Smart Charging of Electrical Vehicle Using Inductive Wireless Technology

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Abstract- *Use of electrical vehicles is been increasing day by day, due to having various benefits over conventional vehicles. The most important component i.e. energy source of electrical vehicles are batteries. These batteries should be long lasting and powerful. The main problem in electrical vehicle is its battery charging process. This process is simplified using wireless charging of electrical vehicles.*

With the emerging wireless technology, it have become an integral part of the system known as Wireless Power Transfer. Wireless power transfer is done using inductive coupling between two coils providing a convenient method towards charging. Installation of wireless system is proving beneficial to both the user and provider. Wireless charging offers various advantages, which includes better safety, avoids need of annoying cables.

Storage systems stores electrical energy which is transferred through two copper coils placed on the ground and on the vehicle.. This paper discusses the techniques and components used for wireless vehicle charging

Keywords- Storage systems, Inductive Coupling, Electric vehicle, Batteries, Wireless power transfer

I. INTRODUCTION

There is an increase in use of number of electrical vehicles. Electrical vehicles have been considered as an alternative for conventional vehicles, since they have been advantageous over the conventional one. The conventional vehicles produce exhaust gases, which are harmful to human health. Electrical vehicles run on electrical energy. They are propelled using electrical motors on the vehicle that are powered through batteries situated on the vehicle itself. Therefore electrical vehicle has several advantages over conventional such as 60% reduction in fuel cost as compared to conventional, low maintenance, easy to start-stop.[2]

Electrical vehicle have high initial cost and also are not so popular yet due to the charging time required which is half an hour or more depending on the power level of charger. The owner has to plug in the cable and charge the battery. Many times we forget to plug in and find out of battery later. Charging cables may create tripping hazards. There may be leakage from cracked old cables, in cold areas, and may lead to accidental hazards. Therefore, use of Wireless Power Transfer (WPT) for charging of batteries, which would reduce all the charging troubles. In Wireless Power Transfer, the driver has to park the car and leave. Battery capacity of EVs with wireless charging could be reduced to 20% or less compared to EVs with conductive charging.[2]

The mechanism used to transfer power wirelessly uses a transmitter and receiver. The power transfer has to be efficient over a distance. Inductive coupling techniques have high power transfer efficiencies (upto 90%) for very small length of 1-3cm.[1].With increase in distance between the transmitter and receiver coil the efficiency tend to decrease. However, inductive coupling have various advantages such as high efficiency, small size and longer life.

II. ELECTRICAL VEHICLE

Electrical vehicle uses electrical motor for operation of vehicle. The electrical motor is driven through batteries placed on the vehicle. The flow to the motor through batteries is controlled through the switches.

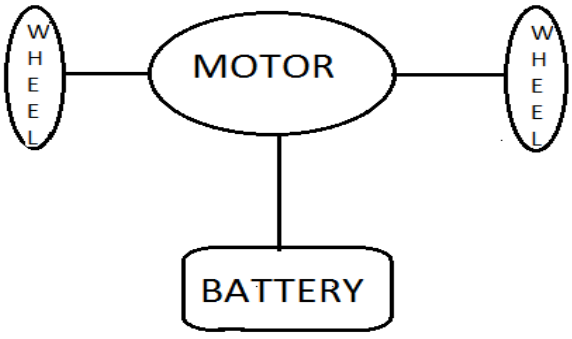

Fig 1. Electrical Vehicle

2.1 **Electrical Motor**- Electrical vehicle run on both AC as well as DC Motors. DC motors are generally used due to

having high starting torque for quick start of vehicle. DC motor generally used is brushless DC motor. In case of AC motors, three phase motors are used due to having ease of availability in various size and shape. This motor in turn drives the wheels of electric vehicle as shown in Fig 1.

2.2 **Batteries**-Batteries are used to store electrical energy, which is then fed to the motor .Batteries store the electrical energy in the form of chemical energy, and convert back whenever required. LiMH batteries are generally used for storage which are more efficient and increase the driving range of cars.

III. WIRELESS POWER TRANSFER

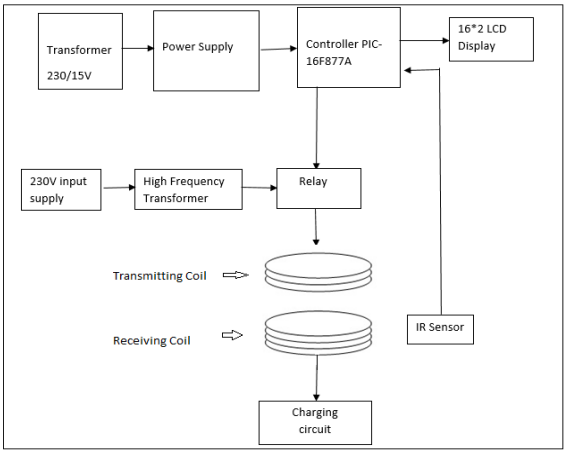

Fig 2- Block diagram of Wirless Power Transfer

Wireless power transfer is done through a transmitting and a receiving coil. WPT also requires various components starting from power source, microcontroller, relay circuit, Infrared Sensor (IR) for sensing, Transmitting and Receiving coil, Battery, etc.

3.1 Power Supply-

Power Supply has the function of supplying power to the load..It converts one form of energy to another form. The power unit receive power from input supply from the incoming 220V. Input voltage is step down .Incoming voltage is given to the rectifier, which converts it to a12V DC supply, which is filtered using capacitor. The output from the capacitor is given to the regulator 78XX which regulates the supply. Power supply may obtain inputs from various inputs that can be renewable sources, transmission lines supply or from batteries storage system. They can also can be supplied from generators or alternators. The power supply should be designed accordingly.

3.2 Rectification-

A rectifier is an electrical device that converts alternating current AC which converts the supply to DC current that flows in one direction. This process of conversion is known as rectification. Rectifiers are used generally at DC power supplies and DC power transmission systems. We have used rectifier for rectification of AC supply to DC.

3.3 Filtering-

Filtering is a device used to filter the unwanted signal from the output of rectifier. The rectifier output consists of various unwanted signals that are to be eliminated .These signals are filtered using filter such as capacitor .Capacitor filters the unwanted sinusoidal signals from the rectifier output and gives pure DC output.

3.4 Microcontroller-

Microcontroller is a computer containing a memory and programmable input output peripherals. The program is stored in the memory of Microcontroller ATMEGA16 is used in this case as it is easily available and at an affordable price. Automatic detection of electrical vehicle on arriving above the transmitting coil, which in turn turns ON the supply to the Transmitting coil is done through microcontroller.. Thus, the transmitting coil gets energised which produces magnetic field. Position of vehicle is sensed through sensor and signal given to the microcontroller, which in turn operates the coil.

3.4 Sensor-

Sensor is used to sense the movement of vehicle above the transmitting coil. Infrared sensor is used to sense the vehicle stopped above the transmitting coil and send a signal to the microcontroller. Microcontroller receives the signal and send a signal to the relay to operate.Relay switch ON the transmitting coil and the charging is turned ON. The two main types of detectors are thermal and photonic (photo detectors). The thermal effects of the incident IR radiation can be followed through many temperature dependent phenomenon.IR Sensors work by using a specific light sensor to detect a select light wavelength in the Infra-Red (IR) spectrum. By using an LED which produces light at the same wavelength as what the sensor is looking for, you can look at the intensity of the received light. When an object is close to the sensor, the light from the LED bounces off the object and into the light sensor

3.5 LED-

LED is a Light Emitting Diode is a semiconductor diode as a light source.It is a p-n junction diode which emits

light when a voltage is applied.Diode has a positive and a negative terminal. When a suitable voltage is applied to the leads the electrons are able to recombine with electron holes within the device releasing energy in the form of photons.

3.6 Coils-

It consists of a transmitting and a receiving coil. These coils are made up of copper. The transmitting coil is connected at the power supply side and the receiving coil is placed on the vehicle. Power transmission takes place between the coils due to inductive coupling between the coils. Automatic detection is done through sensor and power transmission is done transmission and receiving coils makes wireless power transfer possible.

3.7 High Frequency Transformer -

High frequency supply is required to efficiently transfer electricity through wireless technology .High frequency supply is given to transmitting coil that produces flux that are cut by secondary coil .

For a given supply voltage, flux density in transformer core is inversely proportional to supply frequency and inversely proportional to cross sectional area of core. So as the operating frequency of a transformer increases, for the same voltage and power, we can use less turns and a smaller cross sectional area. So high frequency transformer is smaller than a low frequency transformer of same rating.

However there is one problem running at higher frequencies –the hysteresis losses in the core will increase with frequency if the flux density is kept constant. Therefore for a high frequency transformer ferrite material for core instead of laminated iron core.

3.8 Liquid Crystal Display -

A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in colour or monochrome. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as preset words, digits, and 7-segment displays, as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements.

IV. INDUCTIVE COUPLING

In inductive coupling is a coupling in which power is transferred by magnetic fields between two circuits one is transmitter and one is receiver. Efficient power flow between the two coils is done by keeping the distance between two coils as small as possible.

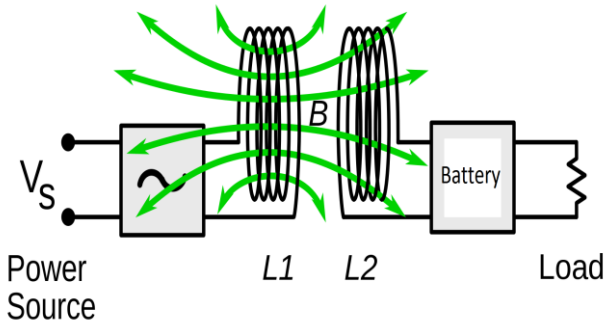

Fig 3- Inductive coupling

In inductive coupling, it is the mutual inductance between two wires. Mutual inductance between two wires is increased by winding the wires into coils and placing them together on a common axis. The two coils are magnetically coupled such that change in current through the wire induces a voltage across other wire through electromagnetic.

V. COUPLING COIL

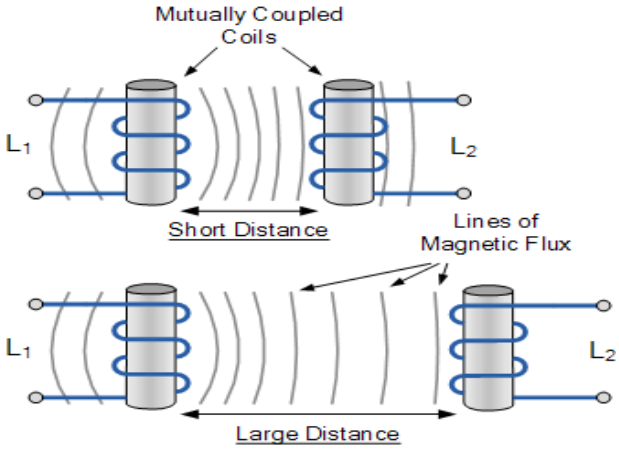

Fig 4- Transmitting & Receiving Coils

Two conductors are referred as mutually coupled or magnetically coupled when they are coupled such that change in current in one wire induces a voltage in the other wire through electromagnetic induction.The inductive coupling between two coils is measured by their mutual inductance.

Coupling between the two coils can be increased by winding the wires into coils and place them as close as possible so that the magnetic field of one coil passes through another coil.

VI. PERFORMANCE ANALYSIS

Observations –

9.2.1 Turns Ratio –

I. Primary Turns Ratio: 18
II. Secondary Turns Ratio: 36

9.2.2 Coil Calculations -

Sr. No.	Ground Clearance	Voltage	Coil Diameter
1	3 cm	12 V	9cm
2	4 cm	10 V	12 cm
3	5 cm	8 V	15 cm
4	6 cm	6 V	18 cm
5	7 cm	4 V	21 cm
6	8 cm	2 V	24 cm

Battery Calculations –

At actual we have the values of voltage and current Rating is,
Voltage = 12 V
Current = 40 A/hr.

And For demonstration purpose we use voltage and current Rating is,
Voltage = 12 V
Current = 100 Ma

Suppose 40A = 1Hr & 100 mA = x…. (x is a time)
So, x= 100mA/40A , x=2.5 Hrs.

We require 40 A current to charge battery in 1hr. whereas for demo we use 100mA current to charge battery normally in 2 hrs. 50 min.

VII. CONCLUSIONS

Charging of electrical vehicle is an important function which has to be done effectively and efficiently. Wireless charging of electrical vehicle batteries eliminate the need of plug in wires or cables for charging.Bridge rectifier to rectify and a capacitor for filter is been used. Also, automatic detection of electrical vehicle and charging turn ON is useful in electrical vehicle charging and also important in bus charging. Use of Electrical vehicle also reduces the usage of fossil fuels hence has certain environmental effects.

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