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WIRELESS CHARGING STATION AND BATTERY MANAGEMENT UNIT OF ELECTRIC VEHICLE

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ABSTRACT

In this paper we designed a wireless power transmission charging circuit for electric vehicles to increase the battery life of the vehicle and also to sort out the issue of battery overheating due to plugged in charging. In plugged in charging heat losses are more and it directly affects the life of the battery so that Battery thermal management is the main issue for electric vehicles.. When we use wireless technology for the charging very less amount of heat is produced comparatively. Wireless chargers for Electric Vehicles (EVs) would also be a convenient feature, avoiding any need to remember to plug in a power cord after parking the vehicle. Additional safety advantages may also be achieved due to eliminating exposed contacts. application of wireless charging to an EV requires a comprehensive analysis to ensure consumer safety. This paper focuses on the safety considerations of wireless charging for EVs, including potential electrical shock hazards, magnetic field exposure hazards, fire hazards, etc. It provides a historical background of wireless charging, particularly for EVs. It also reviews two potential technologies applicable to wireless charging of EVs. Wireless power transmission with the help of inductive coupling is the main motive of our paper.

Keywords: Wireless Charging, Wireless Power Transfer, Inductive Power Transfer, Monitoring System, Electric Vehicles.

I. INTRODUCTION

Electric vehicles are the best alternative for transportation to minimize use of petroleum products & reduction in pollution levels caused due to resources used presently. Wireless Power Transmission (WPT) is thus an approach to noiseless, cost efficient and convenient charging. But for electric vehicles, traveling range and charging process are the two major issues affecting its adoption over conventional vehicles. Method of dynamic wireless charging allows to keep the vehicle charge while running. To overcome the issue of charging time, a research on wireless charging & battery management unit for electric vehicle is still going on. The most famous wireless technology is the Tesla tower made by Nikola Tesla where he attempted wireless electricity transmission.

II. LITERATURE SURVEY

The concept of wireless power transfer by IPT method is discovered from many years is now gaining more. Literature survey is prime component during this dissertation ; an exhaustive review on the subject area has been done as given below.

Akshya K. Swain [1] ,[27 February 2014] explain bidirectional IPT system in which wireless power transfer is possible easily between the two sides which are separated by air gap, through weak magnetic coupling. Without an accurate mathematical model system is difficult to design and control. A dynamic model has been developed by state variables.

Dukju Ahn and Songcheol Hong [2], says that for IPT system the concept of repeaters can be applied, in which enhance the power transfer distance between transmitter and receiver coil by placing intermediate repeaters. The position of the repeater between transmitter and receiver is carefully obtained.

Hui Zhi (Zak) Beh [3] [29 January 2014] proposed a DCS (double-coupled system) which is used for charging of a battery of electric vehicle. In between primary coil and secondary pickup intermediary coupler is placed where it operates as a switch. The system efficiency is increase by sharing all losses between the branches .

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Sheldon S.Williamson,Akshay K.Rathore,Fei Gao, Jin Ye and Lalit Patnaik[11], [25 January 2017] Studies report that the main obstacles in CPT are low power efficiency, misalignment tolerance, cost, range and charging time anxiety. This paper presents a review based on existing literature of the CPT systems for EV charging

Binod Vaidya, Hussein T. Mouftah,[6], [2018] Wireless charging system for Connected and Autonomous Electric vehicle.

Miss. Shital R. Khutwad ,Mrs. Shruti Gaur [3],[1016] "Wireless Charging system for electric vehicle" International conference on Signal Processing, Communication, Power and Embedded System.

Chunlong Li, Hui Huang, Luming Li[4], [2019], State Monitoring System Based on Wireless Charging.It proposes a feasible wireless chargingbased state monitoring system implementation scheme and application mode to provide a new power supply method for the state monitoring system, which has important practical significance for promoting the application of the state monitoring system based on wireless sensor network.

Chunhua Liu, Chaoqiang Jiang, Chun Qiu,[9], [2017]," Overview of Coil Designs for Wireless Charging of Electric Vehicle. As a key part of wireless charging system for EVs, the coil design is indispensable for improving the system performance.

Govind Yatnalkar and Husnu Narman ,[8],[2018]," Survey on Wireless Charging and Placement of Stations for Electric Vehicles". Duration of Charging of Electric Vehicles is a limitation and does not allow Electric Vehicles to be widely adopted by public.

III. SYSTEM DEVELOPMENT

Fig.1 represents the block diagram of proposed wireless power supply system for charging battery of electric vehicle. It consists of three parts a transmitter to generate AC signal which is to be transferred, transmitting and receiving coil to transfer power wirelessly and receiver to convert received AC signal into DC voltage for charging the battery of electric vehicle. The aim of implemented system is to design a prototype of wireless power supply system to recharge the battery of an electric vehicle and avoid wastage of power.

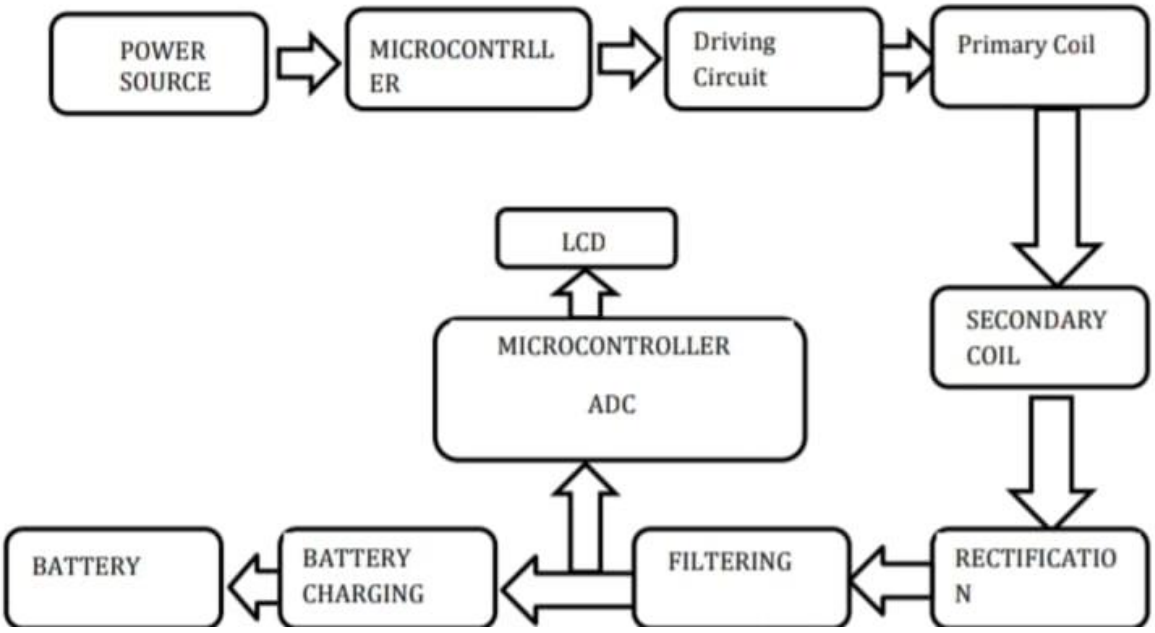

Fig: Block diagram of WPT system

A basic block diagram of wireless power transfer system consists of two sections. One is a transmitter section or primary coil and another is receiver or secondary coil section. AC source provides 230V, 50Hz AC signal. Micro-controller is used to control the AC current in transmitter coil through MOSFET switch. By Amperes law an alternating current (AC) passes through the transmitting coil which creates a magnetic field then it is passes through the receiving coil. By Faradays law of electromagnetic induction an alternating EMF (voltage) is induced in receiver coil which creates an AC current in secondary. This AC signal is converted into DC signal using rectifier. Voltage regulator gives regulated DC signal so that it can be used for electric vehicle. In

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proposed system 12V DC source is applied to AC converter. AC converter converts this DC signal into AC. AC current is applied to transmitting coil and it creates a magnetic field. Power is transferred through this magnetic field to the receiving coil. At receiving coil received AC signal is converted into DC using rectifier. Rectified voltage is stored in battery, Hence rechargeable battery is used in a proposed system. Now as per conventional system, once the supply is given, the whole equipment starts working and magnetic field is produced which induces voltage and the wireless transmission occurs. When vehicle is present IR sensor sense the active low signal and send this signal to MOSFET switch then turn ON the supply and transmitter transfer power to receiver circuit. When vehicle is absent, IR sensor send the active high signal to MOSFET switch then turn OFF power supply. The magnetic field radiation problem is prevent also energy wastage is overcome by using micro-controller for controlling purpose.

1. COIL DESIGN-

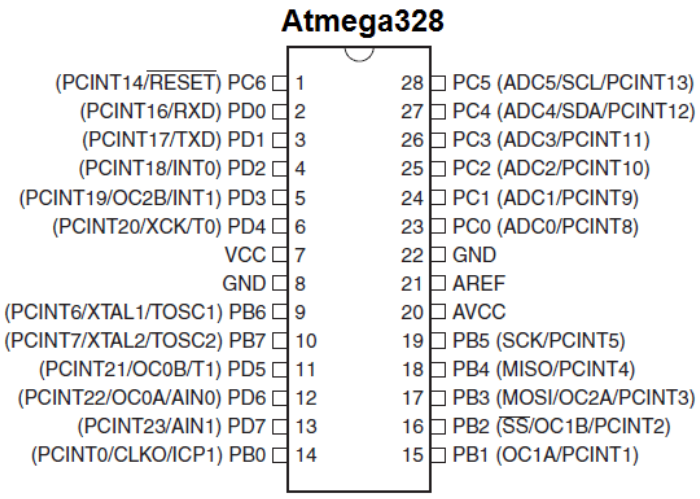
The transmitter coil and receiver coil is the key part of the whole system. The coils are tightly coupled if they have the same size and same configuration. In a proposed system tight coupling configuration with small distance power transfer system is used to achieve high efficiency for electric vehicle application. System consists of two coils tuned at the same frequency. Transmitter and receiver coils have been constructed using electrically conducting copper tube with a diameter of 16cm. Each coil has 48 numbers of turns and an inductance of 56uH. The air gap between these two coils is 6cm.

2. COMPONENTS

A) MICROCONTROLLER PIC16F877

PIC16F877 is 40 pin IC and 8 bit microcontroller which are one of the most advanced microcontrollers from Microchip. Because of its high quality, low price, and ease of availability it is mostly used in experimental and modern applications.

- PIC16F877 microcontroller provides the following features:-
- 14K bytes of flash memory
- 368 bytes of RAM
- 256 bytes of EEPROM data memory
- Two 8 bit and one 16 bit timer
- Five input output ports
- Two serial communication ports
- (MSSP, USART) x 8 channel 10 bit ADC x 2 CCP modules.
- In developed system PIC16F877 microcontroller is used because of following reasons.
- It has inbuilt ADC which is required to sense battery voltage and convert it in digital format.
- It requires low power supply



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B) RECTIFIER

Rectifier is used to converts AC signal into DC signal for charging battery but the DC output is varying. In many power supply circuits, the bridge rectifier is used. In proposed system single phase full wave bridge rectifier is used to convert received AC voltage into DC. A full wave bridge rectifier is used because it has a high efficiency of 81.2%.

C) LCD

In proposed system 16x2 LCD is used to display current activity of project. 16x2 LCD means there are two lines in LCD and each line display 16 characters. LCD provides the following features because of that it is used in developed system:It is display numbers, characters and graphics. The LCD consist of refreshing controller to reduce the overhead of the CPU Programming of such LCD is easy .

D) VOLTAGE REGULATOR 7805

It eliminates ripple and provides a stable voltage. By using 7805 voltage regulator high DC voltage is stepped down into 5V DC voltage. In general, an IC7805 regulator can withstand voltage ranging from 7.2V to 35V and gives maximum efficiency of 7.2V voltage. There is an energy loss in the form of heat if the voltage exceeds above 7.2V. In this system voltage regulator 7805 is used to give 5V DC voltage to regulate the supply .

System design

Compared with the existing system, the state monitoring system based on wireless charging will increase the energy flow on the basis of the original business data flow and management data flow, increase the energy node on the basis of the existing system, increase the energy control function in the system control, and improve the existing monitoring node to have the function of energy wireless receiving. The system consists of monitoring nodes, energy nodes and monitoring platform, as shown in Figure 4. Monitoring nodes acquire power through multiple energy access; energy nodes act as the energy supply source in the system, providing wireless energy supply for nodes in the network; monitoring platform manages nodes and energy sources in the network, predicts the trend of network energy change by acquiring energy information of nodes in the network, and then dispatches energy sources to supply energy to nodes.

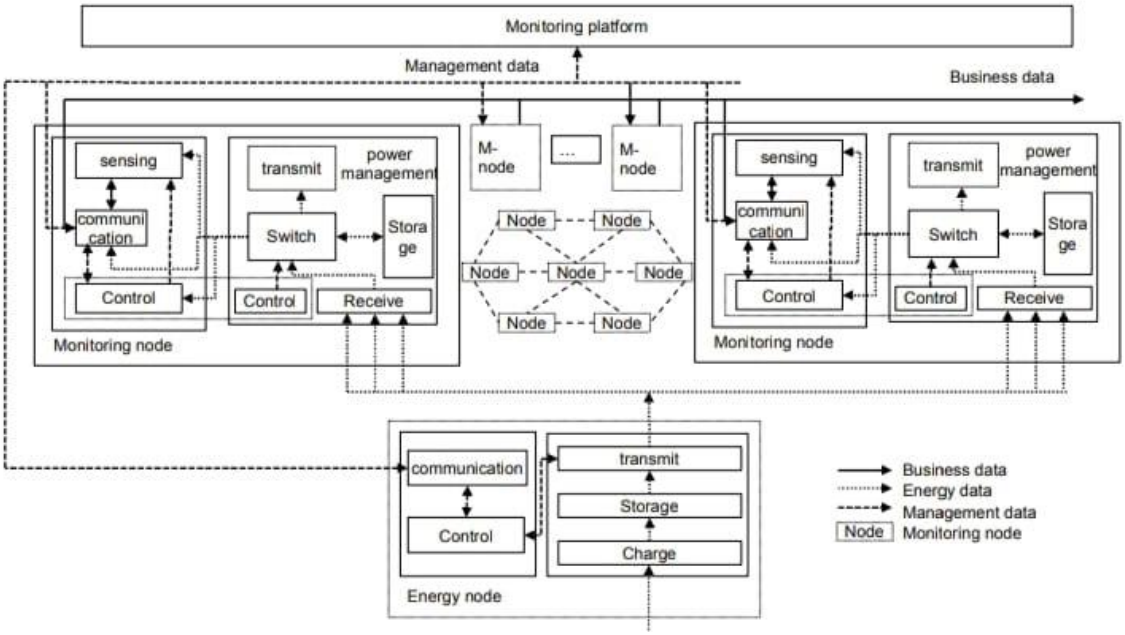

Fig: State monitoring system based on wireless charging.

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Design on monitoring node

The function modules of the monitoring node can be divided into communication module, sensing module, control module and power management module.

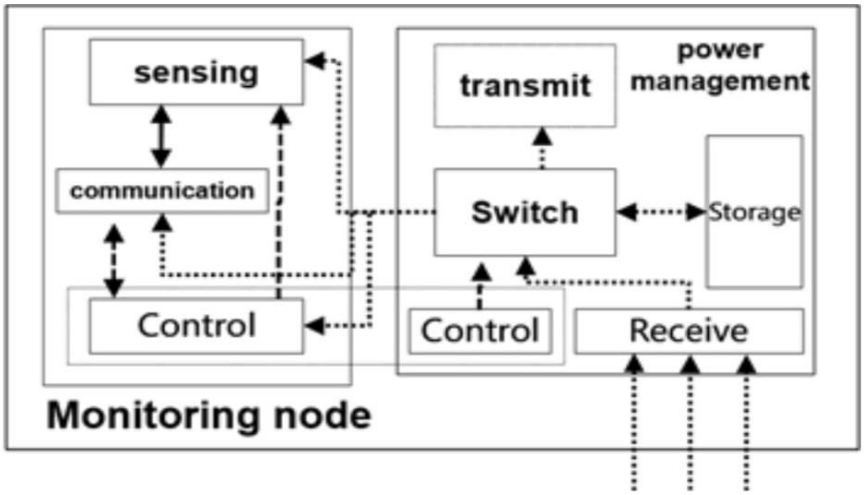

Fig: monitoring mode

The sensing module and communication module on the left side of above figure are responsible for sampling/collecting sensitive information of the controlled object, and transmitting the information by wireless transceiver. Its function and realization principle are completely consistent with the traditional wireless sensor. The control module is the core component of the monitoring node. Its functions include: collecting sensing data of the sensor module and controlling the sensing module;controlling the communication module, and using the communication module to interact with business data; building-in energy scheduling strategy to control the power management module according to the real-time state of energy supply, energy storage and energy consumption.

The power management module can be subdivided into energy receiving unit, energy switching unit, energy storage unit and energy transmitting unit. The energy receiving unit is responsible for adapting the access of multiple energy sources. It can collect the energy adaptively according to the type and level of the access energy, and then output the electric energy with stable voltage. Energy switching unit is responsible for dispatching electric energy, according to the realtime state of energy supply, energy storage and energy consumption, dispatching the use and storage of energy. Energy storage unit is responsible for storing energy, supporting fast storage of strong power and long-term storage of energy. The energy transmitting unit can transmit the energy in a wireless way according to the application requirements.

The monitoring node adopts modular design and has strong reconfigurability. It can access traditional sensors through standard interface to realize the transformation and upgrading of sensors. The integrated schematic diagram is shown in Fig.

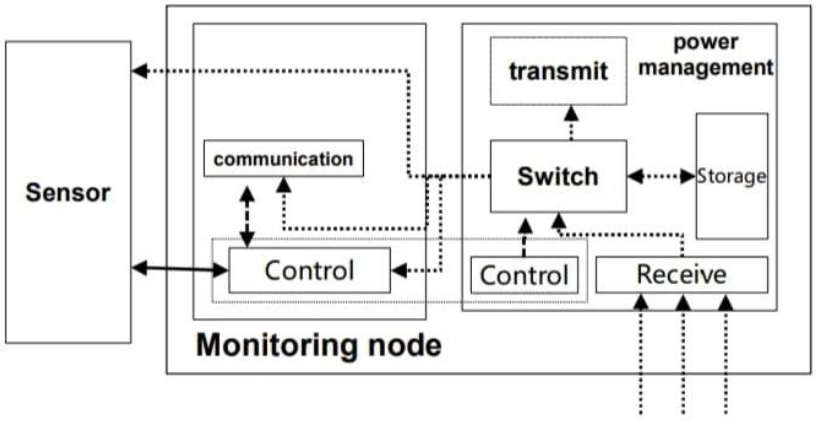

Fig: upgrading scheme based on existing sensors

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IV. RESULTS AND DISCUSSION

Calculation:

First of all, we calculate charging current for 1Ah Battery as we know that charging current should be 10% of the Ah rating of battery.

charging current for 120 Ah battery= 1Ah *(10/100)=0.1Amp

Charging time for 120Ah Battery =1/13=10 hour

PARAMETERS	VOLTAGE
Transmitting coil voltage	10V
Receiving coil voltage	6.72V
Distance between coil	6 cm

V. CONCLUSION

The IPT concept is implemented for wireless charging system which is used to recharge an electric vehicle battery. The driving circuit is used between the transmitter coil & receiver coil where MOSFET and micro-controller is operates as a switch. Power transferred is allowed by turn ON the transmitter circuit when the vehicle is present, and turn OFF power transfer when the vehicle is absent to overcome the energy waste and to avoid the magnetic field radiation problem. The proposed driving circuit utilizes an ac switch which control the system power transferred. The implementation of an inductive power transfer system is verifies by using battery charger application of electric vehicle. A prototype practical system is developed with efficiency level of 67 % and results are verified. The system provides reliability, long life and safety.

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