Dynamic Inductive Charging For Electric Vehicles

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Abstract-The introduction and production of electric vehicles have created a major impact on automobile sector. Electric vehicles provide more cost efficient and sustainable solution for energy consumption and to reduce the amount of pollution. Establishing accessible and robust network of charging infrastructure is an essential pre requisite in transition from conventional to electric vehicles. The proposed project aims at providing an alternate charging method of electric vehicles through wireless power transfer implemented through inductive power transfer technology.The proposed system works on the principle of electromagnetic induction. The implementation of the system is done by interfacing components like transmission and receiving coils, power electronic devices that form the transmission and receiving circuit. On practical implementation on roads this system requires specially designed roads with energized coils buried underneath. Electric vehicles in general take a considerably long charging time when compared to conventional vehicles. The proposed method aims to reduce the constraint in charging time and also to provide a future without needing to stop or search resources to charge the vehicle. Prototype of the proposed charging method was developed to simulate and analyze the Rate of charging of batteries and efficiency of this method compared to the solutions available.

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1. INTRODUCTION

The ongoing climatic conditions have led to the research and development of electric vehicles over the past decade. The increasing global warming has caused an awareness among the people to switch to electric vehicles. The time required to wait at charging stations while the battery is being charged will be reduced by a considerable amount of time when the charging will be done on road while driving the vehicle. Even though electric vehicles are an alternative, there needs to be development in its charging system to make it the prime option for transport. For this purpose, the charging systems should be developed. Dynamic charging systems are more reliable, user friendly and time efficient. Also, the battery size can be reduced, and the range can be improved. This charging system can also be implemented in the travel routes, traffic signals, bus stations.

According to a survey done by International Energy Agency, the use of electric vehicles will grow from 3 million to 25million by the year 2030. That is almost 41 times of what it is today, with the increasing demand of fossil fuel and problems with pollution. Owing to that, all major IC engine car manufactures like Ford and General Motors (GM) are slowly turning their attention towards the electric vehicles. The market and consumers are in need for a cheaper personal transportation, whereas the government has started supporting electric vehicles through its policies. Considering all these facts it is pretty much evident that very soon electric cars will be zooming all around the roads.

Fig1 A practical example of wireless charging of lane in UK.

1.1 PLUG IN V-2G AND WIRELESS V-2G

Plug in V-2G technology for electric vehicle is basically done through a bi-directional charger to switch between the home and grid network. The vehicle is charged using the AC socket. To produce the DC source, the AC is converted to DC. The converter DC current is supplied to a battery via BMS other converters.

Fig1.1 Plug-In V2G

Fig1.2 Wireless V2G

The basic operating principle of wireless charging is similar to transformer working. Wireless charging system consists of transmitter and receiver coils which is embedded with AC-DC and DC-AC converters. The AC mains from the grid is converted into high frequency AC and it is transferred through the transmitter coil which creates alternating magnetic field that cuts the receiver coil and receives the production of AC power output in receiver coil . But the important factor to be considered here is that for efficient wireless charging, the resonant frequency has to be maintained between the transmitter and the receiver coil. To maintain the resonant frequencies, compensation networks are added at both sides of system. The AC power at the receiver side is rectified and filtered to produce stable DC, which is further utilized for charging the battery through BMS .

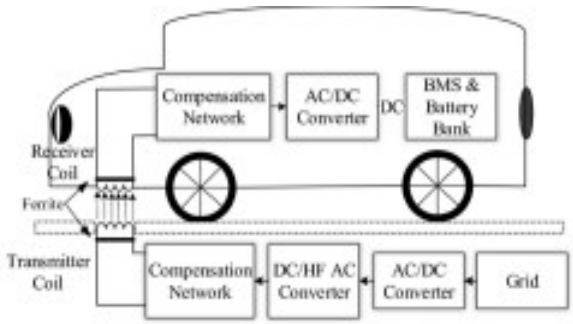

Fig1.3 Block diagram of wireless charging system.

II. RELATED WORK

A ride that is powered by one or more electric or traction motors. A collector system that draws electricity from an external power source can be used to power an electric vehicle. It can also be fitted with batteries, solar panels, fuel cells, or a generator that produces power from fuel. When electricity was one of the main means for motor vehicle propulsion in the middle of the 19th century, electric vehicles were developed. These vehicles provide gasoline automobiles of the era previously unheard of levels of comfort and simplicity of use. The internal combustion engine has been the main form of propulsion for cars for almost a century, but electric propulsion is still widely used in trains and other sorts of small vehicles.Electric cars are sometimes referred to as "electric vehicles." Due to technology advancements, a greater emphasis on renewable energy, and the possibility to lessen transportation's influence on climate change and other environmental challenges, electric vehicles have witnessed a resurgence in the twenty-first century. Electric cars are included as one of the top 100 modern climate change solutions in the electric vehicle with wireless charger. Lithium ion is typically used in electric cars (Li-Ion or LIB). Compared to the majority of other usable batteries, lithium-ion batteries have better energy densities, longer cycle lives, and higher power densities. Safety, durability, and heat deterioration are complicating elements. Cost. For optimal performance and safety, Li-ion batteries should be used within acceptable voltage and temperature limits.Increasing battery life lowers the overall cost. One method is to operate a portion of the battery cells at a time and alternate between those portions. In the past, certain electric automobiles, including those built by General Motors, used nickel-metal hybrid battery cells. Because of their propensity to self-discharge in the heat, certain battery types are regarded as being out of date. A further obstacle to the widespread development of these batteries was Chevron's ownership of a patent for them. Due of these qualities and their high price, lithium-ion batteries are now the most common kind of battery used in electric cars. The cost of lithium-ion batteries is continuously falling, which lowers the price of electric cars.

III.EXISTING SYSTEM

STATIC AND DYNAMIC WIRELESS CHARGING

Wirelesscharging system of an electric vehicle charges the vehicle by electromagnetic field to transfer the energy. This methodology of charging the electric vehicle can be classified into two categories:

1. Static Wireless charging.
2. Dynamic Wireless charging.

3.1 STATIC WIRELESS CHARGING

In this type of wireless charging system, the batteries of the vehicle can be charged autonomously while the vehicle is being parked in static mode where the transmitter enclosed with the primary coil is installed underneath the ground along with additional power converters and its circuitries. Here, a very high frequency AC is

transmitted from the transmitter coil. The receiver coil which is enclosed with the secondary coil is mounted on the underside of the vehicle receives the AC. The received energy is converted from AC to DC using the power converter and is transferred to the battery bank. For safety measurements, the receiver coil is enclosed with battery management system (BMS) and power control with a wireless communication network to receive any feedback from the primary side. The charging This concept of wireless charging can be well suited for mass transit applications, where it can be used at parking areas at shopping mall, garages, commercial buildings etc. An implementation of this system can be done by installing an automatic guidance system in the vehicle to help the driver align the vehicle directly above the primary charging pad. The transmitter end of the charging station and the receiver coil of the vehicle can exchange data using the inductive link or through short range communication methods. This feature allows the charging stations to adjust the charging procedure according to the condition of the battery and according to the driver's preference duration of an electric vehicle depends on their charging pad sizes, power supply level and distance (air gap) between the transmitter and the receiver. The distance between the transmitter and the receiver coil is approximately 150- 300mm.

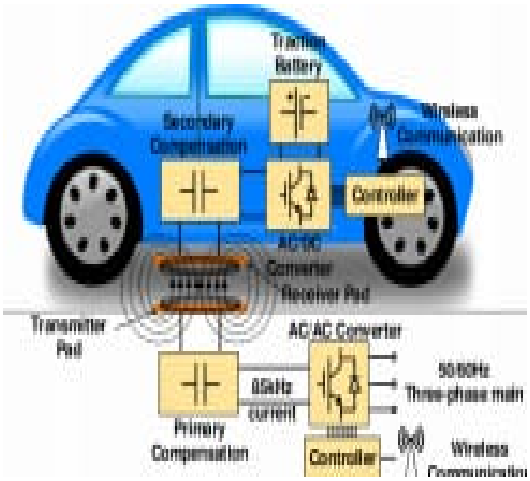

Fig3.1 Typical structure of Static Wireless Electric Vehicle Charging System (SWEVCS).

IV.PROPOSED WORK

4.1 DYNAMIC WIRELESS CHARGING

In static wireless charging, sufficient amount of charge must be present in the vehicle before starting. So, in order to store the charges, bigger batteries are required to provide constant power to the vehicle. But use of bigger batteries results in system inefficiency. Revolution in wireless charging motivated researchers to use dynamic wireless vehicle charging [13]. In this type of wireless charging system, the battery size is reduced and vehicles are charged while they are in motion, where the transmitter is enclosed with a primary charging pad which is installed beneath the concrete of the road along the pathway with high frequency AC along with its circuitries and the receiver enclosed with a secondary coil is placed below the front of the vehicle with power converter and battery management system which converts high frequency AC into DC and charges the battery bank.

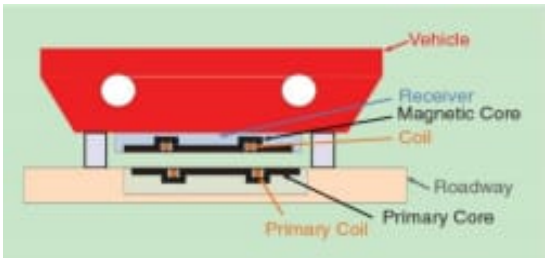

Fig4. 1 An illustration of dynamic Wireless charging concept.

But the primary charging pad which is installed on the vehicle moving path, can be classified into two categories:

1. Lumped charging pad (Single coil design)

2. Segment charging pad (Multiple coil design)

4.1.1 LUMPED CHARGING PAD

In lumped charging pad, one single winding coil is used as the primary coil of the transmitter side. This technique is basically used for static wireless charging because when the displacement occurs the mutual inductance of the primary and the secondary coil will change which will result in deflection of the magnetic flux. In this case of dynamic charging there should be a control strategy which will correct the flux deflections. The number of power converters and controllers used are less in lumped type. Due to this, the power transfer capability is limited.

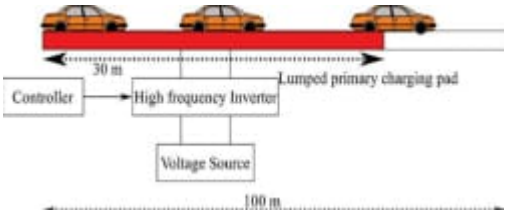

Fig4.1.1 Block Diagram of Lumped Charging Pad.

4.1.2 SEGMENT CHARGING PAD

In segment charging pad, the primary winding of the coil is divided into segments and placed throughout the pavements of the road for power transfer. A particular segment is energized when vehicle moves over the segment. During this process, the remaining segments which is not energized remains in off state. This reduces the power loss of the system. But disadvantage of this process is that individual inverters and controllers are employed for each segment which increases the complexity and cost of manufacturing the system. As the vehicle moves on the pavement there is chance of misalignment between the transmitter and receiving pads which affects the system performance. Various controlling methods have to be proposed in order to overcome it.

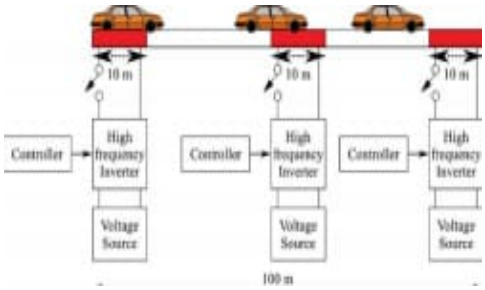

Fig 4.1.2 Block Diagram of Segment Charging Pad.

V.PERFORMANCE EVALUATION

We have successfully conducted the wireless charging of EV through renewable energy grids, it was observed that the efficiency was 90% with a distance of 125-175mm with power of 20KW. The voltage reduces when the distance is increased. The experiment was conducted with coils wound for several turns each in primary and secondary. However, if there is not proper alignment of primary and secondary coils the charging time of battery will increase.

VI.CONCLUSION

Wireless charging of electric vehicle has the potential to revolutionize the road transportation from the automotive industry. With the advancement of electric vehicle technology, wireless charging technique is expected to increase significantly by next decade. The main agenda of this paper is to give an overview of various wireless charging techniques out of which inductive wireless transfer has proven to be the best method of wireless charging. This paper also attempts to review about the application of static and dynamic wireless charging and how battery plays an important role in the electric vehicle.Here, the battery size is effected by wireless charging techniques which lowers the overall cost of the electric vehicle. The electric vehicle batteries which were to take quite a lot time to charge up to the rated value will be charged within less time comparatively as their battery capacity is reduced. However, simplicity and minimum driver intervention are key features that win out time-and time again and when these features are coupled with high power transfer efficiency, wireless charging of electric vehicle is a winning combination.

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