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E-Vehicle Charging Using Wireless Power Transmission

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ABSTRACT: Usually, electric vehicle systems are based on various modules that should ensure the high power and stability of the vehicle on the track. The majority of these components are linked to the charging mechanism. In this regard, dynamic wireless power transfer is a practical method to solve electric vehicle range anxiety and reduce the cost of onboard batteries. Wireless recharging has long been common with pure electric vehicles and is designed to allow charging even when the vehicle is in motion. However, it is difficult to analyze this method since its operating philosophy is complex, particularly with the existence of several variables and parameters. Also, the state of the vehicle, whether it is in motion or not, defines several parameters such as the vehicle speed as well as the sizes and dimensions of the coil receivers. This paper presents a novel method to improve the performance of the dynamic wireless recharge system. In the proposed system, receiver coils have been added to maximize charging power by offering a dynamic mathematical model that can describe and measure source-to-vehicle power transmission even though it is in motion. In the proposed mathematical model, all physical parameters describing the model were presented and discussed. The results showed the effectiveness of the proposed model. Also, the experimental tests confirmed the validity of the simulation results obtained by providing two coil receivers under the vehicle.

KEYWORDS: Charging Power, Vehicle Power Transmission, Energy Efficiency

I. INTRODUCTION

The scarcity of fossil fuels, as well as environmental concerns, point to new energy challenges. Overall, the traditional transport industry absorbs half of the world's oil production resulting in massive emissions. Taken together, these issues have an impact on the automotive industry and are also important for the research and development of electric vehicle (EV) technologies as a solution to these problems. Electric power storage is also one of the main research topics these days. Technological advances in electrical energy storage have culminated at a sufficient mass density of energy and power to meet automotive needs. The biggest drawback of these storage technologies is their high production expense.

Nowadays, researchers are attempting to build good storage solutions and enhance their charging strategy and reliability to reduce the overall cost of the vehicle. Many technology storage systems have been developed in this area and integrated into the power train system, resulting in positive performance. The perfect control of the main electrical engine, or the perfect control of the battery recharge system, helps reduce the vehicle's power system's loss. Authors have investigated different control algorithms to improve the system's efficiency. Moreover, several studies have been carried out on the battery's internal structure to improve global productivity. Also, many solutions were provided to boost the energy efficiency of the e-transportation system. This is incorporating a strong autonomy record in the recent model of electric vehicles. Some researchers have paid attention to the charging tools to improve the vehicle's global autonomy and efficiency. For instance, in, the authors presented a new wireless charging approach other experiments have been focused on the hybrid recharge system, using two power sources within the vehicle. Besides, photovoltaic systems have been applied to the vehicle for providing more than one source of electricity mixed sources.

Concerning the problems raised in the above models, recharging solutions, the shading effect, and the car's additional structures, photo voltaic and hybrid recharging solutions are the main interests. The wireless charging approach has been studied to identify a solution that is more stable and beneficial. The objective of this project work is based on the literature on their charge approach; many researchers have shown that this approach is highly efficient only if the two elements are fully parallel as a receiver and transmitter. If the two sections are moved by few inches, the



global machine's performance would be limited. Hence, the analysis will be accurate only if the two parts were set in the right alignment and were steady (not in motion). But if one of these components is still in motion the analysis accuracy will be changed.

Many techniques for wireless energy transfer were presented in the literature, Such as inductive power transfer, magnetic gear wireless power transfer, capacitive wireless power transfer, and inductive coupling link wireless power. The last method is one of the most widely used techniques that were found suitable for charging the EV.

The mathematical representation of this recharge tool was widely discussed, and several representations have developed in the literature. Authors have investigated static modeling to improve system efficiency of 22 kHz and 85 kHz 50 kW wireless charging system for EV. This model has relied on the mutual inductance related to primary and secondary coils, it was verified only for the case of superimposing of the receiver and transmitter coils. In the authors have studied the dynamic situation, where they try to explain the relationship between the receiver and the transmitter coils position deviation. The calculation of the power output and the global efficiency factor was made. The internal parameters the resistance, inductance, and the pitch angle between the two coils - were involved in the study and the mathematical model.

In the two previous methods were compared and analyzed, and the specification of each method was criticized. All of these analyses were applied in the case of only one receiver coil, without taking into consideration the importance of the speed deviation of the receiver part faces the transmitter part. The different present research works have not studied the case of the two-receiver system correctly nor investigated its energetic yield. For example, some questions should be answered, such as if a two-receiver system is developed, is it possible to have a dual-energy model Is it possible to extend the battery life cycle and is it possible to extend the vehicle's autonomy. These questions have not yet been answered correctly, and even the results presented were not justified in the literature. This is why this paper has been drafted. This paper deals with the possibility of using two receivers coils and compares this approach to the traditional approach, based on only one receiver coil.

This study is based on a new mathematical representation of the wireless power transmission system. In the new proposed model. The efficiency of their charge tool was investigated given all the parameters mentioned earlier, where resistance, inductance, pitch angle, coil dimensions, the distance between the coils, and the receiver coil displacement speed were investigated. This new model helps to find the necessary information on the right number of wireless coils to fully charge the vehicle if it is on a chargeable road. A detailed mathematical model explain their charging method operates is presented. It also provided useful findings demonstrating the effectiveness of the physical equations used. It has been accomplished in two ways: first, when the vehicle is in stop mode, and second when the vehicle is in motion. This analysis also puts two wireless receivers in the car for testing, and the results obtained show how useful this proposed model.

As the vehicle's speed changes, the positioning of the receiver with respect to the transmitter was investigated, and the consequences of the vehicle's autonomy were addressed and discussed. These findings are compared to current methodologies. Thus, the results revealed in this paper demonstrate the effectiveness of having two receivers underneath the vehicle.

II. PROPOSED METHODOLOGY

The SV 2A Large Current Wireless Charger Module Transmitter Receiver Charging Coil Module is for a variety of small electronic products, wireless charging, power supply development, and design, with a small size, easy to use, high efficiency, low price characteristics.

III. WIRELESS CHARGER MODULE

It is mainly used in mobile electronics products such as for charging the mobile phone wirelessly, game machines, tanks, MP3, MP4, adult products, digital cameras, electric shavers, machine learning, health care, etc. Due to the adoption of a Contactless charging power supply, to complete sealing of the products, waterproof and dust proof; increase product

service life, use more convenient. The wireless power transmission can be defined as the energy that can be transmitted from the transmitter to a receiver through an oscillating magnetic field.

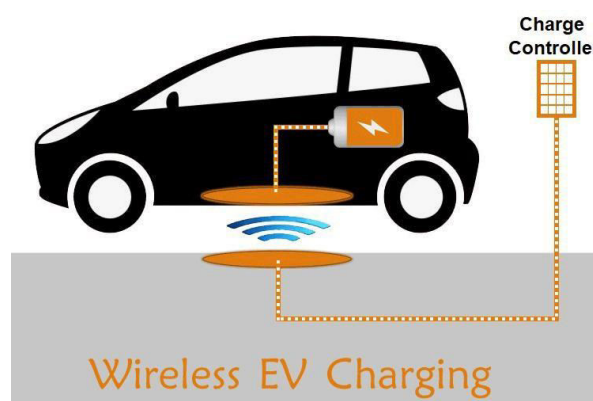
To accomplish this, power source (DC current) is changed into high- frequency AC (Alternating Current) by particularly designed electronics erected into the transmitter. The AC boosts a copper wire coil in the transmitter, which produces a magnetic field. When the receiver coil is placed in proximity of the magnetic field, the magnetic field can make an AC (alternating current) in the receiving coil. Electronics in the receiving coil then alter the AC back into DC which becomes operating power.

Wireless EV charging requires an induction coil that creates an alternating EM field from the charging pad. Meanwhile, a second induction coil in the vehicle receives the EM field from the charging pad, effectively recharging the vehicle batteries after the system converts the EM fields to electric currents. Wireless electricity works in this way: the transmitter converts AC into a magnetic field. The device picks up the field and converts it back to AC. Sounds fairly simple, but there's a reason it took over a century to become viable. The sticking point has been something called magnetic resonance energy transfer. Wireless power transfer is the transmission of electrical energy without wires as a physical connection. Wireless power uses the same fields and waves as wireless communication devices.

Various radio-frequency (RF) technologies are used for wireless power transmission. The LTC4120 wireless power transfer system using Power by Proxi's patented DHC technology can support power transfer of up to 2W at the battery. However, for single-cell Li-ion batteries, the maximum charge voltage of 4.2V and maximum charge current of 400mA limits this value to 1.7W. In short, the transmission of data wirelessly is made possible by the manipulation of radio waves. These waves are generated naturally by generating pulses of electricity. These radio waves can then be modified by their amplitude or frequency in order to transmit sound or data. The conventional way to recharge an electric vehicle is conductive charging. It requires the user to connect a conductor cable between the car and the charging station, and it's no different when you plug in your smart phone charging cord to recharge the battery. Despite its apparent limitations (you need to get out of the car to plug the cable, and charging stations/cables need lots of space), conductive charging has many advantages like:

- Higher power transfer efficiency
- High-speed DC charging capabilities
- Lower maintenance

Zero electromagnetic emissions On the other hand, wireless charging or inductive charging utilizes an electromagnetic (EM) field to transmit energy between two objects in this case, between the charger and the car. It also means there's no need to fiddle with charging cables in the rain or biting cold and the recharging process starts by simply parking or aligning the vehicle to the wireless charging pad in the ground. The process is no different from the wireless smart phone charger inside your car, albeit on a grander scale. Wireless EV charging requires an induction coil that creates an alternating EM field from the charging pad. Meanwhile, a second induction coil in the vehicle receives the EM field from the charging pad, effectively recharging the vehicle batteries after the system converts the EM fields to electric currents.



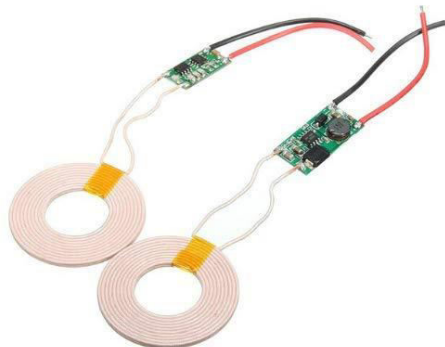


German automaker BMW was the first to release a commercially-viable wireless charging system from Omerit for its 2019 530e plug-in hybrid luxury sedan. Although unveiled in limited numbers, the system output is only 3.2 kW. Enough to replenish the 5-Series PHEV's 9.2 kW battery pack in 3.5-hours Swedish automaker Volvo wants to speed up the wireless charging process by testing a 40 kW wireless charger from Momentum Dynamics to a limited fleet of XC40 Recharge taxis across Gothenburg.

If all goes to plan, Volvo's wireless charger could be up to four times faster than a wired 11 kW AC charger and at wired 50 kW DC rapid charger, breaking open the doors to quicker and more efficient wireless EV chargers with fewer emissions.

It relies on resonant magnetic induction to transfer energy between a pad on the ground, and another under the floor of a compatible EV. The charging pad is around a meter square, while the car's receiving pad is enclosed in a smaller, dinner dish-sized device under the car.

The charging tech can be put into parking spots or structures, or at depots for electric delivery vans and trucks, ride-hailing cars, and buses. Wireless charging is "a nascent market with a lot of potential to grow," said Scott Sheppard, principal research analyst leading insights group at Guide house Insights. But Guide house also forecasts that wireless chargers might only account for 2% of the market by 2030 (with the number of wireless units only a fraction of the overall chargers out there), and challenges stand in the way. Industry standards for the tech are still in the works. It requires buy-in from automakers to install the accompanying receiver on their cars. And even when it is more prevalent, it could be primarily a premium market buy. If they can crack those challenges, wireless charging presents interesting opportunities.



**WIRELESS POWER SUPPLY COIL
(Transmitter & Receiver)**

IV EXPERIMENTAL VALIDATION



EV charging using Wireless Power Transmission

The real WPT prototype is presented and used to verify the established mathematical discretion of the used variable parameters as β and Transfer. This prototype composes of two coils, having a similar inductance value (set to 30 μ H). This prototype is shown in Each transmitter module end-point is connected to the filter output in series through the AC bus line

made of an aluminum bar to eliminate any instability problem. The input voltage is set to 35 VDC to be transformed to an alternating 50 kHz voltage. The global view of the WPT is shown in show the corresponding electronic parts for each coil. The real prototype has a fixed part and a moving part.

V. CONCLUSION

The use of WPT systems for EVs was the focus of this article. The key components of the WPT were studied with respect to the compensation topology and the coil construction. The key result of this study is concerned with the static and dynamic modeling of the proposed WPT method. A new model is developed and defined that incorporates both static and dynamic problems. On laboratory work, this model was experimentally validated. The results obtained were satisfactory and confirmed the effectiveness of the reported observations. This was done all over a single receiver coil. The mutual inductance enhanced value determines the efficiency. Furthermore, having two coil receivers under the EV is an upgrade to the methodology and it was discussed in detail. The mutual inductance is an important parameter in the WPT scheme. As a result, the considered one or two coils cases were extended to derive the used mutual inductance values. An assessment technique was addressed, and the two cases were compared and concluded. The presented work included developing a new type of WPT device to ensure high-efficiency EV battery charging. Extracted data from laboratory setup and simulation experiments demonstrate the overall good performance of the proposed algorithm. The results obtained show that it is possible to increase 100% of the efficiency of the wireless recharge system if a dual-receiver is installed.

The results obtained also show that as the speed increases, the efficiency of the recharge system decreases. Finally, the efficiency of the proposed method is 90% of global efficiency, which helps improve battery life. As a follow-up, a study will address issues related to the efficiency of the used converters while considering the system control difficulties and drive pattern issues. On the other side, integrating renewable energy systems, as solar photovoltaic systems, in this kind of recharge tool appears a serious challenge that can reduce the grid load in such cases.

VI. 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. The control has two sides for the transmitter portion. As a start, the grid can monitor this factor based on the reactive power value, whether it is suitable or not, to ensure overall grid reliability. On the other hand, because there is a certain frequency pulsation region that must be guaranteed to optimize the transmitter function block, the transmitter may be controlled by regulating the final inverter frequency in the permitted area. This control issue can be considered a potential endeavor of this work. Furthermore, this work can be enhanced by comparing the proposed receiver solution with one based on the use of wide receiver coils. For the situation where only a large coil is used, there are two issues. 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 does not 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 coil solution. Environmental pollution has reached almost the threshold level in India. As per the Climate Risk Index 2020, India ranks in the top 5. Which means India is vulnerable to climatic change. So, there seem no other options than to adopt e-mobility. To mitigate environmental issues, the Government of India decided to promote Electronic Vehicles (EV) to reduce pollution. • Proper infrastructure is one of the critical factors. But whatever the cons are of using and promoting EVS on Indian roads, the overall electric cars on the Indian roads will be almost 100 million in the financial year 2030 from just a half million in the financial year 2020. The best part is that, apart from reducing environmental pollution, EVs can lower oil import by about 560 Billion by 2030 Even though, electric engines also emit carbon while their manufacturing but still they manage to cut down the running carbon emission to almost 100%.

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