Wireless Power Transfer for Electric Vehicles

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Abstract- **Wireless power transfer technology has more advantages over conventional means of power transfer and its generation, thus it has received more attention in the few decade and has been employed to apply to a wide range of applications, ranging from low power required for biomedical applications to railway vehicles with efficiency up to 95% or higher in some prototype systems. Magnetic wireless power transfer systems rely on magnetic field coupling to transfer electric power between two or more magnetically coupled coils.**

The main objective of wireless power transfer for electric vehicles is to transfer power within a smaller range. The wireless power transfer system consists of transmitter and receiver part which are separated by small distance of about 3cms. Therefore the transfer can be seen as the receiver receives the power to run the motor. Wireless power transmission technology uses time varying electromagnetic field. This electromagnetic field is created around the free space which carries a steady current of charges creating a magnetic field around it and this field contains energy in it and the EMF is generated between the coils and it is transmitted to the receiver.

***Keywords*— Wireless power transfer, ARDUINO microcontroller, transmitter section, receiver section.**

I. INTRODUCTION

The proposed system implements ARDUINO microcontroller based wireless power charging or generation methodology for charging electric vehicles. This system consists of ARDUINO microcontroller, inductive coils, vehicle prototype module.

Solar panel system is implemented to transfer the power to the primary coil. Solar panel is connected to the battery directly. Then it can drive into the rectifier circuit through an inverter. The inverter circuit is connected with ARDUINO micro controller to switching the power supply. The switched power is fed into the inverter through driver circuit. The coil has high capacity of inductance which can able to transfer the power with high frequency. It is named as the high frequency coil. Those power input are connected to the high frequency primary coil which is laid under the road segment.

The vehicle has receiving coil segment. The receiver section consisting of the receiver coil, rectifier and regulator. When the vehicle move along the primary coil, receiver coil in the vehicle receives the power from the primary coil by the electromagnetic induction technique. That received power is driven to the regulator through rectifying circuit. Then the power is stored in the battery. The battery power is given to the controller and the motor driver circuit. Motor driver is used for control the motor of vehicle.

The vehicle can charge automatically when it cross over the primary coil connected to the battery. This method is used to reduce the pollution of air and demand in petroleum products.

II. BLOCK DIAGRAM

Transmitter Section

The block diagram of the transmitter section is as shown in the Fig 1.1

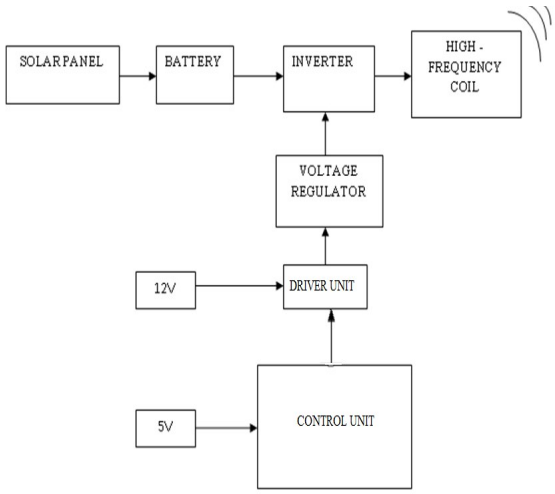

Fig 1.1 Block diagram of Transmitter section

Solar Panel

4×9 Photovoltaic based solar panel is used. Solar panel is used in input side in order to convert sun light into electricity.

Battery

Battery is a device used to store the DC voltage. The battery used is of lead acid battery of 12V.

Inverter

Inverter is the one which converts DC voltage into AC voltage. The MOSFET IRF540 is used as a switch.

Control Unit

Arduino UNO is used as a control unit. Arduino is used to generate pulse signals to the inverter through driver and voltage regulator.

Voltage Regulator

IC 7805 is used as a voltage regulator. Regulator is used to regulate the voltage level. When a steady voltage is needed

voltage regulator is generally used, which convert 12V to 5V DC.

Driver Unit

In the driver unit potentiometer is used. Driver circuit is used to drive the MOSFET effectively and efficiently and is mostly used in high speed switching condition.

High-Frequency Coil

Coil is an electrical conductor generally in the shape of spiral. Electromagnetic coils are used where electric current interacts with magnetic field in order to induce electromagnetic force (EMF).

Receiver Section

The block diagram of the receiver section is as shown in the Fig 1.2

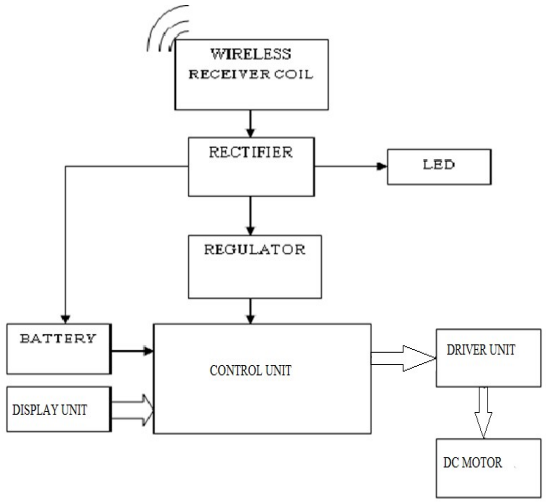

Fig 1.2 Block diagram of Receiver section

Rectifier

It is a device which converts AC into DC that flows in one direction. It is used for serving components of DC power supply. Full wave bridged rectifier configuration is used.

Driver Unit

L293D is a motor driver IC is used, which allows DC motor to drive in forward direction. L293D IC can control a set of two DC motors in any direction.

Regulator

Regulator is used to regulate the voltage level. The regulator used is 7805. When a steady or reliable voltage is needed voltage regulator is generally used, which convert 12V to 5V DC.

DC Motor

DC motor is an electrical machine that converts DC electrical energy into mechanical energy. The DC motor used is geared DC motor.

Display Unit

16×2 LCD is used in order to display whether the battery is charging or not.

III. SCHEMATIC DIAGRAM

Transmitter Section

Schematic diagram of transmitter section is as shown in the Fig 1.3

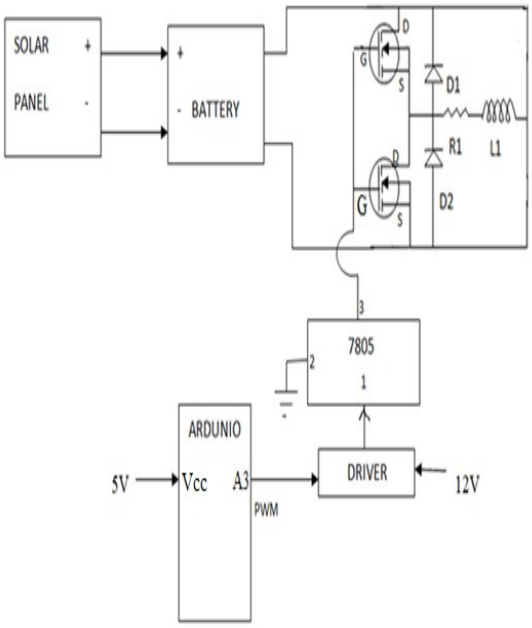

Fig 1.3 Schematic diagram of transmitter section

Receiver Section

Schematic diagram of receiver section is as shown in the Fig 1.4

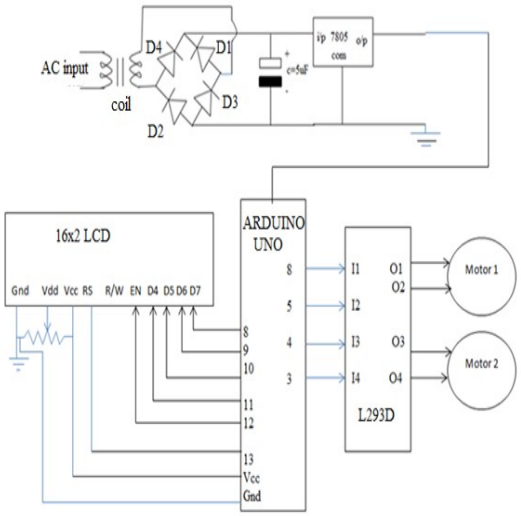

Fig 1.4 schematic diagram of receiver section

IV. SYSTEM SOFTWARE

The required software tools used in this system are as follows:

- Arduino IDE is used for programming Arduino UNO.
- Proteus is used for simulating the motor.

Flow Chart

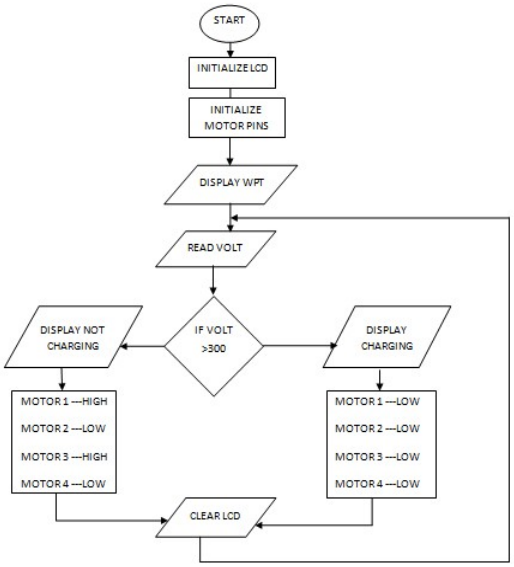

Fig Flow chart

IV. TEST, RESULTS AND CONCLUSION

Test and Results

Table 1 shows the condition of the electric vehicle.

Table 1 Test and Results of the designed system

Test	Condition	Result
When the vehicle is moving	Voltage at the receiving coil is 0V	Battery is not charging
When the vehicle is at rest	Voltage at the receiving coil is ≅ 12-14V	Battery is charging

Fig 1.5 indicates the hardware setup of transmitter section

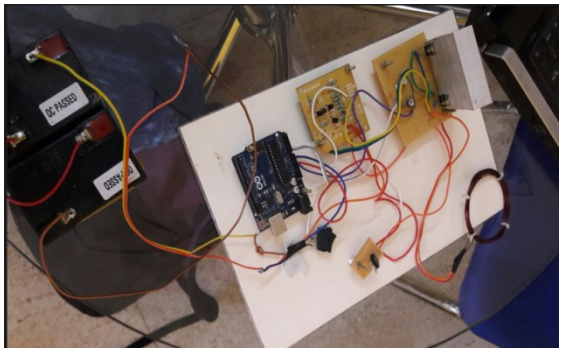

Fig 1.5 Hardware setup of transmitter section

Fig 1.6 indicates the hardware setup of receiver section

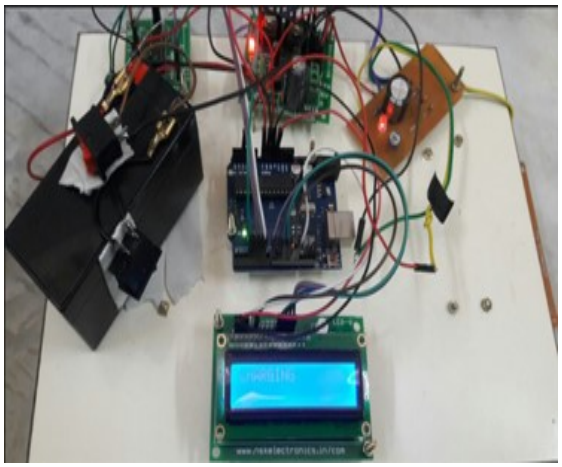

Fig 1.6 Hardware setup of receiver section

V. CONCLUSION

In this project, the system is developed to charge the battery of electric vehicle wirelessly. It mainly consists of the transmitter and receiver section. The transmitter section transfers the power to the receiver section through the coil. This transmitted power is used to charge the electric vehicle and drive the vehicle. A model was outlined, assembled and tried with solar panel to check the circuit execution of the created wireless charging framework.

REFERENCES

[1]. F. Musavi and W. Eberle, "Overview of Wireless Power Transfer Technologies for Electric Vehicle Battery Charging," in IET Power Electronics, vol. 7, no. 1, pp. 60-66, January 2014.
[2]. M. P. Kazmierkowski, R. M. Miskiewicz and A. J. Moradewicz, "Inductive coupled contactless energy transfer systems - a review," Selected Problems of Electrical Engineering and Electronics (WZEE), 2015, Kielce, 2015, pp. 1-6.
[3]. J. H. Kim et al., "Development of 1-MW Inductive Power Transfer System for a High-Speed Train," in IEEE Transactions on Industrial Electronics, vol. 62, no. 10, pp. 6242-6250, Oct. 2015
[4]. R. Haldi and K. Schenk, "A 3.5 kW Wireless Charger for Electric Vehicles with Ultra High Efficiency," Energy Conversion Congress and Exposition (ECCE), 2014 IEEE, Pittsburgh, PA, 2014, pp. 668-674.
[5]. C. Y. Liou, C. J. Kuo, and S. G. Mao, "Wireless-power-transfer system using near-field capacitively coupled resonators," IEEE Transactions on Circuits and Systems II: Express Briefs, Vol. 63, Issue: 9, Sept. 2016, pp. 898-902.
[6]. C. S. Wang, O. H. Stielau and Covic, G. A, "Design considerations for a contactless electric vehicle battery charger," IEEE Transactions on Industrial Electronics, vol.52, no.5, pp.1308-1314, Oct. 2005.
[7]. C. L. Yang, Y. L. Yang, and C. C. Lo, "Subnanosecond Pulse Generators for Impulsive Wireless Power Transmission and Reception," IEEE Transactions on Circuits and Systems II: Express Briefs, 2011, Vol. 58, Issue: 12, pp. 817-821.
[8]. C. S. Wang, G. A. Covic, and O. H. Stielau, "Power transfer capability and bifurcation phenomena of loosely coupled inductive power transfer systems," IEEE Transactions on Industrial Electronics, vol. 51, no. 1, pp. 148-157, Feb. 2004.
[9]. FariborzMusavi and Wilson Eberle, "Overview of wireless power transfer technologies for electric vehicle battery charging," IET Power Electronics, Volume 7, Issue 1, 2014 , p. 60 – 66.

[10]. Z. U. Zahid, Z. M. Dalala, C. Zheng, R. Chen, W. E. Faraci, J. S. Lai, G. Lisi, and D. Anderson, “Modeling and control of series-series compensated inductive power transfer (IPT) system,” IEEE Journal of Emerging and Selected Topics in Power Electronics, 2015, Vol. 3, Issue: 1, pp. 111-123.

[11]. A. J. Moradewicz and M. P. Kazmierkowski, "Contactless energy transfer System with FPGA-controlled resonant converter," IEEE Transactions on Industrial Electronics, Vol. 57, no. 9, Sep 2010.

[12]. U. K. Madawala and D. J. Thrimawithana, “New technique for inductive power transfer using a single controller,” IET Power Electronics, Volume 5, Issue 2, 2012, p. 248 – 256.

[13]. U. K. Madawala and D. J. Thrimawithana, “A two-way inductive power interface for single loads,” 2010 IEEE International Conference on Industrial Technology (ICIT), March 2010, pp. 673-678.

[14]. H. H. Wu, A. Gilchrist, K. Sealy, and D. Bronson, “A 90 percent efficient 5kW inductive charger for EVs,” in Energy Conversion Congress and Exposition (ECCE), Sept. 2012, pp. 275-282.

[15]. Y. Kawaguchi and M. Yamada, "Experimental evaluation of A 3-kW high-efficiency inductive contactless power transfer (IPCT) system for electric vehicles," 2014 16th European Conference on Power Electronics and Applications (EPE'14-ECCE Europe), 26-28 Aug. 2014.