WIRELESS POWER TRANSFER FOR CHARGING ELECTRIC VEHICLE

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Abstract—*Wireless power transfer system based wireless electric vehicles, classified into roadway powered electric vehicles and stationary charging electric vehicles are in the spot light as future main streams transportations. Roadway powered electrical vehicles(RPEV) are free from a serious battery problems such as large, heavy and expensive battery packs and long charging time because they get power directly from the road while moving. The power transfer capacity, efficiency, lateral tolerance, EMF, air gap, size, weight and cost of the WPTSs have been improved by virtues of innovative semiconductor switches, better coil designs, road way construction techniques, and higher operating frequency.*

Keywords—wireless electric vehicle (WEV), roadway powered electric vehicle (RPEV)

1. INTRODUCTION

PEV was proposed as the prospective mode of transportation to address environment, energy and many other issues. In spite of receiving many government subsidy and tax incentives, EVs have not become an attractive solution to customers, major drawback of EV is with the energy storage weight, slower charging and low energy density. It would be infeasible to achieve range of gasoline vehicle from a pure PEV with current battery technology.

WPT technology can be used as a solution in eliminating many charging hazards and drawbacks relative to cables. The concept of dynamic WPT enabled EVs is that which means the EV could be charge while moving in a road increase the effective driving range while reducing the volume of battery storage. Some futuristic concepts of motor, capacitor, WPT, EVs have been proposed where EV is continuously charged and possible to run forever without batteries. WPT is yet to fully mature in terms of power transfer efficiency, range and power rating.

1.1 Basics of WPT Technology

WPT is a transmission of electrical power from the power source to an electrical load without use of physical connectors. History of WPT began with the formulation of Maxwell's equations in 1862. Maxwell described phenomena of radio waves in his equations. Later in 1884 Henry pointing illustrated electromagnetic waves as an energy flow and is used in his pointing theorem. Nikola tesla investigated the principle of WPT at the end of 19th century. Tesla's experiment was not exploited to a commercial level because of unsafe nature, low efficiency and financial constraints. With the advent of advanced semiconductor technologies, tesla's proposition has now become a reality. The wireless nature of this transmission makes it useful in environments the implementation of physical connectors can be inconvenient, hazardous, particularly in EVs.

Generally, WPTSs for WEVs can be divide into inductive power transfer systems, couples magnetic resonance systems and capacitive power transfer systems. It seems that these three WPTSs are totally different from each other; however CMRSs are found to be just a special form of IPTSs having an externally high quality factor; also, it has been verified that 5m long distance wireless power transfer can be effectively achieved with IPTSs using optimally shaped two dipole coils instead of multiple CMRS coils.

Moreover, the CMRSs not only have difficulty in maintaining resonance conditions due to their externally high Q but are also too bulky to be installed at the bottom of a vehicle. For these reasons, CMRSs are far from the rights candidate for WEVs. Therefore, IPTSs have been considered as the most appropriate WPTS and are commonly used for RPEVs because they are not constrained from the aforementioned problems of CPTS and CMRS. Among WEVs, RPEVs are becoming the most promising candidate for future transportation because they are ideally free from large, heavy, and expensive batteries, and get power direct while moving on a road.

2. SYSTEM ANALYSIS

2.1 Existing System

EVs will get their power from rechargeable batteries installed inside the car and these batteries are not only used to power the car but also used for the functioning of the lights and wipers. Electric car have more batteries than normal gasoline engine. The only difference comes in the facts that in electric vehicle. The environmental impact of an electric car is zero, as well meaning you're reducing your carbon foot print.

Drawbacks are (i) Electric fuelling stations are still in the development stages(ii) Short driving range and speed(iii) Longer recharge time.

2.2 *Proposed System*

From the vehicle view point dynamic WPT enabled infrastructure where EVs can be charge continuously while in motion, theoretically solve the EV battery problem with unlimited driving range. However, employment of such system is reliant on the infrastructure development, which in turn limited by its cost. The Dynamic WPT for EV charging is as shown in fig 1.

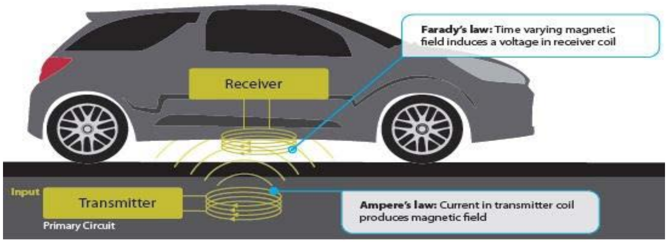

Fig 1: Dynamic WPT for EV charging

Dynamic EV charging approaches can be mainly categorized into two types based on transmitter array design; single transmitter track and segment transmitter coil array. First type consists of a substantially long transmitter track connected to a power source. The receiver is noticeably smaller than the length of the track. Segmented coil array based designs have multiple coils connected to high frequency power sources.

Track based transmitter systems are easier to control as the track is powered from a single source. Coupling coefficient along the track is nearly constant when the vehicle moves along the track. The transmitter track can be few meters to several tens of meters long

2.3 *Merits of Proposed System*

The merits of our proposed system are reduced battery size, Wireless power transmission system would completely eliminates the existing high tension power transmission lines, tower, cables and substation, elimination of Human intervention, Fast Response, Conserve charging time.

3. Hardware Components

Fig 2 represents the hardware components for Wireless Power Transfer from road to electric vehicle. These hardware components are transformer, diode, rectifier, capacitor, filter, array resistor, voltage regulator, LCD, MOSFET, and PWM generator, battery, DC motor.

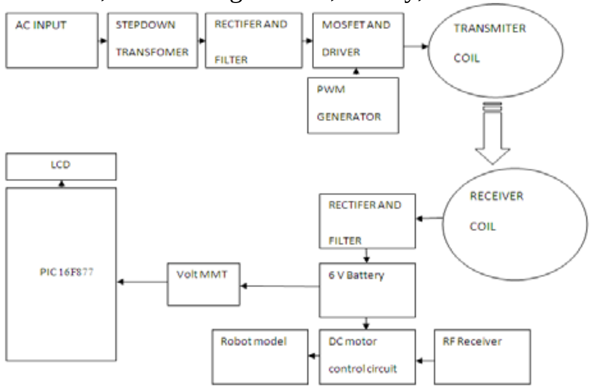

Fig 2: Wireless Power Transfer from road to electric vehicle

3.1 *Power Supply*

The ac voltage, typically 220v rms, is connected to a transformer, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ac variation or ripple.

A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular regulator IC units.

3.2 *Clock Generator*

The clock generators are used to generate the square wave pulse. The clock generators are used to the circuit where the external clock pulse is needed. The clock generator is constructed by CD 4046 IC with external components. The CD 4046 is a micro power phase locked loop consists of a low power, linear and voltage controlled oscillator. The linear voltage controlled oscillator produce an output signal whose frequency is determined by the voltage at the VCO input and capacitor, resistor, connected to the pins.

3.3 *PIC Microcontroller*

Microcontroller is a general purpose device, which integrates a number of the components of microprocessor a number of the components of a microprocessor system on to single chip. It has in built CPU, memory and peripherals to make it as minicomputer. A microcontroller combines on to the same microchip. These are the CPU core, memory (both ROM and RAM), some parallel digital input and output.

Micro controller is a standalone unit, which can perform functions on its own without any requirements for additional hardware like I/O ports and external memory. The CPU core is the heart of the microcontroller. In the past, this has traditionally been based on a 8-bit microprocessor unit. For example a basic 6800 Motorola microprocessor core in their 6805/6808 microcontroller devices. In the recent years, microcontrollers have been developed around specifically designed CPU cores, for example the microchip PIC range of microcontrollers.

3.4 *PIC (16F877)*

Various microcontroller offer different kinds of memories. EEPROM, EPROM, FLASH etc. are some of the memories of which FLASH is the most recently developed. Technology that is used in pic16F877 is flash technology, so that data is retained even when the power is switched off. Easy programming and erasing are other features of PIC16F877.

3.5 *CPU*

CPU is not different from other microcontrollers CPU. PIC microcontroller CPU consists of arithmetic logic unit, memory unit, control unit, accumulator etc. we know that ALU mainly used for arithmetic operations and taking the logical decisions, memory used for storing the instruction which is to processed and also storing the instructions after processing, control unit is used for controlling the all the peripherals. Accumulator is used for storing the results and used for further processing. As I said earlier PIC microcontroller supports the RISC architecture that is reduced instruction set computer or controller is said that it supports reduced instruction set you should remember the following points. These are RISC has very few instruction which are used in the program, length of the instruction is small and fixed takes same amount of time for processing, as the instruction is small it will take less time to process another words CPU will be fast, compiler need not be complex and debugging will be very easy in the programmer point of view.

3.6 RF Transmitter and Receiver

This circuit utilizes the RF module for making a wireless remote, which could be used to drive an output from a distant place. RF module, as the name suggest, uses ratio frequency to send signals. These signals are transmitted at a particular frequency and a baud rate. A receiver can receiver these signals only if it is configured for that frequency. A four channel encoder/decoder pair has also been used in this system. The input signals, at the transmitter side, are taken through four switches while the outputs are monitored on a set of four LEDs corresponding to each input switch. The circuit can be used for designing remote appliance control system. The outputs from the receiver can drive corresponding relays connected to any household appliance.

3.7 Description

The ratio frequency transmission system employs amplitude shift keying with transmitter/receiver pair operating at 434 MHZ. the transmitter module takes serial input and transmits these signals through RF. The decoder is used after the RF receiver to decode the serial format and retrieve the original signals as outputs. These outputs can be observed on corresponding LEDs.

3.8 Encoder IC Receives parallel data

Encoder IC receives parallel data in the form of address bits and control bits. The control signals from remote switches along with 8 address bits constitute a set of 12 parallel signals. The encoder HT12E encodes these parallel signals into serial bits. Transmission is enabled by providing ground to pin 14 which is active low. The control signals are given at pin 10-13 of HT12E. The serial data is fed to the RF transmitter through pin 17 of HT12E. Transmitter, upon receiving serial data from encoder IC, transmits it wirelessly to the RF receiver.

4. RESULT

The wireless power transfer based roadway charging electrical vehicle with operation was done. This module works on induction principle. The electrical vehicle is used to get charged while moving on the road by induction between the transmitter and receiver coil. Charging and discharging of the battery is shown in LCD display, the movement of vehicle module is controlled using the RF remote controller. The experimental setup is as shown in fig 3. Circuit can also be made to utilize the RF module (Tx/Rx) for making a wireless remote, which could be used to drive an output from a distant place using bluetooth control. The status of electrical vehicle charging ,amount charged for unit consumed was displayed using bluetooth module as shown in fig 4.

Fig 3: Experimental Setup

Fig 4: Status of vehicle charging

5. CONCLUSION

This paper has proposed an on-road charging systems with a single transmitting coil and multiple receiving coils. For maximum receiving power of each EV for a system with identical loads, the resistance should be adjusted according to the number of charging EVs. Avoiding excessive primary current and satisfying a minimum charging demand are taken into consideration to determine the power control strategy. Specifically, self-adaptive source voltage and constant source voltage are applied to charge different numbers of EVs, respectively, due to different traffic conditions. To charge each EV with rated power when the voltage source can support enough charging EVs, adjustment of the source voltage based on primary current detection is proposed. As for congested traffic with too many EVs, the source is regulated to maximum output and EVs are permitted to charge according to first come, first serve rule. In addition, a balanced speed is used as guidance for drivers to adjust the individual driving speed to acquire efficient energy compensation. In the case of particular power demand, the corresponding resistance is adjusted from the point of the average power distribution to the point of maximum power. We control strategies perform close to the theoretically analysis, applying to systems with different topologies or parameters. As a concluding remark, an on road charging system including a single TX and multiple RXs can serve as an efficient way to make up for EV power loss. IPT offers the unique advantages of a galvanically isolated power transfer to the vehicle without the need for moving mechanical parts that are subjects to corrosion, wear, and fatigue. This is highly attractive for the opportunity charging of public transport systems, where the reliable and the maintenance requirement of the charger are a considerable factor in the operating costs. For passenger EVs, a contactless charger with a lower power level, e.g.. 3-7 KW, and therefore a smaller size could be considered as a premium feature in addition to a high power conductive charger rated for 22 KW or more. To reduce the cost and limit the necessary construction volume on the vehicle, the on board power electronics of both charging systems could be optimally integrated into a single unit. In this way, the contactless would improve the convenience and safety for the routine use case, while faster battery recharging would remain possible with the conductive charger.

REFERENCE

[1] Liang chan, Ganesh R. Nagendre, John T. Boys, and Grant A. Covic, "Double-coupled systems for IPT roadway applications," IEEE Journal of Emerging and selected Topics in Power Electron., Vol.3, no.1,pp.37-48, March 2015.

[2] Chang B. Park, Sung W. Lee, Gye H. Choi, and Chun T. Rim, "Innovative 5-m-off –distance inductive power transfer systems with optimally shaped dipole coils," IEEE transcation on power electronics, vol.30,no.2,pp.817-827,Nov.2014.

[3] Ki B.Lee, Zeljko pantiv, and srdjan M. Lukic, "Reflexive field containment in dynamic inductive power transfer systems," IEEE Trans. On power electron., vol 61, no. 3, pp. 1179-1192, Mar.2014.

[4] Grant A.Covic and John T. Boys, "Inductive power transfer" Proceedings of the IEEE, vol.29, no.9, pp. 4592-4602, 2014.

[5] J.Shine, S.Shine, Y.Kim, S.Ahn, S.Lee, G.Jung, S.Jeon, and D.Cho, "Design and implementation of shaped magnetic resonance based wireless power transfer system for roadway powered moving electric vehicles,"IEEE Trans. Ind. Electron., vol 61, no. 3, pp. 1179-1192, Mar,2014.

[6] J.Kim, Jong H.Kim, and Seung Y.Ahn, "Coil design and shielding methods for a magnetic resonant wireless power transfer system," Proceeding of the IEEE, vol.101, no.6, pp.1332-1342, June 2013.

[7] John M.Miller, Omer C.Onar, and P.T.Jones,"ORNL developments in stationary and dynamic wireless charging," IEEE Energy Conversion Congress and Exposition,2013.

[8] E.Mascarell "VICTORIA: Towards and intelligent e-mobility," Unplugged final event 2015.

[9] Julio A.Ruiz "ITS system developing in malage," second congress EU core net cities ,2014.

[10] Technical article eCarTec 2014 in INTIS website http://www.intis,de/intis/downloads_e.html.