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A Systematic Review On Grided Wireless Charging Station for Electric Vehicle

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***Abstract* — As an alternate form in the road transportation system, electric vehicle (EV) can help reduce the fossil-fuel consumption. However, the usage of EVs is constrained by the limited capacity of battery. Wireless Power Transfer (WPT) can increase the driving range of EVs by charging EVs in malls, parking lots etc., when they stand over a wireless charging lane embedded in a platform. The amount of power that can be supplied by a charging lane at a time is limited. Wireless Power Transfer (WPT) systems transfer electric energy from a source to a load without any wired connection. WPTs are attractive for many industrial applications because of their advantages compared to the wired counterpart, such as no exposed wires, ease of charging, and fearless transmission of power in adverse environmental conditions. Adoption of WPTs to charge the on-board batteries of an electric vehicle (EV) has got attention from some companies, and efforts are being made for development and improvement of the various associated topologies.**

WPT is achieved through the affordable inductive coupling between two coils termed as transmitter and receiver coil. In EV charging applications, transmitter coils are buried in the road and receiver coils are placed in the vehicle. Inductive WPT of resonant type is commonly used for medium-high power transfer applications like EV charging because it exhibits a greater efficiency.

I. INTRODUCTION

Wireless charging station for electric vehicle's (EVs) use electromagnetic fields to transfer energy from the charging pad to the vehicle's battery without the need for the physical cable. This technology is still relatively new and is not yet as widely available as traditional plug-in charging station.

For energy, environment, and many other aspects, the electrification for transportation has been carrying out. In railway systems, the electric locomotives have already been well urbanized for many years. However, for electric vehicles (EVs), the high elasticity makes it not easy to get power in a similar way. Instead, a high power and large capacity battery pack is usually prepared as an energy storage unit to make an EV to operate for an acceptable distance. Owner has to face some complex scenarios by means of this wired EV.

Until now, the EVs are not so attractive to consumers even with many government motivation programs. Government subsidy and tax incentive are one key to increase the market share of EV today. The problem for an electric vehicle is nothing else but the electricity cargo space technology, which requires a battery which is the bottleneck today due to its unacceptable energy density, limited life time and high cost. Wireless charging depend upon the principle of Inductive Power Transfer (IPT)or magnetic resonance. This is the method of transferring an electrical current between two objects through the use of coils to induce an electromagnetic field. Supply voltage is converted into high frequency alternating current which is sent to the transmitter coil by the transmitter circuit.

Then the alternating current induces a time varying magnetic field in the transmitter coil. Alternating current flowing within the transmitter coil induces a magnetic field which tends to the receiver coil (when within a specified distance). The magnetic field produces current within the receiver coil. The method in which the energy is transmitted between the transmitter and receiver coil is also referred to as magnetic or resonant coupling and is achieved by both coils resonating at the same frequency.Wireless charging station use electromagnetic induction transfer energy from the charging pad.

REVIEW OF LITERATURE

VenuGopalan.K et. al., [2019], proposed a method on **"Transfer Wireless Power Technology (WPTT)-Through Resonance"** in this system describes about the All of the electronics devices needs power and the power given wirelessly to devices like embedded or real time systems, gets more advantages. The major issue of the consumer products is the short life of battery even in high technology support systems. Many researches are going on with wireless power transfer technology via magnetism, microwaves, resonance etc... One method resonance is covered in this project.

William C. Brown [2020], proposed a method on **"The history of wireless power transmission"** in this system describes about the history of wireless power transmission at microwave frequencies is reviewed with emphasis upon the time period starting with the post World War II efforts to use the new microwave technology developed during the war. A nationally televised demonstration of a microwave powered helicopter at the Spencer Laboratory of the Raytheon Co., in 1964 was the result of these early efforts and broadly introduced the concept of wireless power transmission to scientific and engineering communities and to the public.

Subsequent development efforts centered on improving the efficiency of the interconversion of d.c. and microwave power at the ends of the system to reach a demonstrated overall d.c. to d.c. system efficiency of 54% in 1974. The response to the requirements of applications such as the Solar Power Satellite and high altitude microwave powered aircraft have changed the direction of technology development and greatly expanded the technology base. Recent and current efforts are centered on examining the use of higher frequencies than the baseline 2.45 GHz, and in reducing the system costs at 2.45 GHz.

Linhui Chen , Shuo Liu , et al. [2020], proposed a method on "An Optimizable Circuit Structure for High-Efficiency Wireless Power Transfer" in this system describes about the magnetically resonant coupling was suggested for wireless power transfer (WPT), the theoretical analysis and experimental verifications of several resonant coupling structures have been investigated by several groups. Series-resonant and shunt-resonant structures are two common circuit models which are widely used in WPT. Here, a simple circuit topological structure, the series-shunt mixed-resonant coupling, is presented with better performance in the transfer distance and efficiency. In the experimental verification, a pair of resonant coils with 10-cm diameter

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was used. The experimental results show that high efficiency of 85% was achieved at a distance of 10 cm (one relative distance) and 45% efficiency at 20 cm (two relative distances). The proposed structure has another advantage that circuit parameters can be easily optimized for high transfer efficiency under different distances.

EXISTING SYSTEM

There are several existing systems for wireless charging of electric vehicles, and the technology is still rapidly evolving. Some of the most popular and widely used wireless charging systems for EVs are:

Plug-less: This system uses magnetic resonance technology to wirelessly charge electric vehicles. It consists of a charging pad that is installed on the ground and a receiver installed on the underside of the EV. When the EV is parked over the charging pad, the two devices create a magnetic field that transfers power wirelessly to the EV battery.

WiTricity: This is another popular wireless charging technology that uses magnetic resonance to transfer power wirelessly. It can charge both electric cars and buses, and can be installed in both public and private spaces.

HEVO: This is a wireless charging system that is specifically designed for electric buses. It uses magnetic resonance to charge the bus wirelessly while it is parked at a bus stop.

Qualcomm Halo: This wireless charging system uses magnetic induction technology to charge electric vehicles wirelessly. It is designed for both electric cars and buses, and can be installed in public spaces such as parking lots and garages.

Evatran: This is another wireless charging system that uses magnetic resonance technology to charge electric vehicles. It can be installed in both public and privatespaces and is compatible with a wide range of EV models.

3.1 PROPOSED SYSTEM

There are several proposed systems for wireless charging of electric vehicles that aim to address the limitations of existing systems. Some of the most promising proposed systems are:

Dynamic Wireless Charging: This system uses magnetic resonance technology to wirelessly charge electric vehicles while they are in motion. It involves installing charging pads underneath the road surface that can charge the EV's battery as it drives over them. This could potentially eliminate the need for frequent stops to charge EVs on long journeys.

Solar-Powered Wireless Charging: This system combines wireless charging technology with solar power generation. It involves installing solar panels on the charging pads to generate renewable energy, which can then be used to wirelessly charge EVs.

3.2 FLOW CHART

The flow chart in constituted by a charger vehicle that is capable of charging another vehicle wirelessly on a highway. The user vehicle would be en route on a trip that would typically require at least one pit-stop. During the trip, the user vehicle can request for the VVR as the SOC of the battery goes low. Fig. 8 shows a general overview of how the charger vehicle engages and disengages from the user vehicle. It is assumed that the user vehicle starts its trip with a full SOC .

The concept is that these charger vehicles would have either large batteries or an on-board electric generator that is capable of delivering power to multiple vehicles shows the charger vehicle 100% electric, implemented with a large battery package, while introduces the hybrid charger vehicle with an embedded generator set. The proposed system could be implemented with either option. The hybrid charger vehicle could be implemented first to lower the cost of the entire system, and as batteries costs reduce, then electric charger vehicles would be a substitute to the hybrid counterparts. Note that the WPT charging mechanism can be placed at either the front or back of either of those vehicles.

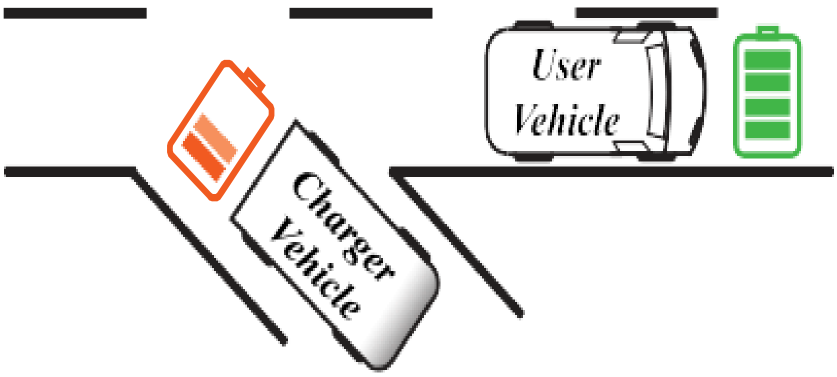

Fig. 3.3 (a) Hybrid charger vehicles

The autonomous vehicle subsection covers the importance of such technology Fig.3.3(a) shown in terms of safety and reliability, that could be implemented on the VVR system. Furthermore, modeling, analysis, and simulation is presented to validate the feasibility of the proposed system.

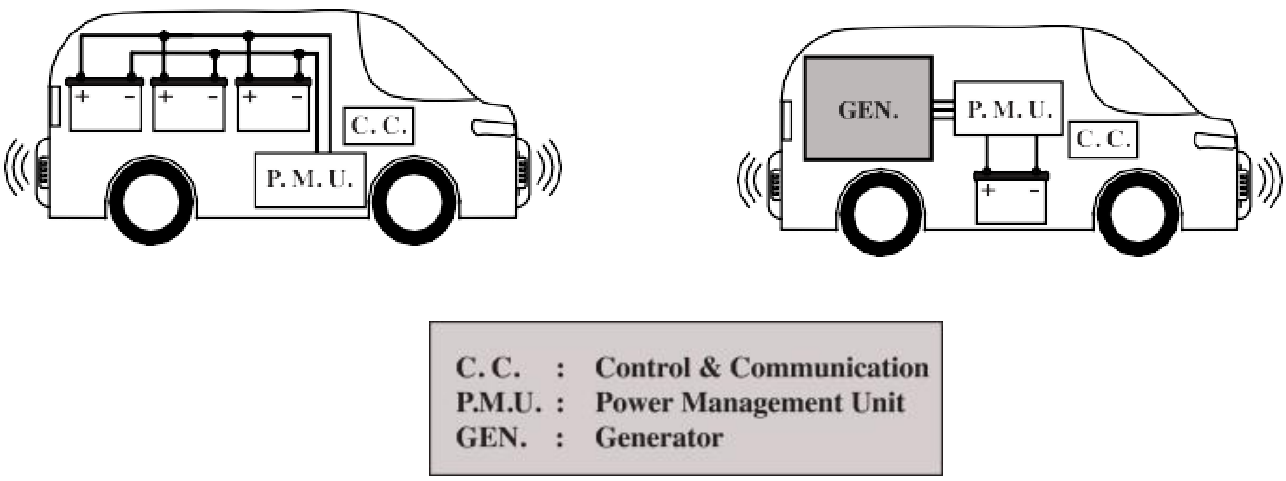

Fig. 3.3(b) WPT Charging mechanism

In the fig. 3.3(b) WPT charging mechanism has applied. PID controller to define the accelerator pedal position (APP) along with the brake pedal position (BPP).

The output of the limiter is the positive torque needed for propulsion, subtracted by the regenerative torque (obtained from a brake model) to get the total net tractive torque going to the driveline. The autonomous vehicle subsection covers the importance of such technology in terms of safety and reliability, that could be implemented on the VVR system. Furthermore, modeling, analysis, and simulation is presented to validate the feasibility of the proposed system. The second solution in this dissertation proposes an architecture for EVs that incorporates three electric motors with different operating regions to be used for propulsion. The main advantage is that at different operating regions, a controller can determine which motor would be running based on their efficiency map. The operating region is defined as the demanded torque to achieve the current speed. This way the motor with maximum efficiency at the current speed will be used for propulsion, or a combination of motors that would be considered a more efficient solution for the current operating region.

3.3 BLOCK DIAGRAM OF PROPOSED SYSTEM

In this block diagram, Coils are used as inductive power transfer via magnetic coils. The theory is simple. Power is delivered to coils in the roadway, and then picked up via induction by a coil on the moving vehicle.

In the stationary wireless charging method, the vehicle charges under standstill conditions. Hence, we could easily park the EV at the designated parking space or in a garage that integrates with a wireless charging station. The vehicle's undercarriage carries the receiver, and the transmitter is installed underground. The transmitter and receiver get aligned before leaving the vehicle to complete charging. The distance between the transmitter and receiver, the

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size of their pads, and the AC supply power level all affect how long it takes to charge. The optimal places to construct this static wireless charging station are those where EVs are parked for a certain period.

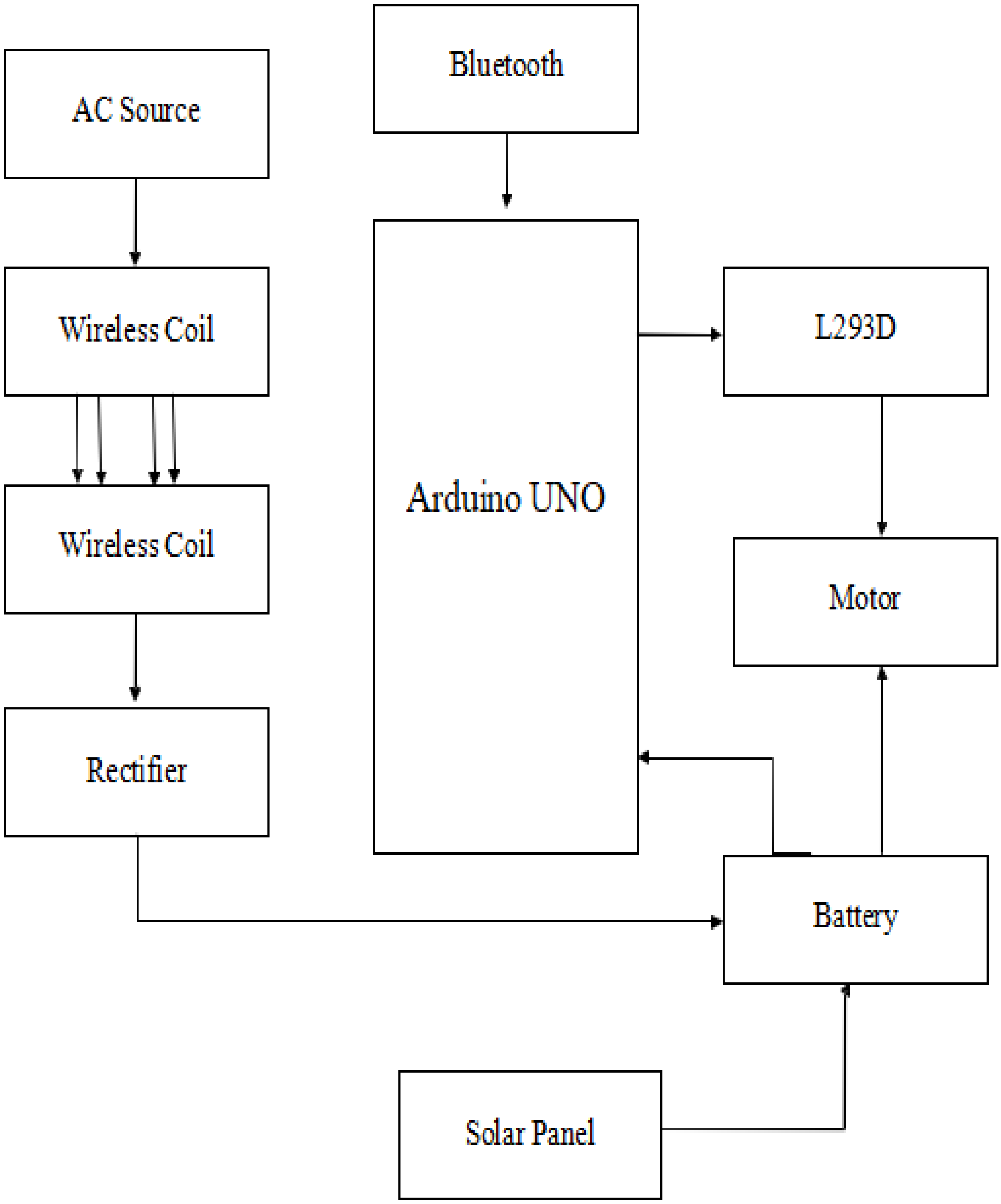

Fig. 3.4 Block diagram for the wireless charging station for electric vehicles

METHODOLOGY

Methodology for Wireless Charging Stations for Electric Vehicles:

1. Define Objectives: Clearly define the objectives of the wireless charging station project. This may include factors such as efficient charging, user convenience, scalability, cost-effectiveness, and compatibility with various electric vehicle models.

2. Site Assessment: Conduct a comprehensive assessment of the site where the wireless charging station will be installed. Consider factors such as available space, power supply, accessibility, environmental conditions, and any necessary permits or approvals.

3. Technology Selection: Research and select an appropriate wireless charging technology that meets the project's requirements. Consider factors such as power transfer efficiency, charging speed, compatibility with electric vehicle standards (e.g., SAE J2954, ISO 15118), and the ability to handle different power levels.

4. System Design: Design the wireless charging system layout based on the site assessment and selected technology. Determine the optimal placement and number of charging pads or coils, positioning of power electronics, and any necessary infrastructure modifications.

5. Power and Network Infrastructure: Assess the existing power infrastructure and determine if any upgrades or modifications are necessary to support the wireless charging stations. Consider the installation of dedicated electrical panels, transformers, and network connectivity for monitoring and control.

6. Safety Considerations: Ensure the wireless charging station adheres to relevant safety standards and regulations. Incorporate features such as ground fault detection, overcurrent protection, temperature monitoring, and fault reporting mechanisms.

7. Installation and Testing: Execute the installation of the wireless charging stations following the system design. Conduct thorough testing and verification to ensure proper functioning, power transfer efficiency, and compatibility with different electric vehicle models.

8. User Interface and Payment System: Develop a user-friendly interface that provides essential information, such as charging status, availability, and

instructions. Implement a secure and convenient payment system, which may include options like mobile apps, RFID cards, or contactless payment.

9. Monitoring and Maintenance: Set up a monitoring system to track the performance of the charging stations, including power consumption, charging duration, and any potential faults. Implement regular maintenance procedures to ensure optimal operation and address any issues promptly.

10. Scalability and Future Expansion: Design the wireless charging station infrastructure with scalability in mind. Consider the potential for future expansion, including the ability to add more charging pads, accommodate higher power levels, and integrate with evolving electric vehicle standards.

11. Integration with Renewable Energy Sources: Explore opportunities to integrate the wireless charging stations with renewable energy sources, such as solar or wind power. This can help reduce the carbon footprint of the charging stations and promote sustainability.

12. Education and Promotion: Develop educational materials and awareness campaigns to educate users about the benefits and proper usage of wireless charging stations. Collaborate with stakeholders, such as electric vehicle manufacturers, utilities, and government agencies, to promote the adoption of wireless charging technology.

13. Regulatory Compliance: Ensure compliance with relevant regulations, codes, and safety standards specific to wireless charging stations, electrical installations, and electric vehicle infrastructure.

14. Continuous Improvement: Regularly monitor user feedback, technological advancements, and industry best practices to identify areas for improvement and innovation. Continuously update and enhance the wireless charging station infrastructure based on these insights.

By following this methodology, you can effectively plan, design, and implement wireless charging stations for electric vehicles, providing convenient and efficient charging solutions for electric vehicle users.

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RESULT AND DESCRIPTION

The final output of the system is extracted, classified and analyzed. The wireless charging station successfully charges devices that are compatible with wireless charging technology.

The charging speed may vary depending on the device and the charging station specifications.The charging efficiency may also depend on the distance between the charging station and the device being charged.

Wireless charging technology has become increasingly popular in recent years due to its convenience and ease of use. While some may argue that wired charging is still faster and more efficient, wireless charging has improved significantly and can now provide similar charging speeds and efficiency.

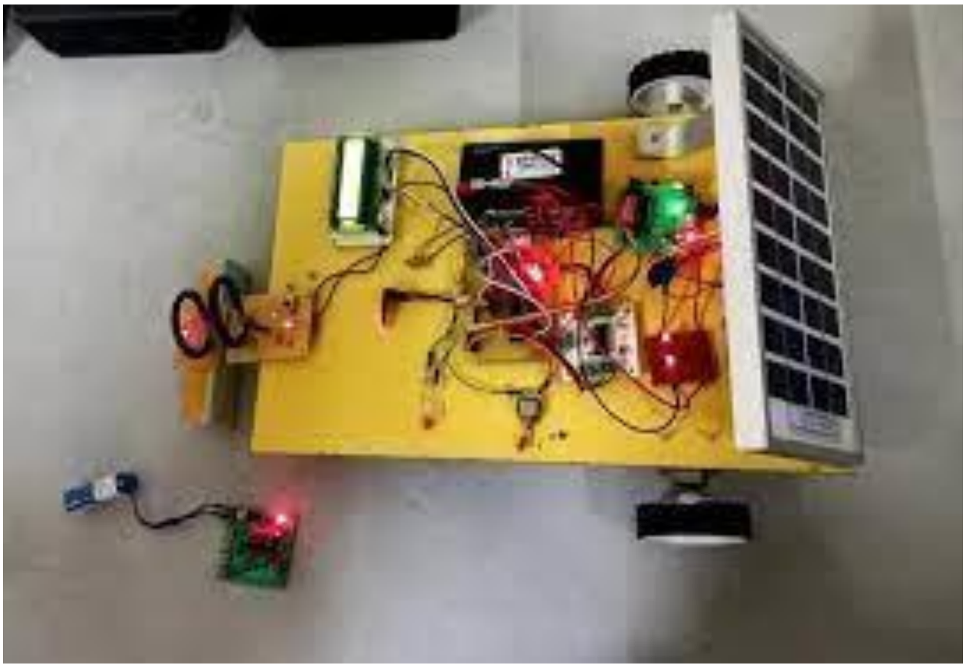

Fig. 7.1 Hardware setup of a proposed system

As a result, the grid receives full impact from the irregular charging/discharging loads of EVs, thus increasing the level of power quality (PQ) problems in the power distribution system.

Then as both vehicles get off the highway (at about 4,700 seconds), the charger disengages and the user continues the trip. The user vehicle here has a battery size of about 23.7 kWh, while the charger vehicle's battery capacity is 35.91 kWh.

CONCLUSION AND FUTURE SCOPE

Conclusion

In this paper, we implemented wireless energy transfer systems based on resonant inductive coupling with application to the charging of electric vehicles. In this paper, we implemented wireless energy transfer systems based on resonant inductive coupling with application to the charging of electric vehicles.

A wireless energy transfer system based on two inductively coupled resonant circuits separated by an air gap. It is how that the coupled wireless energy transfer system has two resonance peaks and that the separation of these peaks increase with increasing coupling coefficient.

Metal plates above the secondary coil can efficiently shield the surrounding from magnetic fields. However, the magnetic fields induce eddy currents in the metal plates, which decrease the coupling coefficient and increasethe resistive losses.

8.2 FUTURE SCOPE

After scanning the control issues, the control would be only on the transmitter side. The receiver must always have the highest flux possible, and its power is linked to the SOC of the battery.

It depends on whether the coil is circular or not, as well as the segment dimension. The two proposals are not the same. Power loss is always greater in high segment cables, as in the case of using a large coil size. This problem doesnot exist in the two proposed receivers because the coil size is smaller.

Also, the free space covered by the two receivers would be larger than that of a single wide receiver, allowing the vehicle to have more room. These points cannot address the major issue of mutual flux between the two coils and do not occur for the large coilsolution.

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