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ON ROAD CHARGING OF ELECTRIC VEHICLES

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Abstract: This paper discusses about wireless charging of electric vehicles on the road. Wireless power transmission is a method used to transmit electricity through the air medium. Wireless charging has been in development for a quite long time, and companies like ElectReon from Israel, have taken these standards to the next level with an innovation that sounds like it came right out of a science fiction film and this innovation is none other than wireless charging roads. This picks up electricity provided by a coil, which is beneath the road. Electric vehicles are normal, fitted with batteries, but the beneficiary is that people can transport as long as possible with this technology, as continuous electricity is provided through the coil. There is no time wasted in charging the vehicle, in the station. Even the existing electric vehicles can be slightly modified to attain this technology. And even the best part is that, for no battery electric vehicle, this will be the best option, as battery weight will be reduced, and with ease electric vehicle can transport.

Keywords: CPT, WPT, Magnetic Coupling Effect, SMFIR, Recharging road, Power pickup unit, plug in electric vehicle, OLEV, IPT.

I. INTRODUCTION

As we all know there are many environmental problems, and one of them is pollution and the depletion of the ozone layer due to the burning of fossil fuels. Electric vehicles produce zero emissions, unlike vehicles that use fossil fuels. " The latest report warns that atmospheric levels of the three main greenhouse gases - carbon dioxide, methane, and nitrous oxide - reached new record highs in 2021, showing the biggest year-on-year jump in methane concentrations since systematic measurements began nearly 40 years ago." This was published by WMO, Greenhouse Gas Bulletin on the 26th of October, 2022. By seeing such reports, we can assume that there is a need for an alternative solution for vehicles that use fossil fuels to transport. And we all know that the best alternative for such vehicles is vehicles using electricity as a source to transport people. Even many nations, such as the United States, India, Canada, Germany, China, Japan, etc. are promoting the usage of electric vehicles, and are treating electric vehicles are the future. There are many reasons to switch to electric vehicles rather than using petrol or diesel vehicles as they are significant in cost cutting, low maintenance, eco-friendly, and many more, depending on individual thoughts. Even many electric vehicle manufacturing companies are putting efforts into moving from traditional vehicles to electric cars.

The wire is used worldwide for the transmission of electricity from power plants to every location. Technology that uses wireless power transfer may be able to lessen or even do away with the requirement for batteries and wires. In situations where connecting wires would be difficult, dangerous, or impossible, wireless transmission can be used to power electrical devices. Electric cable comprised of copper and aluminum is used less frequently thanks to wireless power transfer technologies. Future generations won't have access to the metals used to produce electrical wire. Electric cable utilization will decrease if we adopt wireless power transfer technologies. In the future, it would be advantageous if wireless power transfer technology could be used to transmit power wirelessly from a power plant to any location. Another strong argument in favor of using wireless charging is autonomous car fleets. Wireless charging turns from being a convenience to being a requirement when there is no one to plug in but the car can drive itself to a charging location. This study examines how wireless power transfer based on magnetic resonance can be used to charge electric cars. A description of the technology used for this application, performance statistics from a cutting-edge system, a review of standardization efforts, and a discussion of certain obstacles to general adoption are all included.

However there are several issues with the current electric car technology, such as the battery being too heavy and the range being impacted if battery size is decreased. And because electronics differ between the two, using a high-quality, quick charger will be more expensive than using a standard one. In general, electric vehicles are more expensive than existing vehicles.

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On-Road Ticketing A new electricity-powered transportation system called an electric car can be employed to get beyond the current electric vehicles' technological limitations. This is a fundamental concept, wherein a road is constructed in a way that coils beneath the road can be used to deliver power to electric vehicles utilizing inductive coils or conductive rails. Given that electric vehicles may operate with a battery (although a smaller one) or without one, this is the greatest solution to the current issue. While ground-based power systems are thought to be the most cost-effective by experts, overhead powerlines are employed in the majority of electric road systems that are currently in operation across the world.

There are several ways to put these technologies into practice, including using solar panels, roads, and many more. However, only the first two are considered in this study and are discussed in length.

II. METHODS

A. Through Solar Panels :

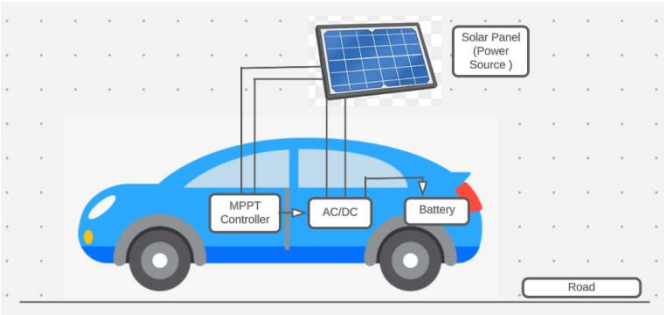

Fig.1 Electric car charging on road, through solar panel

This method is the best and sufficient method, to store and use electricity, which is converted from solar energy. The sun has been playing various important roles in human existence. Solar energy can be generated maximum and utilized fully efficiently when the sunlight falls on the equator region. When the solar intensity is maximum, the electric car battery might be fully charged as well. This can be done simultaneously, such that the battery gets charged continuously and is utilized by electric motors. But the major drawback for this technology to be used is that in some geographic regions, sun light reaches very less in amount, and where this technology may be like a waste of investment, and for night traveling, we have to rely on battery power only, as there is no sunlight in night.

B. Through Road :

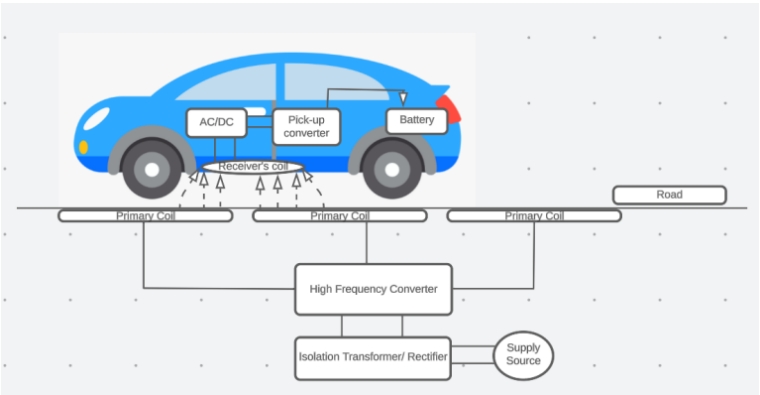

Fig.2 Electric car charging on road, through CPT.

The world is facing a tough challenge in the perspective of climate change in the global energy supply, mainly caused by a heavy dependence on fossil fuels. Transportation with electrified vehicles can reduce global dependence on fossil fuels and reduce the emission of greenhouse gases. However, the commercial deployment of electric vehicles has lagged behind due to technological issues associated with the battery including price, weight, volume, driving distance, and limited investment in charging infrastructure.

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A wireless charging system is required:
1. Easy and automatic charging method.
2. No human input is necessary.
3. It is smaller and more compact than a wired system.
4. It takes up less room and can be installed below the surface than a wired system.
5. No exposed electrical connections exist since it lacks any contact.
6. It can eliminate the risk of electrocution that is frequently associated with electrical cords.
7. The effectiveness of newer WPT designs is improving.

Here comes Capacitive Power Transfer (CPT), a form of wireless power transfer that transmits electricity through an air medium. WPT employs a Shaped Magnetic Field in Resonance (SMFIR). By wirelessly transmitting electricity from the road surface while the car is moving, the Shaped Magnetic Field in Resonance (SMFIR) technology created and developed by the Korea Institute of Aviation Safety Technology (KIAST) enables electric vehicles to get beyond these restrictions. The first country to introduce electric automobiles based on this technology was Korea. The wireless charging device is buried beneath the section of the road. A sensor along the road stretch recognizes when an electric vehicle passes over the SMFIR charging mechanism and turns on the charging system. The power inverter located on the road generates a 20 kHz electromagnetic field, which is used to power the underground electrical lines. Under the car, there are pickup coil sets adjusted to the magnetic flux's resonance frequency of 20 kHz. The coil is created with an optimal shape to allow for maximal exposure to the magnetic field that is generated.

As a result, it boosts transmission frequency and lowers magnetic field leakage outside of the space's design constraints. A Power Distribution Unit (PDU) distributes the DC power that has been created from the induced current of the magnetic flux that has been collected to the necessary areas of the vehicle. Additionally, these devices are carefully insulated to ensure that no people or animals are hurt. The receiver coil above the road will absorb almost all of the power that the road coil emits when they are in wireless communication. The metal body of the car itself absorbs the majority of the lost portion. Some electric vehicles can now be charged by parking them on top of charging pads that are up to 20 centimeters from the receiving coil at the bottom of the car thanks to this technology. The following phase is to install coil wiring on the roads so that vehicles like automobiles, buses, and even lorries may be charged while they are in motion. The dynamic wireless charging of electric buses and cars in motion using the tailored magnetic field in resonance technology has recently been put to the test by RTA Dubai.

This type of technology can even be implemented in existing plug-in electric vehicles.

This technology can be used in multiple ways, by installing charging pads near traffic signals, as the vehicle stops in traffic, the battery of electric vehicles gets charged, and in parking lots, where vehicles are parked and charged. These are some static charging methodologies. For dynamic, charging pads can be installed beneath the road, as mentioned in the above korean case.

The wireless power transfer technology has the following benefits:

1. Charging is quick and automatic.
2. No human interaction is needed.
3. It is smaller and more compact than a wired system.
4. It takes up less room and can be installed below the surface than a wired system.
5. No exposed electrical connections exist since it lacks any contact.
6. It can eliminate the risk of electrocution that is frequently associated with electrical cords.
7. The effectiveness of newer WPT designs is improving.

III. CHALLENGES FOR WPT

1. To install these technologies, new infrastructure has to be built, replacing existing roads with new infrastructure.
2. Radio frequency or magnetism has to be maintained accordingly, which should not harm any living being.

IV. WORKING MECHANISM

Inductive Power Transfer (IPT) technology is the foundation for wireless EV charging. A primary coil at a wireless charger is connected to the electrical grid, while a secondary coil is placed at the EV with a sizeable air gap between them.

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A transmitting coil of the wireless charger creates a magnetic field in this near-field charging approach, which transmits energy to a nearby receiving coil of the EV via induction. The power transfer is aided in some measure by the magnetic flux generated by the transmitting coil and penetrating the receiving coil. Additionally, the quality factor and coupling between the coils have an impact on transfer efficiency.

For wireless charging, there are primarily two forms of IPT:

1. Static IPT is activated when the car is spotted in a parking lot.
2. IPTs are deployed when the vehicle is either moving or briefly stopped at a traffic red light, respectively.

V. ASPECT OF IMPLEMENTATION

1. The main obstacle to the development of wireless power transfer systems, will expand the applications that can be used for the devices and could pave the way for the adoption of entirely wireless systems for automobiles and other equipment.
2. This will be possible when every nation on Earth accepts wireless power transmission technology.

Starting with the installation of wireless charging stations for cars, which may be used to charge the vehicle while it is traveling. In a few nations like the UK, Italy, the Netherlands, and South Korea, electric buses have already undergone testing.

VI. FUTURE COURSE OF ACTION

In the future, electricity can be used without a wire to power appliances. Discussing some applications for wireless power transfer technology are below.

1. Solar-powered satellites: Solar-powered satellites are used to harness the sun's energy as efficiently as possible.
2. Home appliances that are wirelessly powered: In the future, power will be transmitted to every appliance in the house via a transmitting device that is housed inside.
3. Wireless charging of electric vehicles while in motion: In the future, charging electrical vehicles won't require stopping. Charging is possible while traveling.
4. A worldwide power source for emergencies.
5. Wireless Traction Train: Wireless power supply may be available for trains in the future. Wire connections to the train won't be necessary.

VII. CONCLUSION

Wireless charging is set to play an important part in the electrification of transportation. Wireless charging systems offer a practical hands-free way to charge electric cars at the same rate and effectiveness as conventional conductive AC chargers. A wide range of wireless power transfer applications have been seen, and wireless electric car charging employing WPTs technology and its varieties has been researched.

Both methods can be used in single vehicles, like solar energy can be extracted and stored in the battery, where there are no roads, and roads which supply power, and can be utilized sufficiently. But the major issue comes when there is low sunlight, or the geographic area where sunlight is poor, as solar will be a waste of investment, and the cost of this technology is also high compared to normal EVs.

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