Implementation of Magnetic Resonance Based Wireless Power Transfer System for Electric Vehicles

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Abstract: ***To reduce the effects of global warming, green house, pollution, we humans are always making an efforts to minimize its causes. Hence humans are attracted towards pollution free assets as reason behind this pollution hazards are due to burning of petroleum fuels. Considering this major effects electric vehicle concept is introduced in the market. Market penetration of electric vehicle is growing day by day. Electric vehicles are seen to be running on the roadway but still conventional method of charging means plug in method is used. This method of charging is useful for short term purpose. To travel long distance it is not reliable. Considering this wireless charging of electric vehicle concept is proposed. This is possible with the concept of electromagnetic induction.***

Keywords: Petroleum fuels, Electric vehicle, Wireless charging, Electromagnetic induction**.**

1. Introduction

Electric vehicle concept is indeed a noble one. Considering the environmental issues electric vehicles are distributed widely. Charging of these electric vehicles "Conductive Charging" method is used means we have to plug the cable pin into socket and charge it. Most of the people charge their vehicle overnight then also it is not reliable to travel long distance, if in midway charging required it is not possible that each and every time charging socket is available. Sometimes charging becomes nil in midway then what to do is still question mark (?). Hence we can conclude that this type of charging is used for short term purposes, to travel long distance this method defeats.

Considering the issues related to charging "Inductive Charging" concept is proposed. Here charging is done with the help of electromagnetic induction. We know that when current flows through any wire it create magnetic field. In a proposed system we are going to implement this concept. Track is implemented on the roadway which consists of two or more than two magnetic coils. This coil is made up of copper. Another magnetic coil is deployed at the base portion of electric vehicle. Whenever electric vehicle wants charging it enters into a parking zone which contains this overall setup of wireless charging. Entering the zone vehicle will park upon that track hence with the concept of magnetic induction charging is done.

As electric vehicle market is increasing day by day considering environmental issues, Inductive charging method is most suitable and reliable for day to day life to travel long distance.The related work about the previous research is explained in section II. Section III describes the Electromagnetic Induction. Section IV gives Implementation platform, Section V gives proposed method and section VI and VII gives the Result and conclusion.

2. Related Work

Various techniques are available to charge the electric vehicle. In paper [1] author give how electric vehicles are charged while moving on the roadway. But practically to implement this type of system its cost goes very high and also power is delivering from electronic grid. Price increases automatically if market of electric vehicles increases hence it seems to be very complicated. If petroleum vehicle drive on the roadway then also charging is provided to that vehicle so it is not efficient.

Authors in paper [2], gives Nash equilibrium, the author is very concerned about what happen when market penetration of electric vehicle is increased? So keeping this question in mind he gives decentralized way of charging where each vehicle determine their own charging level and charge the battery of plug in electric vehicle. They install one terminal for charging and depending upon the time and demand of electricity it provide charging at particular cost. This plug in method concern only electricity cost and fully charge. Also this method came into existence when market of electric vehicle is increased.

Concept of electromagnetic induction is explained in paper [3], [4], [5] present the analysis of two coupled coils used to transfer energy to charge battery. Tight coupling occur when coupling coefficient is equal to 1, then most of the power is not transferred from primary to secondary coils. Over coupling occurs when secondary coil is kept so near that it tends to collapse to primary coil. Hence loosely coupled coils are considered which are kept at some distant from each other for maximum power transfer efficiency. Author in this paper analyze how electromagnetic induction works with coupled coils, they compare tight coupling, over coupling and loose coupling of coils and conclusion is drawn. [6] It explain how inductive coupling work, according to amperes law we know that when current flows through any conductor it creates a circular magnetic field, induction works on the same concept, when current and voltage flown from primary coil it automatically transferred to secondary coil due to magnetic flux which are generated between this coils. Hence power is transformed same concept we are going to use in our proposed system to charge the battery of electric vehicle.

The authors in [7] analyzed the effect of air gap with the help of helical antennas. These helical antennas are kept at some distance from each other and its effect is noted. They perform experiment with different values calculate the effect of air gap in power transfer. With the help of Neumann formula efficiency of air gap is calculated. Set up consist of vector network analyzer to measure the transmission and reflection ratio of system. From this experiment finally it is concluded that if distance between antennas is increased then efficiency of power transfer is decreases. In [8] authors give the design of different core structure, and estimated that depending on the core structure transmission of power varies. In practical implementation this core structure helps to gain the result. This core structure removes drawbacks related to power transfer efficiency.

In paper [9], authors present various topologies such as SS, SP, PS, PP depending upon the topology design capacitors are connected in the primary and secondary winding. In this geometry of coupling capacitor C2 is chosen to operate in secondary coil to achieve maximum power transfer and capacitor C1 is chosen to cancel out the reactive part of circuit to achieve zero displacement factor. Voltage source characterizes series compensation capacitor and current source characterize parallel compensation capacitor. This paper gives the design for ICPT system; it shows that if proper design is selected, it is possible to deliver high power with high efficiency.

Author gives the core shape analysis in [10] to transfer power three parameters are responsible first is magnetic core, second is size of air gap and third is construction design. Core shape structure is selected for railway system. [11] This paper presents a new pickup configuration that improves the power profile of pick up relative to track, [12] give how cell phones are charged with the magnetic induction property. In the proposed system we are trying to reduce the cost of the system by making circuit simplified and easy to understand.

3. Electromagnetic Induction

Figure shows the circuit of inductive coupling. This circuit is fundamentally the same as the circuit model of transformer.

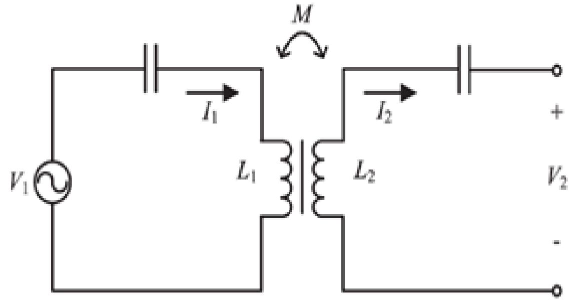

Figure 3.1: Inductive Coupling [1]

Electromagnetic induction phenomenon state that when current flows through any coil it creates a circular magnetic field. When two coils come close to each other it generates a magnetic flux due to current and voltage in the coil. Magnetic core makes the flux propagate upwards towards receiver coil. As shown in above figure it consist of transmitter coil L1 and receiver coil L2. When an alternating current flows through the transmitter coil it generates a magnetic field, which creates a voltage in the receiver coil. Hence battery is charged with the help of this voltage. The efficiency of the power transfer depend on the coupling (k) between the inductor and their quality. Electromagnetic coils are used in applications where electric current interact with magnetic field. We are going to use this concept while charging the electric vehicle.

4. Proposed Concept

Block diagram of proposed system is as shown in fig. below. It is the combination of transmitter, platform and receiver.

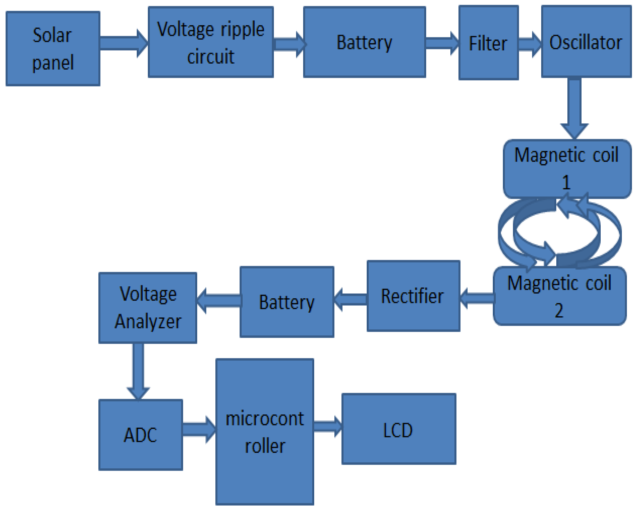

Figure 4.1: Block Diagram of Overall Circuit

Overall set up of an system is shown in figure. Solar panel is nothing but the set of photovaltaic system it generate and supply electricity. It uses light energy from the sun to generate electricity through photovaltic effect. Output of solar panel is given to voltage ripple circuit which removes ripples and passes the current to battery, Battery is charged. Current coming from battery is direct current (D.C.). Battery is connected to filter and oscillator circuit, Filter is used to remove ripples and oscillator convert D.C. current into A.C. current. This alternating current is driven into magnetic coils which are built into track. Magnetic coil is an electrical conductor such as wire. It is made up of copper. We know that when current passes through any conductor it creates a circular magnetic field around the conductor due to ampere law.

Here we are using coil shaped magnetic field such that it increase the strength of magnetic field produced by a given current. When two magnetic coils are come closer then it create a magnetic flux and the magnetic core make the flux propagate upwards. Other magnetic coil which is deployed at the base portion of vehicle, magnetic core capture the magnetic flux which inducs voltage along the coil.

Compensation capacitors are connected to the coil to compensate the impendence of inductance.This magnetic coil is connected to rectifer which convert A.C. to D.C. current, here we are using half wave bridge rectifier circuit and electric vehicle battery is charged. Voltage analyzer is used to analyze the voltge of battery. Analog to digital converter is used to analyze the voltage of battery that is it used to convert the given physical quantity into digital number that represent a quantity of amplitude. Then this value is given to the microcontroller, microcontroller is so programmed such that it display the value on LCD about the charging level of battery. In this way electric vehicle battery is charged with themagnetically coupled wireless concept.
System require good horizontal and vertical alignment beteen vehicle pickup module and track to ensure large amout of power delivery.

5. System Flowchart

System working is as shown in flowchart:

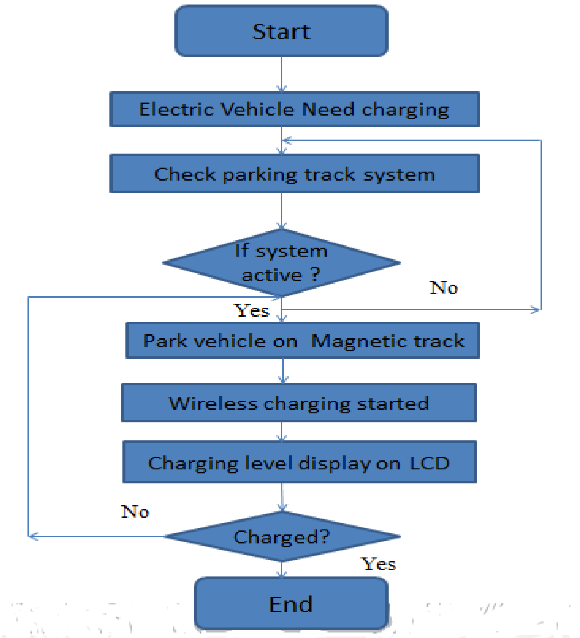

Figure 5.1: Flowchart

6. Implementation Platform

6.1 Hardware Requirements

- AT89S52 Microcontroller
- 12v DC Solar panel
- 12v DC*2 Lead acid battery
- Magnetic Coils
- 7805 Voltage regulator
- ADC 0809
- 16*2 LCD
- DC motor
- L293D H bridge IC
- RF Transceiver

6.2 Software Requirements

- Kiel uVision4 for Embedded C programming
- Flash Magic for burning program to IC
- Xpress PCB software for PCB design

7. Results

As shown in picture solar panel, battery is install on the roadway. Coils are kept at the track. Like a petro pump, it is parking track of electric vehicles.

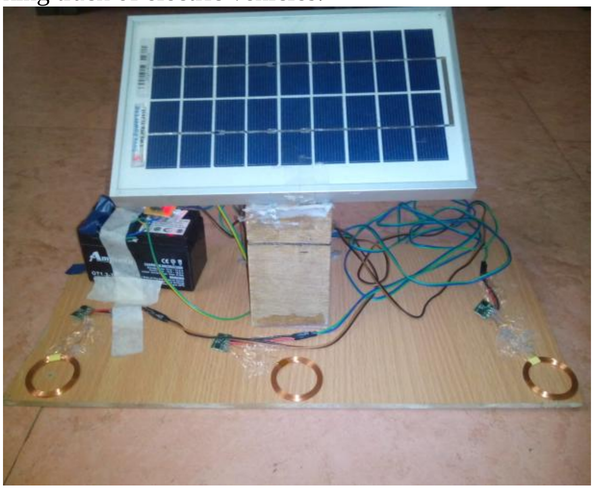

Figure 7.1: Parking Track

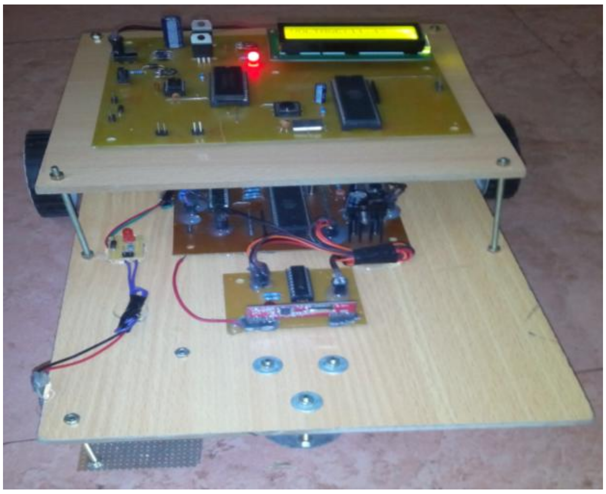

Figure 7.2: Prototype of Electric Vehicle

This is the prototype of an electric vehicle. When vehicle comes and park on that platform or track then charging started, charging level is displayed on LCD.

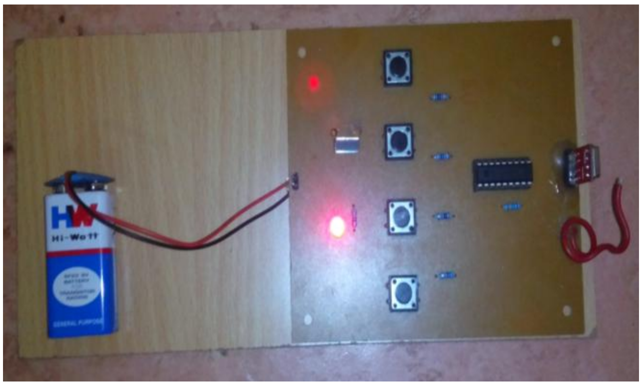

Figure 7.3: Remote Control

This is the remote to control the robotic vehicle through RF transceiver. It contains forward, reverse, right and left buttons to control robotic vehicle.

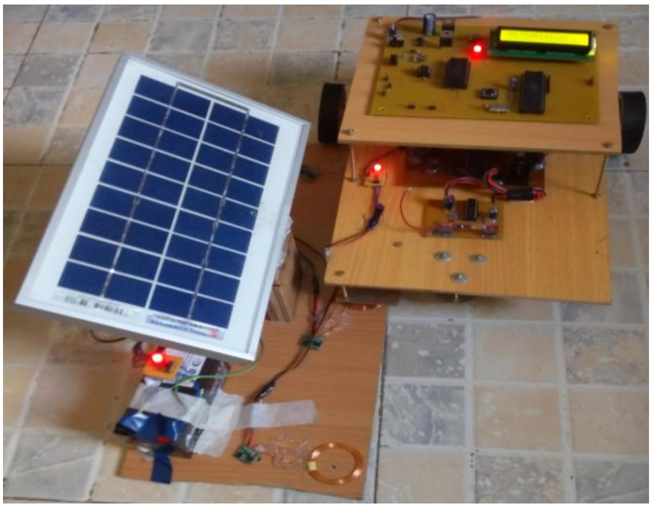

Figure 7.4: Overall System

8. Conclusion

As electric vehicle is alternative of gasoline vehicle it helps to make a system ecofriendly. To recover the disadvantages like long charging time and short driving range, wireless charging concept helps to remove some sort of drawbacks. Comparing conductive method and inductive method of charging, inductive charging is more significant. It helps us to achieve cost effective system, as solar panel is using battery is charged with solar panel not from the electricity grid. Electromagnetic induction concept is indeed a great and noble one; wireless charging of electric vehicle is possible because of this inductive coupling. This concept can also be used in various application which contains secondary batteries like mobiles phone, palmtop etc.

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