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Electrified Road for Charging Electric Vehicle Wirelessly

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Abstract: *Electric vehicles (EVs) are a promising solution for reducing emissions and improving air quality in transportation. However, one of the major challenges with EVs is the limited range of battery-powered vehicles. Wireless power transfer (WPT) is a promising technology for extending the range of EVs by allowing them to be charged while driving or parked. This project will investigate the feasibility of using WPT to charge EVs in dynamic and stationary applications. The project will focus on the following specific objectives: • To identify and evaluate the different WPT technologies that are suitable for EV charging. • To design and develop a WPT system for EV charging, taking into account the technical and economic constraints. • To conduct simulations and experiments to validate the performance of the proposed WPT system. The project is expected to make significant contributions to the field of WPT for EV charging. The project outcomes are expected to help in the development and commercialization of WPT systems for EVs, which will play a key role in the transition to sustainable transportation.*

Keywords: Electric Vehicle, Wireless Charging, Solar Supply, DC Motor, Electrified Road

I. INTRODUCTION

Nowadays, the depletion of fossil fuels and the phenomena of global warming are key factors that push us to change our modes of transportation. Vehicle-based internal combustion engines are no longer desired, they contribute significantly to climate changes, and they are dependent to the petroleum product. The electric vehicle (EV) is an alternative choice, it can be considered as a suitable method for a sustainable transportation, it has the advantage of zero emissions and it is powered by electricity which can be considered as a renewable energy. However, the basic configuration of an EV contains a rechargeable battery pack which can be considered as its main drawback. The battery needs to be recharged frequently because of its low capacity; thus, the charging operation takes several hours, which reduce the driving range of the EV and limit its success in the market. Several methods are used to recharge EV batteries. In the conductive charging, the power is transferred efficiently to the vehicle by cables, but the user must intervene in this operation which is dangerous in certain specific conditions such as snow and rain that can cause electric shocks [1]. Powering an electric vehicle using the wireless method is much easier and safer for the user, thus, the absence of physical contact (no mechanical friction) can prolong the product life and reduce its maintenance. The wireless power transfer (WPT) can be in a stationary or dynamic way. In stationary mode, the vehicle is wirelessly charged while parked in a location (parking or garage) equipped with a specialized power utility. The dynamic charging which means that the vehicle can be recharged while moving is invented as an attempt to reduce the size of the battery (i.e., reduce long charging times and vehicle weight) and extend the vehicle driving range. In general, the electric field (EF) and the magnetic field (MF) are used in the wireless power transfer. In the inductively coupled power transfer (ICPT) method, the power is transferred wirelessly between separated coils via MF, while the capacitive power transfer (CPT) relies on the EF to transfer power between two pairs of metal plates. Recently, several automobile manufacturers are adopting the WPT charging method, especially the ICPT; one can quote Toyota, Nissan, Chevrolet, Audi, and BMW. The CPT has been widely used in applications where low powers (few watts) and short distances (few mm) are required but despite these limitations several recent researches are devoted to make it a suitable method for EV applications.

NEED OF PROJECT

- Reduce emissions and improve air quality in transportation. Electric vehicles (EVs) produce zero tailpipe emissions, which can help to reduce air pollution and improve public health [1].
- Extend the range of EVs. One of the major challenges with EVs is the limited range of batterypowered vehicles. Wireless power transfer (WPT) could allow EVs to be charged while driving or parked, which would extend their range and make them more practical for long-distance travel [2].
- Improve the convenience and usability of EVs. WPT would eliminate the need for drivers to plug in their EVs, which would improve the convenience and usability of these vehicles.
- Reduce the cost of EVs. WPT systems could potentially reduce the cost of EVs by eliminating the need for large and expensive batteries [3].
- Create new jobs and industries. The development and deployment of WPT systems for EVs could create new jobs and industries in the transportation sector [4].

Overall, WPT is a promising technology for addressing some of the key challenges with EVs. By developing and commercializing WPT systems for EVs, we can make electric transportation more sustainable, convenient, and affordable [5].

AIM OF PROJECT

The aim of this project is to develop an advanced and sustainable electric vehicle (EV) charging system that seamlessly integrates solar energy, a reliable power station supply, and wireless charging through electromagnetic induction coils. The primary goal is to provide uninterrupted and eco-friendly charging for EVs, enabling them to charge while in motion and eliminating the need for conventional charging stops. This innovative solution aims to significantly reduce the environmental impact of EVs, enhance their usability, and pave the way for a more sustainable and efficient future of transportation.

II. LITERATURE SURVEY

AnkitaJha, AyushBajpai, Vol. 8, Issue 6, June 2020, Electrified Road for Charging Electric Vehicle Wirelessly, International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering, 2321-5526. The recent development in simulation speed and capacity of magnetic field, and the power electronics, the field of wireless power transfer has been developed significantly. In the future transport area, electric vehicles are considered as replacement of oil-powered internal combustion engine driven vehicles, especially for the CO2 reduction and alternative energy perspective.

Abinand D, Deepak M, Maaz Ahmed, Phanindar Ravi Parimi, Volume: 07 Issue: 06 June 2020, Wireless Charging Of Electric Vehicle: A Review, International Research Journal of Engineering and Technology (IRJET), 2395-0072. Electric vehicles are today's zero emission vehicular technology which is considered as the future of automotive industry. The batteries of the vehicles get charged in order to drive the vehicle. The methodology of charging the electric vehicle currently is through plug-in method where the charging station charges the battery of an electric vehicle.

Gowresudarshan Ashok, Vikas, Sindhu Reddy, Abinezer, T. Vinay Kumar, Volume 6 Issue 11 MAY 2023, Wireless Electric Vehicle Charging System , IRE Journals, 2456-8880. Electric vehicles require fast, economical and reliable charging systems for efficient performance. Wireless charging systems remove the inconvenience to plug in the device to be charged when compared with the conventional wired charging systems. Moreover, wireless charging is considered to be environment and user friendly as the wires and mechanical connectors and related infrastructure are not required. This paper presents basic structure, operating principles and distinct features for wireless charging of EVs. First, the general techniques for wireless power transfer are described and explained.

J. Ravi Kumar, K. Sankeerthana, Ch. Sravani, A. SaiCharan, B. MeherVikas, M. Ravi Shankar, Vol 4, no 3, pp 3085-3090, . March 2023, Dynamic Charging of Electric Vehicle Through Electrified Roads, International Journal of Research Publication and Reviews, 2582-7421. Due to the significant fuel emissions and relative benefits of electric vehicles, the majority of automotive industries are currently producing electric vehicles. The EV runs on a battery and the battery has to be charged regularly. There are many different types of charging methods, static wireless charging is becoming more common for recharging electric vehicles.

VinayChauhan, VishveshPandey, Pranay Bhatt, Sooraj Patel, SwatikaSrivastava, Volume 8, April 2023, A Review Of Static Wireless Electric Vehicle Charging System, IJRTI, 2456-3315. The principal element of wireless charging is to transmit power by an electromagnetic field across specified space. As electric vehicles are a superior choice to control continuous contamination, it is essential to make revisions in the battery charging cycle to achieve a more prominent and unwavering quality. Electric vehicle battery charging should be possible by plugging in at charging stations or by wireless power transfer. Wireless power transfer can be carried out as a static or dynamic charging system. A dynamic charging system can be carried out to charge the vehicle in any event, when it is moving.

Dr. S. Narendiran, Dr. P. Manju, Dr. K. Muralibabu, Ajith. B. Singh, 10 April 2023, Creating a Dynamic Wireless Power Transfer System to provide the car with electricity, ISSN, 2063-5346. The transport industry is transitioning to electrified vehicles because they are more dependable, safe, smart, and environmentally friendly. The next generation of transportation for development of a social and high mobility is electric cars (EVs). The drawbacks of the current conductive or plugin chargers force research on wireless power transfer (WPT) technology for EV charging, which would result in the utmost convenience of owning an EV. A practical charging method that is " independent," "no contact," and "park and charge" is WPT technology. Despite its benefits, this technology hasn't been widely used in the transportation industry. The technology is still relatively costly and inefficient compared to alternative options, which may account for the delay.

Theodora Konstantinou, Diala Haddad, Akhil Prasad, Ethan Wright, FHWA/IN/JTRP-2021/25 , June 2021 , Feasibility Study And Design Of In-Road Electric Vehicle Charging Technologies, Joint Transportation Research Program Indiana Department Of Transportation And Purdue University, 4314. Electric Roadways (ERs) or Dynamic Wireless Charging (DWC) lanes offer an alternative dynamic and wireless charging method that has the potential of giving electric vehicles (EV) limitless range while they are moving. Heavy-duty vehicles (HDVs) are expected to be early adopters of the DWC technology due to the higher benefits offered to these vehicles that are traveling on fixed routes. The goal of this project was to assess the feasibility of ERs in Indiana and design a test bed for inroad EV charging technologies. The most suitable locations for implementing DWC lanes were identified on interstates that are characterized by high truck traffic.

V. Arun, AditiTiwari, Ritesh Kumar Singh, Volume 5, Issue 10 October 2018, Wireless Charging Of Electrical Vehicles, JETIR, ISSN-2349-5162. The profitable development and quick adoption of electrified transportation need quick, economical, and reliable charging infrastructure. This paper provides a comprehensive, progressive review of all the wireless charging technologies for an electrical vehicle (EVs), characteristics and standards on the market within the open literature, besides as property implications and potential safety measures. A comparative summary of semiconductive charging and wireless charging is followed by an in-depth description of static wireless charging, dynamic wireless charging (DWC).

Aqueel Ahmad, Mohammad SaadAlam, RakanChabaan, December 2017, A Comprehensive Review of Wireless Charging Technologies for Electric Vehicles, IEEE Transactions on Transportation Electrification, 2771619.

Siqi Li, Chunting Chris Mi, VOL. 3, 1 March 2015, Wireless Power Transfer for Electric Vehicle Applications, IEEE Journal Of Emerging And Selected Topics In Power Electronics, 2569. Wireless power transfer (WPT) using magnetic resonance is the technology which could set human free from the annoying wires. In fact, the WPT adopts the same basic theory which has already been developed for at least 30 years with the term inductive power transfer. WPT technology is developing rapidly in recent years.

III. METHODOLOGY

The main component of this system is the various ways of stepping down the incoming voltage. A conventional 220Vrms/50 Hz means is stepped down using the transformer to our required voltage and then converted to DC voltage. By using an inverter, the DC is converted to AC of our desired high frequency. The power is then transmitted through the transmitter coil to the receiver coil through inductive coupling. The receiver coil is placed at a particular distance and AC power is delivered at the end. This power is then rectified and regulated using a bridge rectifier and Zener diode circuit. Afterwards, the energy is harnessed to charge the battery. The transmitter and the receiver coils were designed to achieve maximum quality factor to maximize power transfer at the frequency of operation. AC main from the grid is converted into high frequency AC through AC/DC and DC/AC converters to enable power transfer from transmission coil to the receiving coil. Series and parallel combinations-based compensation topology are used in both receiving and transmitting sides to improve the overall system efficiency [9]. Receiving coils are fixed under the vehicle to convert the oscillating magnetic field to high frequency AC. The high frequency AC is converted into a stable DC supply which can be used by the onboard batteries. To avoid any kind of health and safety issues and stable operation the power control, communications, and battery management system (BMS) are used. To reduce any harmful leakage fluxes and to improve magnetic flux distribution, magnetic planar ferrite plates are used at both transmitter and receiver sides.

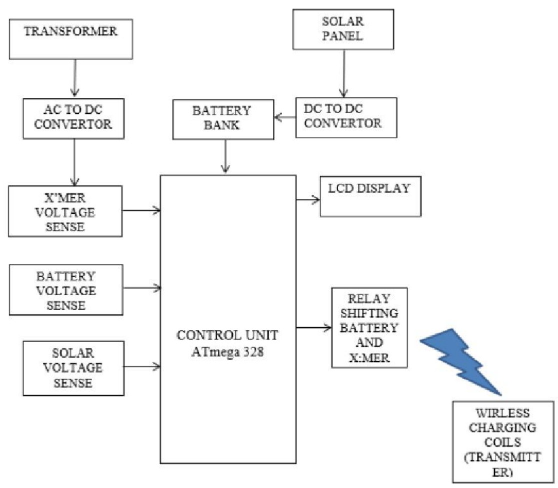
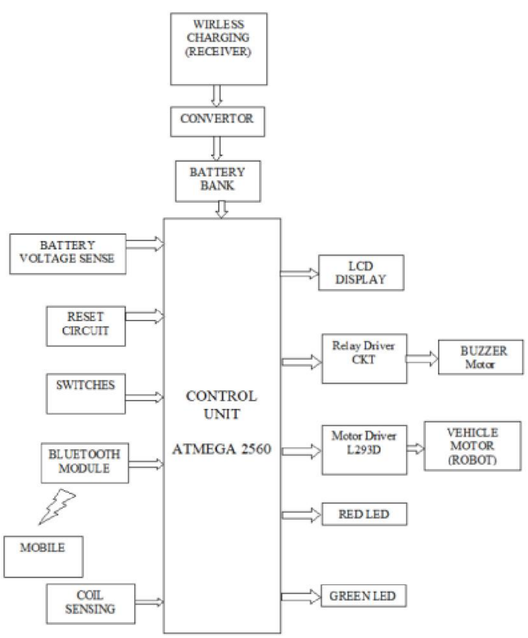


Fig. 1. Block Diagram Road Section (Transmitter Section)



.Fig. 1. Block Diagram Vehicle Unit (Receiver Section)

AtMega 2560 Microcontroller

The Atmega 2560 microcontroller is a popular choice for many embedded systems projects. It is a highperformance, low-power microcontroller that is based on the 8-bit AVR RISC architecture. The Atmega 2560 has 256 KB of flash memory, 8 KB of SRAM, and 4 KB of EEPROM. It also has 86 GPIO pins, 32 general-purpose working registers, a

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real-time counter, six timer/counters with compare modes, PWM, four USARTs, a byte-oriented Two-Wire serial interface, a 16-channel 10-bit A/D converter, and a JTAG interface for on-chip debugging. The Atmega 2560 is also popular among hobbyists and makers, due to its low cost, ease of use, and wide range of available libraries and resources.

256 KB of flash memory • 8 KB of SRAM • 4 KB of EEPROM • 86 GPIO pins • 32 general-purpose working registers • Real-time counter • Six timer/counters with compare modes • PWM • Four USART

Fig. 2.AtMega 2560

LCD Display

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD

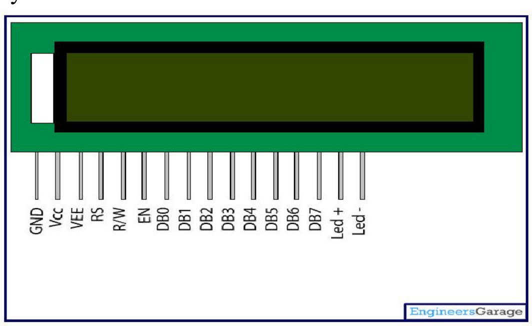

Fig. 3. LCD Display

Lead Acid Battery

These Lead acid batteries are the most common large-capacity rechargeable batteries. They are very popular because they are dependable and inexpensive on a cost-per-watt base. There are few other batteries that deliver bulk power as cheaply as lead acid, and this makes the battery cost-effective for automobiles, electrical vehicles, forklifts, marine and uninterruptible power supplies (UPS). Lead acid batteries are built with a number of individual cells containing layers of lead alloy plates immersed in an electrolyte solution, typically made of 35% sulphuric acid (H_2SO_4) and 65% water (Figure 1). Pure lead (Pb) is too soft and would not support itself, so small quantities of other metals are added to get the mechanical strength and improve electrical properties. The most common additives are antimony (Sb), calcium

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(Ca), tin (Sn) and selenium (Se). When the sulphuric acid comes into contact with the lead plate, a chemical reaction is occurring and energy is produced

Fig. 4.Lead Acid Battery

DC Gear Motor

RelayA DC motor is an electric motor that uses direct current (DC) to produce mechanical energy. DC motors are used in a wide variety of applications, from small appliances to large industrial machinery. DC motors work by using the magnetic force between a permanent magnet and a rotating electromagnet. The electromagnet is called the armature, and the permanent magnet is called the field magnet. When an electric current is applied to the armature, it creates a magnetic field that interacts with the magnetic field of the field magnet. This causes the armature to rotate. The speed of a DC motor can be controlled by varying the voltage applied to the armature. The higher the voltage, the faster the motor will rotate. DC motors can also be reversed by reversing the direction of current flow to the armature[22]. SPECIFICATIONS: • Voltage: 3-24 V • Current: 0.1-10 A • Speed: 100-10,000 RPM • Torque: 0.1-10 Nm

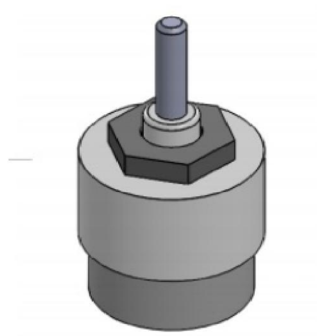

Fig. 5.DC Gear Motor

HC05 Bluetooth Module

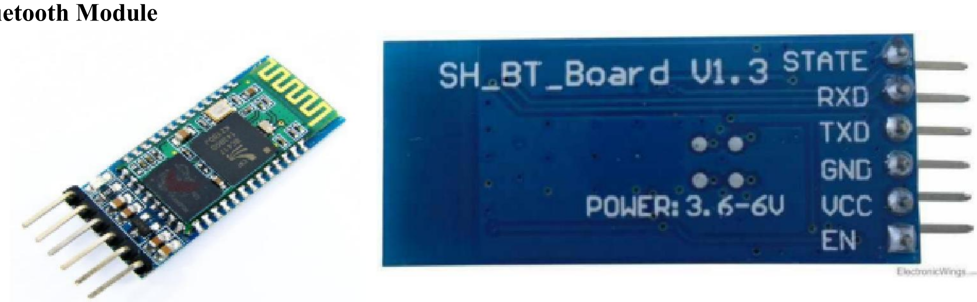

Fig. 6.HC05 Bluetooth Module

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It is u It is used for many applications like wireless headset, game controllers, wireless mouse, wireless keyboard and many more consumer applications.

PIN DESCRIPTION:

• Key/EN: It is used to bring Bluetooth module in AT commands mode. If Key/EN pin is set to high, then this module will work in command mode. Otherwise by default it is in data mode. VCC: Connect 5 V or 3.3 V to this Pin. • GND : Ground Pin of module. • TXD: Transmit Serial data (wirelessly received data by Bluetooth module transmitted out serially on TXD pin) • RXD: Receive data serially (received data will be transmitted wirelessly by Bluetooth module). • State: It tells whether module is connected or not

IV. CONCLUSION

The development of a solar-powered wireless charging system for electric vehicles represents a significant step forward in the transition towards sustainable transportation. By combining renewable energy sources with innovative charging technology, this project has the potential to address several key challenges associated with EV adoption, including range anxiety, limited charging infrastructure, and reliance on fossil fuels. The proposed system offers several compelling advantages, including its ability to provide uninterrupted and eco-friendly charging for EVs, enhance the convenience and usability of EVs, and reduce the overall cost of EV ownership. Additionally, the integration of solar energy into the system further promotes sustainability by reducing reliance on grid electricity and minimizing carbon emissions. While there are some potential challenges to overcome, such as the initial investment cost, lower charging efficiency, and limited range, the potential benefits of this project far outweigh the disadvantages. The ability to charge EVs while they are in motion or parked could revolutionize transportation infrastructure and accelerate the adoption of EVs as a mainstream mode of transportation. By promoting sustainable transportation practices and reducing environmental impact, this project aligns with the global effort to combat climate change and transition towards a more sustainable future. The successful implementation of this technology could have a profound impact on the transportation sector and contribute to a cleaner, more sustainable world.

ACKNOWLEDGMENT

It gives us great pleasure in presenting the paper on “Electrified Road for Charging Electric Vehicle Wirelessly”. We would like to take this opportunity to thank our guide, Prof. Shital Kale, Professor, Department of Electronics and Telecommunication Engineering Department, Amrutnahini Collage of Engg., Sangamner, for giving us all the help and guidance we needed. We are grateful to him for his kind support, and valuable suggestions were very helpful.

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