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Wireless Power Transfer on Road for Electric Vehicles Using Inductive Charging

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ABSTRACT: This project describes the design of solar powered charging station for charging of electric vehicle describes design of solar powered charging station for charging of electric vehicle that solves the key downside of fuel and pollution. Electric vehicles have now hit the road worldwide and are slowly growing in numbers. Apart from environmental benefits electric vehicles have also proven helpful in reducing cost of travel by replacing fuel by electricity which is way cheaper. Well here we develop an EV charging system that solves with a unique innovative solution. This EV charging of vehicles without any wires, No need of stop for charging, vehicle charges while moving, Solar power for keeping the charging system going, No external power supply needed. The system makes use of a solar panel, battery, transformer, regulator circuitry, copper coils, AC to DC converter, atmega controller and LCD display to develop the system. The system demonstrates how electric vehicles can be charged while moving on the road, eliminating the need to stop for charging. Thus the system demonstrates a solar powered wireless charging system for electric vehicles that can be integrated in the road.

KEYWORDS: Wireless Power Transfer, Electric Vehicles, Inductive Charging, Dynamic Road Charging, Resonant Coupling, Embedded Systems, Power Electronics, Energy Transfer Efficiency, EV Charging Infrastructure, Renewable Transportation, Magnetic Field Transmission, Smart Transportation System.

I. INTRODUCTION

The wireless solution is increasingly spreading as a method of battery charging for Electric Vehicles (EVs). The standard technology of wireless EV battery charging is based on the Inductive Power Transfer (IPT) between two coupled coils, one connected to the electrical grid and the other one connected to the rechargeable battery. The IPT provides benefits in terms of safety and comfort, due to the absence of a plug-in operation: through IPT, the electrocution risk typically arising from power cords is avoided and the battery charging operation can automatically start. According to the state of the EV, there are mainly two types of IPT for the wireless charging: static IPT, when the vehicle is stationary and nobody is inside it (e.g. in a parking area); dynamic or quasi-dynamic IPT, when the vehicle is being used (e.g. while in motion or during the traffic red light). The wireless power transfer obviously represents the only solution for the dynamic charging, since the wired connection would be impossible during the motion. Indeed, due to the magnetic coupling between the coils, there is an unavoidable minimum leakage magnetic field, leading to an energy loss.

Furthermore, some technical aspects need to be taken into account in the practical implementation of an IPT system: for example, in order to obtain the maximum coupling, the misalignment between the coils must be as small as possible. As far as safety is concerned, some care is required regarding the magnetic field exposure. In addition to design-related issues, other important considerations should be made, such as costs, infrastructural implications, standardization and customer reception. The proposed project focuses on designing and analyzing a wireless power transfer system for electric vehicles using electromagnetic induction principles. The project aims to study the operation of transmitter and receiver circuits, power electronic components, and sensor systems used in wireless charging applications. The system is designed to improve charging convenience and reduce dependency on conventional charging infrastructure.

II. LITERATURE SURVEY

2.1 Dynamic Wireless Charging System for Electric Vehicles Author: S. Li and C. Mi

Year: 2015 This paper focuses on the development of dynamic wireless charging systems for electric vehicles using resonant inductive power transfer technology. The authors explain the importance of reducing dependency on plug-in charging systems and improving charging convenience for users. The system transfers power wirelessly through magnetic coupling between transmitter and receiver coils. The transmitter coils are embedded under the road surface while the receiver coils are mounted beneath the vehicle. The study mainly concentrates on increasing efficiency and maintaining stable power transfer during vehicle movement. The authors discuss the design of high-frequency inverter circuits and compensation networks required for efficient operation. Different coil structures are analyzed to improve magnetic coupling and reduce energy losses. The paper also explains the importance of alignment between transmitter and receiver coils. Experimental analysis demonstrates that proper alignment significantly improves system performance and charging efficiency. The research highlights the role of resonant frequency in achieving stable wireless power transfer. Another important aspect discussed in the paper is the reduction of battery size in electric vehicles. Since the vehicle can receive power continuously while moving, large battery storage becomes less necessary.

2.2 Wireless Power Transfer for Electric Vehicle Applications Author: J. M. Miller

Year: 2014 This paper presents an overview of wireless power transfer technologies used in electric vehicle applications. The author explains the working principle of inductive power transfer and its importance in modern transportation systems. The study emphasizes the need for efficient charging methods to support the increasing demand for electric vehicles. Wireless charging eliminates the use of physical connectors and improves user convenience. The paper explains different methods of wireless power transfer including inductive coupling and resonant inductive coupling. Among these methods, resonant inductive coupling is identified as the most suitable for electric vehicles due to its higher efficiency and longer transfer distance. The author discusses the design of transmitter and receiver coils used in the charging process. Proper coil geometry and operating frequency are highlighted as critical parameters. The study also analyzes power electronic circuits such as inverters and rectifiers used in the system. High-frequency AC generated by the inverter is transferred through magnetic fields to the receiver side.

2.3 Analysis of Resonant Inductive Power Transfer for EV Charging Author: A. Kurs and R. Moffatt

Year: 2013 This research paper focuses on resonant inductive power transfer technology for charging electric vehicles. The authors explain how resonant circuits can improve power transfer efficiency between transmitter and receiver coils. The study demonstrates that resonance enables efficient energy transfer over moderate distances without physical contact. This principle is highly suitable for electric vehicle charging systems. The paper provides detailed analysis of resonant circuits and compensation techniques. Series and parallel compensation methods are compared to identify the most efficient configuration. The authors explain that proper tuning of resonant frequency is necessary for stable operation. Experimental results show significant improvement in efficiency when resonance conditions are maintained. Another major contribution of the paper is the discussion on magnetic coupling and alignment. The authors analyze the effect of coil distance and misalignment on power transfer efficiency.

III. EXISTING AND PROPOSED SYSTEM

The existing method of charging electric vehicles mainly depends on wired charging systems. In this approach, the vehicle must be physically connected to a charging station using cables. The charging process occurs only when the vehicle is stationary. This method is widely used in current electric vehicle infrastructure. It provides a basic solution for energy transfer but lacks flexibility. The dependence on physical connection limits the overall efficiency of the system. Charging stations are installed at fixed locations, which creates accessibility issues for users. Drivers must locate nearby charging stations before planning their trips. This becomes a challenge in areas where infrastructure is not well developed. The limited availability of stations reduces the convenience of using electric vehicles. It also increases dependency on specific locations. This makes long-distance travel less practical.

The time required for charging is comparatively high. Even fast charging systems require a considerable duration to fully charge the battery. This results in delays during travel and reduces overall productivity. Users are forced to wait for extended periods. This becomes a major drawback in daily usage. It affects both personal and commercial transportation. Another issue with the existing system is the wear and tear of cables and connectors. Frequent plugging and unplugging leads to mechanical damage over time. Environmental conditions can also affect the durability of

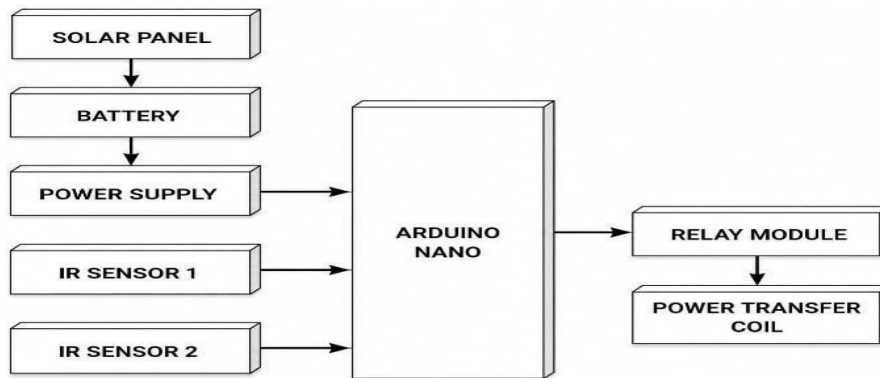
components. This increases maintenance and replacement costs. It also reduces system reliability. Safety risks may arise due to damaged equipment. This reduces efficiency and convenience. It is not suitable for future smart transportation systems.

Overall, the existing system does not support continuous charging during movement. Vehicles must stop for charging, interrupting the flow of travel. This reduces efficiency and convenience. It is not suitable for future smart transportation systems. The limitations highlight the need for advanced technologies. Hence, an improved system is required. The charging process occurs only when the vehicle is stationary.

IV. BLOCK DIAGRAM AND WORKING

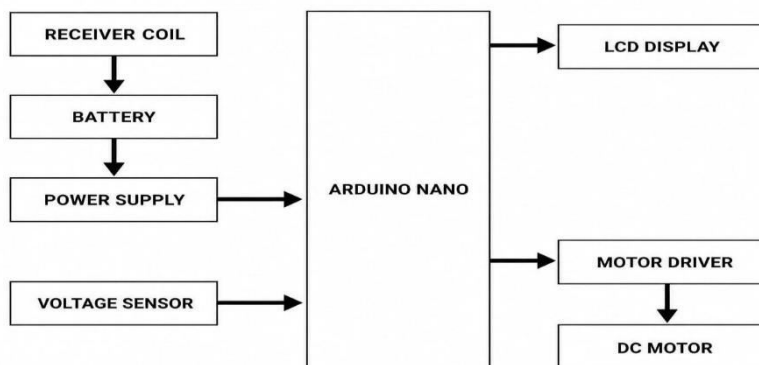
A. DESCRIPTION BLOCK DIAGRAM

The block diagram represents the overall structure and working of the wireless power transfer system for electric vehicles. It includes major components such as power supply, inverter, transmitter coil, receiver coil, rectifier, and battery. Each block performs a specific function in transferring energy from the source to vehicle. On the receiving side, the receiver coil captures the magnetic energy generated by the transmitter. The received energy is then passed through a rectifier circuit to convert AC into DC.



B. RECEIVER BLOCK DIAGRAM

The receiver block diagram focuses on the components present in the vehicle side of the system. It mainly consists of a receiver coil, rectifier, filter circuit, and battery. The purpose of the receiver unit is to capture the energy transmitted from the road. The receiver system converts this energy into usable electrical power. It plays a crucial role in wireless charging. The receiver coil is mounted underneath the electric vehicle. It is designed to align with the transmitter coil embedded in the road. When the vehicle passes over the transmitter, the receiver coil captures the magnetic flux. This induces an alternating current in the coil. The amount of energy received depends on alignment and distance. Proper positioning improves efficiency. The induced AC power is then sent to a rectifier circuit. The rectifier converts the alternating current into direct current. A filter circuit is used to smooth the output voltage. The stable DC output is supplied to the battery for charging. Sensors may also be included to monitor voltage and current.



WORKING

The wireless power transfer system operates based on the principle of electromagnetic induction and resonant inductive coupling. In this method, electrical energy is transferred from the transmitting coil to the receiving coil without the use of physical wires or connectors. The transmitter coils are embedded beneath the road surface while the receiver coils are mounted underneath the electric vehicle. When electrical power is supplied to the transmitter coil, it creates a varying magnetic field around the coil. This magnetic field acts as the medium for transferring energy to the receiver side. The overall process provides a safe and efficient method for charging electric vehicles. The working process begins with the power supply unit, which provides electrical energy to the system. The supplied electrical energy is initially available in direct current form. Since wireless power transfer requires high-frequency alternating current, the power is sent to an inverter circuit.

V. POWER SUPPLIES

The present chapter introduces the operation of power supply circuits built using filters, rectifiers, and then voltage regulators. Starting with an AC voltage, a steady DC voltage is obtained by rectifying the AC voltage, then filtering to a DC level, and finally, regulating to obtain a desired fixed DC voltage. The regulation is usually obtained from an IC voltage regulator unit, which takes a DC voltage and provides a somewhat lower DC voltage, which remains the same even if the input DC voltage varies, or the output load connected to the DC voltage changes.

A. TRANSFORMER

A transformer is an electrical device used to transfer electrical energy from one circuit to another through electromagnetic induction. It is mainly used to step up or stepdown AC voltage levels depending on application requirements. Transformers work only on alternating current because they require a changing magnetic field to operate. In wireless power transfer and electronic systems, transformers are used for isolation and voltage regulation purposes. They play a critical role in power supply systems. Without transformers, efficient long-distance power transmission would not be possible. The working principle of a transformer is based on Faraday's law of electromagnetic induction.

B. RECTIFIER

A rectifier is an electronic circuit used to convert alternating current (AC) into direct current (DC). It is an essential component in power supply systems. Most electronic devices operate on DC power, so rectifiers are necessary for conversion. In wireless power transfer systems, rectifiers are used on the receiver side. They help in converting induced AC into usable DC power for battery charging. The working principle of a rectifier is based on the use of diodes. Diodes allow current to flow in only one direction. By arranging diodes in specific configurations, AC waveform is converted into DC waveform. This process is called rectification. The output is pulsating DC, which requires filtering for smooth output. Rectifiers are fundamental in power electronics.

C. FILTER

A filter circuit is used to remove unwanted ripples from the rectifier output. It converts pulsating DC into smooth DC voltage. Filters are essential in power supply circuits for electronic devices. In wireless power systems, filters ensure stable DC output for battery charging. Without filters, output voltage would be unstable and unusable. The working principle of a filter is based on energy storage elements like capacitors and inductors. Capacitors store charge and release it when voltage drops. This smoothens the output waveform. Inductors resist sudden changes in current. These properties help in reducing ripples in DC output.

D. VOLTAGE REGULATOR

A voltage regulator is an electronic device or circuit that maintains a constant output voltage regardless of variations in input voltage or load current. It is a crucial component in power supply systems used in almost all electronic and embedded applications. The main purpose of a voltage regulator is to ensure that sensitive electronic components receive a stable and safe voltage supply. Without proper regulation, fluctuations in voltage can damage circuits or cause malfunction. They are widely used in communication devices, microcontroller systems, and industrial electronics.

Types of Regulator:

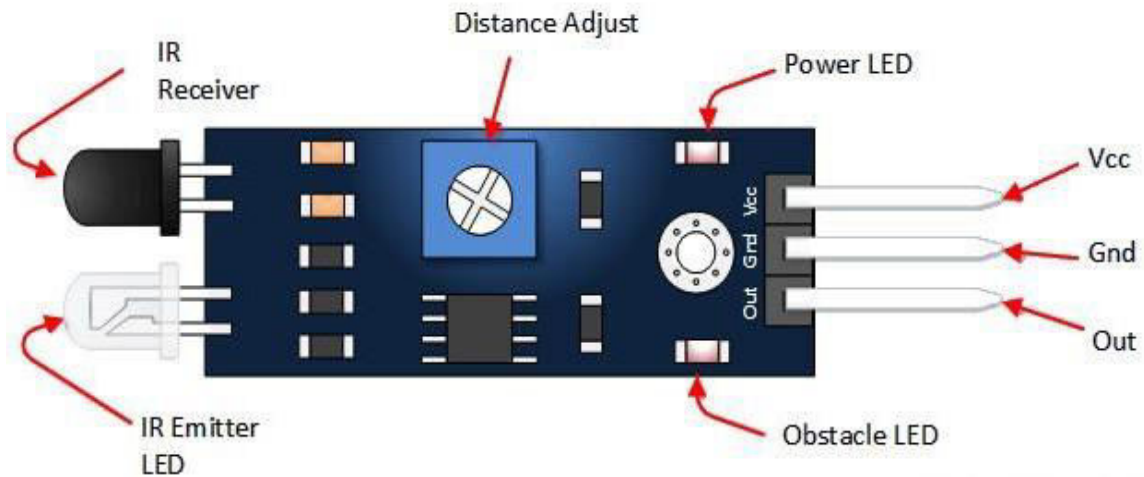
- IC Voltage Regulator
- Three-Terminal Voltage Regulators
- Fixed Positive Voltage Regulators

E. IR SENSOR

An Infrared (IR) sensor is an electronic device used to detect objects and measure distance using infrared light. It consists of an IR transmitter and receiver. When IR light hits an object, it is reflected back to the receiver. The sensor detects this reflected light and generates an electrical signal. IR sensors consist of two main components: IR LED (transmitter) and photodiode or phototransistor (receiver). The IR LED emits infrared light continuously or in pulses.

Variable Resistor

The variable resistor used here is a preset. It is used to calibrate the distance range at which object should be detected.

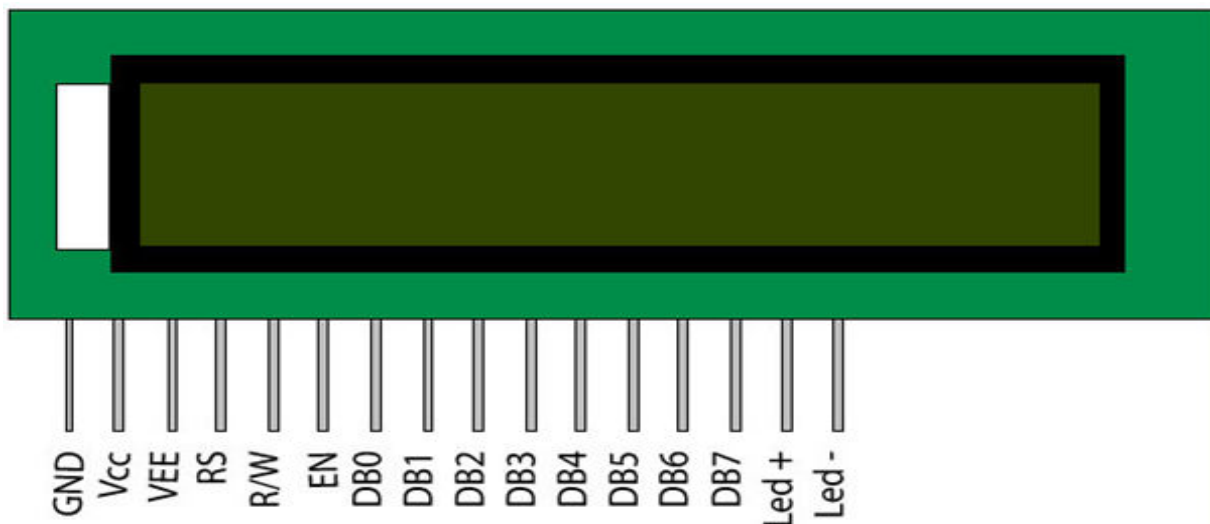


F. LCD DISPLAY

The Liquid Crystal Display (LCD) is one of the most commonly used output devices in embedded systems and electronic projects. It is used to display alphanumeric characters, symbols, and messages in a clear and efficient manner. LCDs consume low power compared to other display technologies, making them suitable for battery-operated systems. When voltage is applied, the orientation of crystals changes, allowing light to pass or block.

Pin Diagram

The LCD pin diagram represents the interface connection between the LCD module and external devices such as microcontrollers. A standard 16x2 LCD consists of 16 pins that are used for power supply, control signals, and data communication. Each pin has a specific function that ensures proper operation of the display. Understanding the pin configuration is essential for correct interfacing.



Improper connections may lead to display malfunction or no output. The pin diagram is an important part of LCD design and implementation in embedded systems. Pin 1 and Pin 2 of the LCD are used for power supply connections. Pin 1 is connected to ground (GND), while Pin 2 is connected to VCC, typically +5V DC. It is also important to avoid noise interference. Pin 15 and Pin 16 are used for backlight connection. Pin 15 is connected to VCC for LED backlight, while Pin

G. DC MOTOR

A DC motor is an electrical machine that converts direct current electrical energy into mechanical energy. It operates based on the principle that a current-carrying conductor placed inside a magnetic field experiences a mechanical force. DC motors are widely used in industrial applications, robotics, electric vehicles, household appliances, and automation systems. The stator produces a magnetic field, while the rotor rotates inside the magnetic field. The armature winding carries electrical current supplied from the power source. Brushes and commutators help maintain the direction of current flow in the armature.



VI. CONCLUSION AND FUTURE SCOPE

The wireless power transfer system for electric vehicles provides an advanced solution for modern charging applications. The system successfully transfers electrical energy without the use of physical wires or connectors. Electromagnetic induction and resonant coupling principles are used to achieve efficient power transfer between transmitter and receiver coils. This technology improves convenience and reduces dependency on conventional plug-in charging systems. The overall system demonstrates the practicality of wireless charging for future transportation. The project mainly focused on developing a reliable and efficient charging method for electric vehicles.

The implementation of transmitter coils beneath the road surface and receiver coils underneath the vehicle enabled wireless energy transfer. Experimental analysis confirmed that electrical power can be transferred effectively through magnetic fields. Proper system design improved charging performance and operational stability. The inverter circuit played an important role in generating high-frequency alternating current required for wireless power transfer. Stable inverter operation improved magnetic coupling between the coils. The resonant circuit increased efficiency and minimized power loss during transmission. This reduces charging downtime and improves transportation efficiency. Dynamic charging is especially useful for highways and public transportation systems.

Continuous research is required to improve efficiency under varying operating conditions. In conclusion, wireless power transfer on roads for electric vehicles is a promising technology with significant benefits for modern transportation. The system improves convenience, efficiency, and sustainability while reducing charging limitations. With further research and infrastructure development, wireless charging systems can become an important part of future electric vehicle networks. Wireless power transfer technology for electric vehicles has significant scope for future

enhancement and development. Continuous research is being conducted to improve the efficiency and practicality of wireless charging systems. Future advancements can make the technology more reliable, affordable, and suitable for large-scale implementation. The integration of advanced materials and intelligent control systems can improve overall performance. One of the major areas of future enhancement is improving power transfer efficiency.

Overall, the wireless power transfer system provides a modern and efficient charging solution for electric vehicles. It eliminates the need for physical cables and reduces dependency on charging stations. Continuous charging capability improves convenience and increases driving range. The technology supports sustainable transportation and future smart city infrastructure. Continuous advancements in wireless charging technology can further improve system performance and reliability. The inverter converts the input DC power into high-frequency alternating current. The magnetic field acts as the medium for wireless energy transfer. When the electric vehicle moves over the transmitter coil, the receiver coil placed underneath the vehicle captures the magnetic flux. This will reduce the need for large battery storage and improve long-distance travel efficiency. Public transportation systems can benefit greatly from continuous charging infrastructure. Artificial intelligence and machine learning techniques can be integrated into wireless charging systems for intelligent energy management.

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