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Coupled Wireless Power Transmission For Electric Automobile.

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Abstract: This project presents wireless power charging to an electric vehicle (EV). The concept of wireless power transmission was introduced by nikola tesla. Now-a-days electric vehicles involves in large range of vehicles which includes two Wheeler, three-wheeler and cars. EV's are come by with more efficient, reliable with growth in range and performance. Electric automobile may be made greater reachable through introducing to wireless charging. Wireless power transmission is the way to transfer power without using conventional copper cables. It uses an electromagnetic field of a certain frequency as the medium of transfer. This paper deals with research and development of wireless charging systems for Electric vehicle using wireless power transmission. The systems deal with an AC source ,transformer, transmission coil, receiver coil, converter and electric load which are battery.

***Index Terms* – Wireless Power Transmission(WPT), Electric Vehicle, Wireless Charging, Inductive Coupling, Electromagnetic Field.**

I. INTRODUCTION

The automobile industry has deviated closer to an eco-friendly alternative, i.e., the electric vehicles. An electric vehicle, together referred to as EVs. The main advantage of Wireless power transfer (WPT) over wired is that it can eliminate the cables and can provide mobility within transmission range it can also eliminate power plug Compatible issues. The wireless solution is increasingly spreading as method of battery charging for Electric Vehicles (EVs). The standard technology of wireless EV battery charging is based on the Inductive Power Transfer (IPT) between two coupled coils, one connected to the electrical grid and the other one connected to the rechargeable battery. The IPT provides benefits in terms of safety and comfort, due to the absence of a plug-in operation: through IPT.

According to the state of the EV, there are mainly two types of IPT for the wireless charging: static IPT, when the vehicle is stationary and nobody is inside it (e.g. in a parking area); dynamic or quasi-dynamic IPT, when the vehicle is being used (e.g. while in motion or during the traffic red light). The wireless power transfer obviously represents the only solution for the dynamic charging, since the wired connection would be impossible during the motion.

The inductive coupling can be also exploited for a reverse power flow, that is from the vehicle to the grid. The Vehicle-to-grid (V2G) is a wide-spread concept, belonging to the up-to-date idea of the active demand: in a smart electrical network, the consumer is able to become producer of energy. The wireless power transfer can represent a support to V2G, and therefore be a Bi-Directional Inductive Power Transfer (BDIPT).

The wireless solution represents an ever-growing method of battery charging in several applications. The lack of wires is desirable whenever the power cable is inconvenient or even impossible to use. Wireless battery charging can be employed in different applications, ranging from the ultra-low power levels of the wireless sensors to the ultra-high power levels of the Railway Applications and passing through the following examples: electrical toothbrush [1], mobile phone [2], laptop [3], television [4], electric bicycle [5], electric car [6], electric bus [7].

The EVs can be recharged or supplied by IPT exploiting mainly three alternative options.

static wireless charging, quasi-dynamic or dynamic wireless charging. The static IPT consists of the EV charging whenever the vehicle is stationary and nobody stays inside it, e.g. in the case of a parked car.

In the quasi-dynamic IPT, the recharge occurs when the electric vehicle is stationary but someone is inside it, e.g. in the case of a cab at the traffic light intersections or a bus at the stop. The dynamic IPT consists in supplying the vehicle during its motion, e.g. in the case of a car running on a highway or of a moving train.

II. WIRELESS CHARGING SYSTEM FOR ELECTRIC AUTOMOBILE

Implemented through Inductive Power Transfer, the wireless charging for car drivers is convenient as far as safety and comfort are concerned: the user should not be worried about handling power cords, thus avoiding the electrocution risk, and could park the car in proper spaces, so that the charging operation can automatically start. The coils are generally placed in the following way: the one connected to the grid is placed on the ground and the other one, connected to the battery, is placed in the bottom of the vehicle chassis, as suggested in below figure. The minimum power level for electric car charging is generally 3 kW.

Different examples of commercial wireless charging stations for electric cars can be provided, since the EV companies are increasingly interested to this innovative charging technology. Among the car manufacturers, *Toyota*, *Nissan*, *General Motors* and *Ford* are some of the companies showing interest in the inductive charging method .

Among the companies producing wireless charging systems for EVs, *Evatran* and *HaloIPT* are leaders in providing and improving the inductive charging technology. *Evatran* has created the inducive charging system *Plugless Power*. *Halo IPT*, one of which images of the inductive charger is shown

IPT-based wireless charging of an electric car.

III. LITERATURE SURVEY

During a lecture, Han Oerested (1820), observed the pointer movement of a compass when electricity flew through a conductor which indicated an electric current magnetic effect. Andrie-Marie Ampere (1826) formulated the relationship between the magnetic field and electric current through his current law. In 1831, Michael Faraday established the "law of electromagnetic induction" which described that in a conductor there is an induction of electromagnetic force by changing magnetic field. A few years later, James Clerk Maxwell proposed that an electric field is produced in a wire as well as in an air gap even in the absence of an electric field and he created the formula for the relationship between changes in a magnetic field and induced electromagnetic force. Finally, in 1888, the existence of "electromagnetic radiation" is proved by Heinrich Hertz.

In 1891, Nicola Tesla developed the tesla coil for transmission of wireless power and he patented his Tesla coil [5]. In 1894, Tesla has lightened a lamp with a couple of coils by this wireless method [6]. In the same year, Maurice Hutin [7] has issued a patent on 3 kHz frequency range Wireless power transmission.

In 2007, the research group of "Massachusetts Institute of Technology (MIT)", presented a magnetic resonant WPT system, to lighten 60W bulb at a distance of 2m with 60 cm-diameter and an efficiency of 40% using a couple of coils and they called it "Witricity" [8]. Intel replicated the MIT group's experiment to transfer the wireless power to lighten the bulb with 75% efficiency at a short distance in 2008 [9]. In 2014, Rim, and his team from "Nuclear and Quantum Engineering" at "KAIST" University, transmitted inductive power with a frequency of 20 kHz signals with variable efficiencies of 29%, 16%, 8% to a distance of 3,4, and 5m respectively [10].

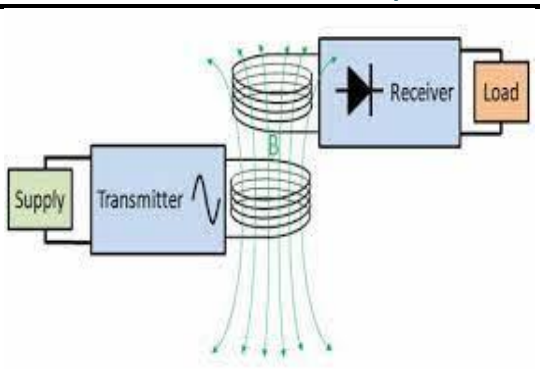
In reference [11], the research between 2001 and 2013 on wireless power transfer is summarized. Also, the USA, South Korea, China, and Japan the major four countries that are actively working on the WPT field [12].

IV. WORKING PRINCIPLE

Wireless Power Transfer relies on magnetic induction between planar receiver and transmitter coils. Positioning the receiver coil over the transmitter coil causes magnetic coupling when the transmitter coil is driven. Flux couples into the secondary coil, which induces a voltage and current flows.

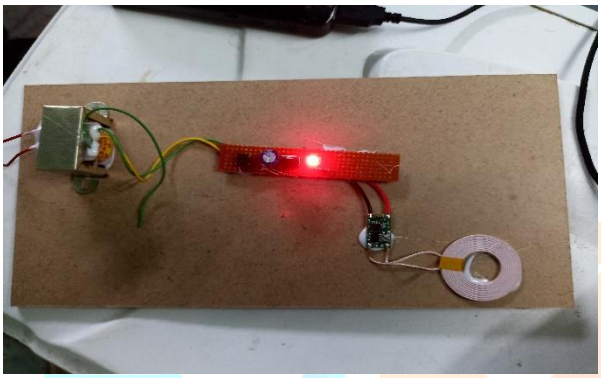
The secondary voltage is rectified and transferred to the load, wirelessly. Wireless power transfer is usually controlled by two coils one transmits and another receives the transferred power, as shown in below figure.

Power transfer depends on coil coupling, which depends on the distance between coils, alignment, coil dimensions, coil materials, number of turns, magnetic shielding, impedance matching, frequency and duty cycle. Receiver and transmitter coils must be aligned for best coupling and efficient power transfer.

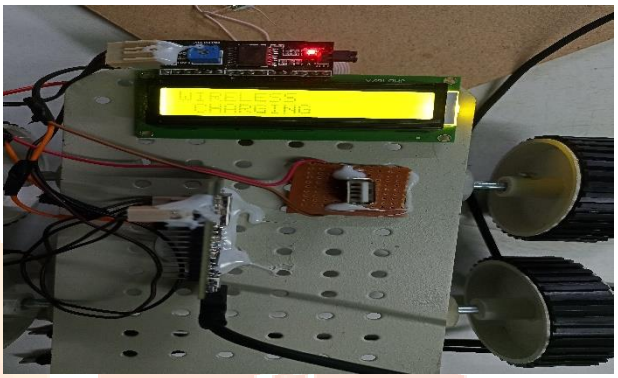


Transmitter And Receiver Coils

The closer the space between the two coils, the better the coupling. However, to account for housing and interface surfaces the practical distance is set to be less than 2 cm, as defined within the WPC Standard. Shielding is added as a backing to both the transmitter and receiver coils to direct the magnetic field to the coupled zone. Magnetic fields outside the coupled zone do not transfer power. Thus, shielding also serves to contain the wireless fields and avoid coupling to other adjacent system components.

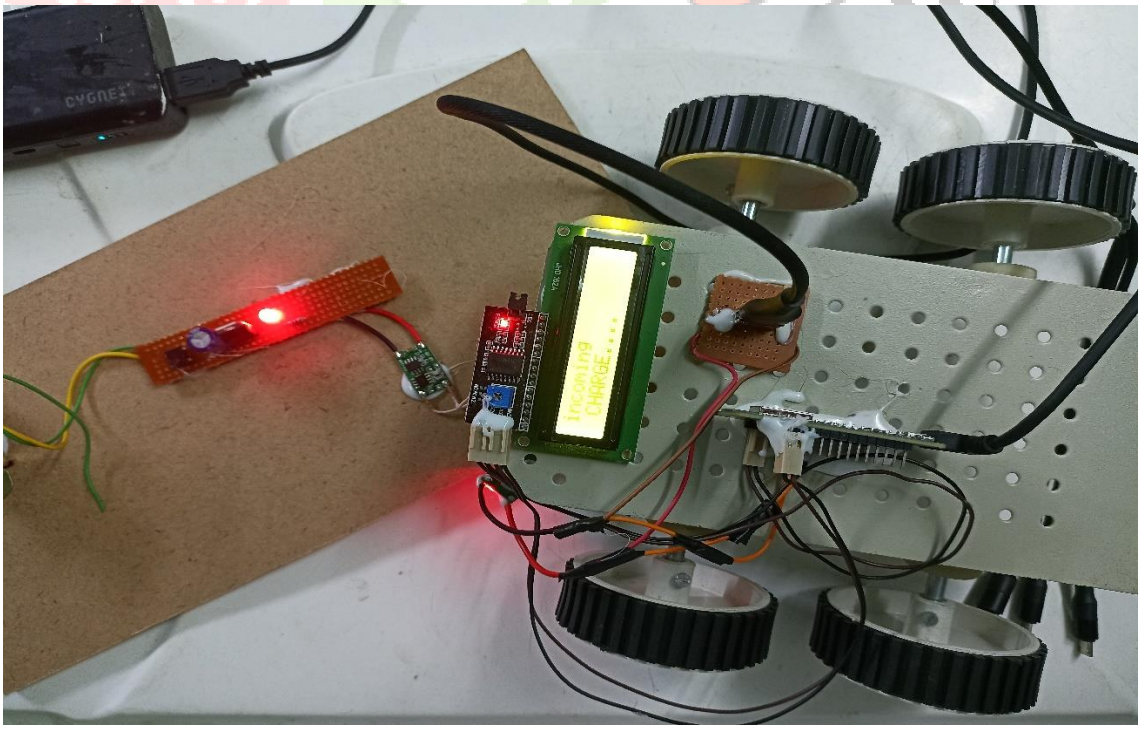


(a)Transmitter part



(b) Receiver part

For the designed IPT system a laboratory prototype has been assembled and several experimental tests have been carried out to test the proper working and to measure the power efficiency and the produced magnetic field.
In addition, this method can be used in several applications, like to charge gadgets like mobile phone, laptop battery, iPod, propeller clock wirelessly. And also this type of charging offers a far lower risk of electrical shock as it would be galvanically isolated.
This is an Emerging Technology, and in future, the distance of Wireless power transfer (WPT) can be improved as the study across the world is still going on.



V. HARDWARE AND SOFTWARE COMPONENTS

i. **Arduino compiler:** The Arduino IDE is an open-source software, which is used to write and upload code to the Arduino boards. The IDE application is suitable for different operating systems such as Windows, Mac OS X, and Linux. It supports the programming languages C and C++. Here, IDE stands for Integrated Development Environment.

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
const int charge=D5;
int chargestate=0;
// Set the LCD address to 0x27 for a 16 chars and 2 line display
LiquidCrystal_I2C lcd(0x27, 16, 2);

void setup()
{
      pinMode(charge,INPUT);
      lcd.begin();

      // Turn on the blacklight and print a message.
      lcd.backlight();
  lcd.clear();
  lcd.setCursor(0,0);
      lcd.print("WIRELESS ");
 lcd.setCursor(0,1);
 lcd.print(" CHARGING");
 delay(2500);
}

void loop()
{
      // Do nothing here...
 chargestate=digitalRead(charge);
 if(chargestate==1){

  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("incoming ");
 lcd.setCursor(0,1);
 lcd.print(" CHARGE....");
 delay(1500);
Ln 21, Col 2                                                    100%
```

ii. **COILS:** An electromagnetic coil is formed when a conductor is wound around a corePrimarily used to transfer energy from one electrical circuit to another by magnetic coupling.

Transmitter And Receiver coil

iii. **NodeMCU:** NodeMCU is an open source firmware for which open source prototyping board designs are available. The name "NodeMCU" combines "Node" and "MCU" (micro controller unit).

NodeMCU

iv. **Lithium ion Battery:** A lithium-ion (Li-ion) battery is an advanced battery technology that uses lithium ions as a key component of its electrochemistry.

LI-ION BATTERY

v. **LCD Display:** LCD (Liquid Crystal Display) is a type of flat panel display which uses liquid crystals in its primary form of operation. LEDs have a large and varying set of use cases for consumers and businesses, as they can be commonly found in smartphones, televisions, computer monitors and instrument panels.

2*16 LCD DISPLAY

vi. **TRANSFORMER:** A transformer designed to reduce the voltage from primary to secondary is called a step-down transformer. The transformation ratio of a transformer will be equal to the square root of its primary to secondary inductance (L) ratio.

STEP DOWN TRANSFORMER

vii. **RESISTOR:** A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element.

1k Resistor

VI. ADVANTAGES

1. It is simple, safe and high transfer efficiency for short distance.
2. We don't need to carry bulky Charging cable in the car.
3. It is pollution free.
4. It is Eco-friendly with environment.
5. The need of different types of chargers manufactures by different companies can be totally eliminated.

VII. DISADVANTAGES

1. The vehicle has to park on the Exact location where charger Coils installed to charge the EV Battery.
2. It is difficult to install the wireless charging system.
3. It is Difficult to Adjust the resonant frequency for multiple devices
4. The vehicle has to park on the exact location where transmitter coil is installed to charge the EV battery.
5. In inductive coupling, short transmission distances need the accurate alignment.

VIII. CONCLUSION

This method of charging is considered to be efficient compared to the fuel-based charging. Wireless charging technique reduces the risk of tripping problem that are caused by plug-in charging. Higher efficiency than plug-in charging for electric vehicles by reducing the hazards caused due to plug-in charging.

Wireless power transmission technology achieves the more attention among many researchers because of it's protection and cordless power supply for many industries and electronic applications**.** It is a promising technology in the last past decades. Thus we understand the wireless charging concept and how it is beneficial to us and we understood the types of wireless charging.

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