer. The WPT system's resonance frequency is optimized for maximum efficiency. The system's performance is tested through simulations and testing to ensure reliability and efficacy under different operating situations.

4. CONCLUSIONS

Wireless charging for electric vehicles has the potential to transform road transport in the automotive sector. Wireless charging for electric vehicles is likely to grow dramatically over the next decade as technology advances. This study provides an overview of wireless charging approaches and identifies inductive wireless transfer as the most effective way. This study examines static and dynamic wireless charging applications, as well as the function of batteries in electric vehicles. Wireless charging reduces the cost of electric vehicles by affecting their battery size.

Electric car batteries that previously took a long time to charge will now charge faster due to lower capacity. Wireless charging for electric vehicles is a successful mix of simplicity, little driver interaction, and excellent power transfer efficiency.

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