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Wireless EV Charging system

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Abstract: This paper gives an overview of current wireless charging technologies on electric vehicles (EVs) charging. In general, the near-field technologies are preferred over far-field ones. Inductive power transfer and strongly coupled magnetic resonance technologies are chosen for detailed review. Furthermore, special issues related to EV applications are also discussed, namely efficient power supply, misalignment tolerance, multiple pick-up control, simultaneous power and data transmission and shielding methods.

The main function of wireless charging is to transmit power by an electromagnetic field across a given space. As electric vehicles are a better alternative to crab the ongoing pollution it is vital to make amendments in the battery charging process to attain greater reliability. Electric vehicle battery charging can be done by plug in charging at charging stations or by wireless power transfer. Wireless power transfer can able implemented as static or dynamic charging system. Dynamic charging system can be implemented to charge the vehicle even when it is in motion. By using inductive power transfers, the power from source can be transferred to the chargeable batteries through transformer windings. For pre-planned routes such dynamic charging stations can be set up for charging batteries. This will not only increase the use of electric vehicles but also make them efficient and reliable for large distances as well. The paper specially presents an evaluation on how the future EV development and wireless charging methods can be implemented.

Keywords: arduino interface, motor controlling, relay control, tesla coil, LCD display, EV Charging.

I. INTRODUCTION

Electric vehicles (EVs) are one of the promising solutions to improve economic efficiency and reduce the carbon footprint in the transportation sector. Earlier research is focused on the plug-in and conductive solutions for charging the EVs and addressed the challenges of integrating this technology into electricity networks. Plug-in EVs have limited travel range and require large and heavy batteries. Therefore, conductive charging strategies require long waiting time that limits the applicability of EVs compared to gasoline-powered vehicles. More recent research efforts introduced wireless or inductive charging solutions that enable in-motion charging of the EVs which makes EV more favorable for the daily use of many drivers. Wireless charging – also referred to as in-motion charging is different from the conventional charging technologies as it enables charging the EV battery while driving in the transportation network. Therefore, the electricity demand for wirelessly charging the EVs is determined by the traffic volume in the transportation network and the decisions made for charging the EVs as they travel over the charging stations. Wireless charging EV is a type of EV in which charging is done using wireless power transfer (WPT) technology, which does not require any physical contact in the process of transferring electric energy. Stationary wireless charging makes the charging process safer and more convenient. However, in terms of charging time, frequency, the operation of the vehicle, and charging station location, stationary charging is not significantly different from conventional plug- in conductive charging.

II. LITERATURE REVIEW

1. **J. T. Boys and G. A. Covic, "IPT fact sheet series: no. 1–basic concepts," Jul 18 2013Inductive Power Transfer systems (IPT) Fact Sheet: No. 1-Basic Concepts, 2012**:
Inductive Power Transfer (IPT) is a wireless power transfer (WPT) technology that enables energy transmission without direct electrical contact. It operates on the principles of electromagnetic induction, where power is transferred from a primary coil to a secondary coil across an air gap. [1]

2. **J. Pries, V. P. N. Galigekere, O. C. On a r, and G.-J. Su, "A 50-kW three-phase wireless power transfer system using bipolar windings and series resonant networks for rotating magnetic fields," IEEE Transactions on Power**

Electronics, vol. 35, pp. 4500-4517, 2019:
The paper by J. Pries, V. P. N. Galigekere, O. C. Owner, and G.-J. Su (2019) presents a 50-kW three-phase wireless power transfer (WPT) system that utilizes bipolar windings and series resonant networks to generate rotating magnetic fields**. [2]**

3. S. E. Shlad over, "Systems engineering of the roadway powered electric vehicle technology," in INTERNATIONAL ELECTRIC VEHICLE SYMPOSIUM (9TH: 1988):
S. E. Shladover's 1988 paper, "Systems Engineering of the Roadway Powered Electric Vehicle Technology," presented at the 9th International Electric Vehicle Symposium, offers a comprehensive examination of the systems engineering aspects of roadway-powered electric vehicles (RPEVs). [3]

4. **X. Wei, Z. Wang, and H. Dai, "A critical review of wireless power transfer via strongly coupled magnetic resonances," energies, vol. 7, pp. 4316-4341, 2014:**
In their 2014 paper, "A Critical Review of Wireless Power Transfer via Strongly Coupled Magnetic Resonances," Wei, Wang, and Dai provide a comprehensive overview of the advancements in wireless power transfer (WPT) through strongly coupled magnetic resonance (SCMR) .[4]

5. "Electric vehicle wireless power transfer (WPT) systems – Part 3: Specific requirements for the magnetic field wireless power transfer systems," in IEC61980-3/Ed.1, ed: IEC, 2019. The "Electric Vehicle Wireless Power Transfer (WPT) Systems - Part 3: Specific Requirements for the Magnetic Field Wireless Power Transfer Systems" (IEC 61980-3/Ed.1, 2019) is an international standard published by the International Electro Technical Commission (IEC). This document outlines the technical and safety requirements for wireless power transfer (WPT) systems using magnetic fields for charging electric vehicles (EVs). It defines specifications related to power levels, efficiency, electromagnetic compatibility (EMC), safety measures, and interoperability between different WPT systems. [5]

6. J. M. Miller, O. C. Onar, and M. Chinthavali, "Primary-side power flow control of wireless power transfer for electric vehicle charging," IEEE journal of Emerging and selected topics in power electronics, vol. 3, pp. 147-162, 2014.
The paper "Primary- Side Power Flow Control of Wireless Power Transfer for Electric Vehicle Charging" by J. M. Miller, O. C. Onar, and M. Chinthavali, published in the IEEE Journal of Emerging and Selected Topics in Power Electronics (vol. 3, pp. 147-162, 2014), explores power flow control techniques for wireless electric vehicle (EV) charging systems. The study focuses on primary-side control strategies, where power transfer is regulated from the transmitting side without direct communication with the secondary (vehicle) side. [6]

7. M. Bertoluzzo, and H. K. Dashora, "Lumped track layout design for dynamic wirelesscharging of electric vehicles," IEEE Transactions on Industrial Electronics, vol. 63, pp. 6631-6640, 2016.
The paper "Lumped Track Layout Design for Dynamic Wireless Charging of Electric Vehicles" by G. Buja,
M. Bertoluzzo, and H. K. Dashora, published in IEEE Transactions on Industrial Electronics (vol. 63, pp. 6631-6640, 2016), explores an optimized track layout for dynamic wireless power transfer (DWPT) in electric vehicles (EVs). The study focuses on the lumped track approach, where power transfer coils are arranged in discrete sections rather than a continuous track, improving efficiency, cost-effectiveness, and feasibility for large-scale deployment. [7]

III. METHODOLOGY

If wired charging system is built at various charging stations. Wired charging station having more disadvantages such as space required is more, socket are different types, a small substation required, converter circuit is installed at every charging station, range of wire is limited and also time required for charging is more. This all problems is solved by wireless electrical vehicle charging system.

The traditional wired or plug-in charging systems are not user and environment friendly. To reduce the charging time, a large number of batteries can be used or the drained batteries can be swapped with the charged batteries when needed. There is energy waste due to line loss when the coil is conducted for long time. Its service life will be decreased because of continuous working.

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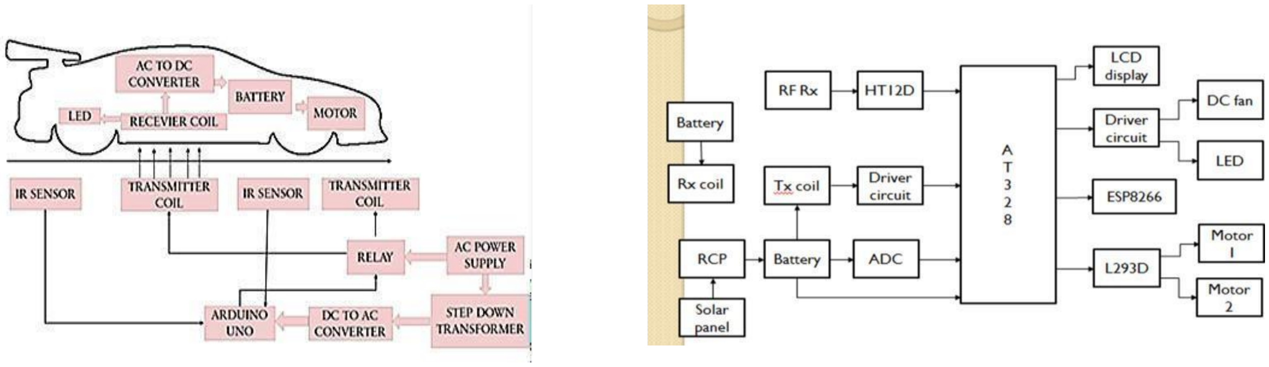


Figure: Block Diagram of wireless EV charging

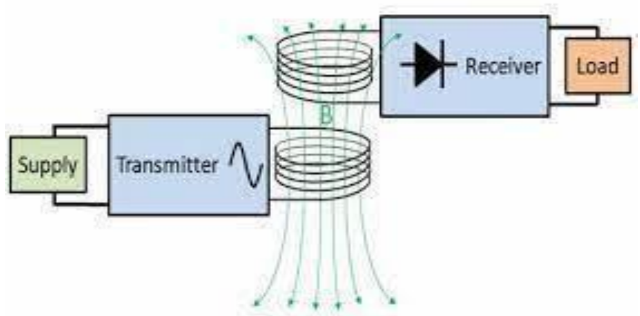
Arduinouno is the main component of the project as it controls and monitor the parameters; IR sensor will detect the presences of the vehicle and sends the signal to Arduinouno. Depending upon the vehicle position, relay is turned on to energize the transmitter coil.

The receiver coil present in the vehicle gets energized by the transmitter coil by mutual coupling, the energy produced is given to AC to DC converter, and the converter is connected to the battery. The battery gives power to the motor to run.

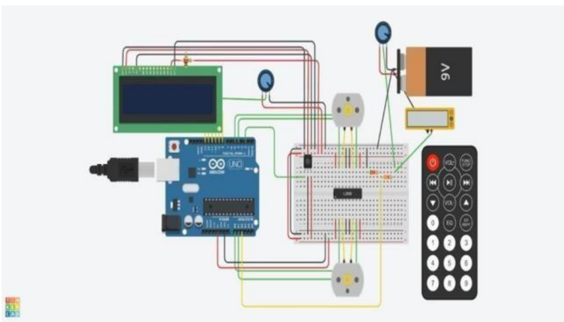
IV. WIRELESS CHARGING ARCHITECTURE

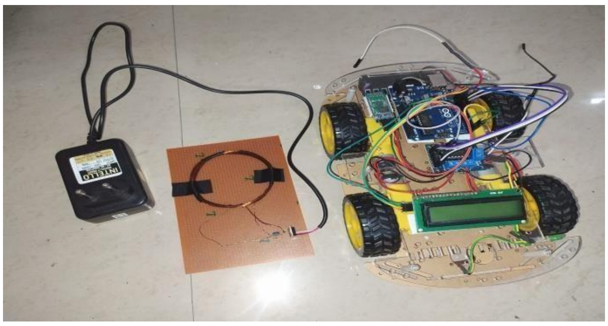
Wireless charging system architecture consisting of AC supply which is used as the source to fed the transmission coil. From the principle of resonant coupling, the reception coil is coupled. The output is given to AC-DC converter to obtain rectified DC to charge the battery which is connected to load. The coils in the project which is used to transmit power wirelessly are called magnetic Resonators.

This creates magnetic field in the region around a transmission coil, tune a reception



coil to the same resonant frequency as the source, it will couple resonating anywhere within that region, converting oscillating magnetic field into an electrical current within the reception coil this response is called coupled magnetic response. The power can be fed to the load for charging battery implementation





The image is a circuit diagram that shows the connections of various electronic components with an Arduino Uno microcontroller. The key components in the diagram include:

- Arduino Uno –The main microcontroller that processes sensor inputs and controls the circuit.
- LCD Display – Displays information such as system status, sensor readings, or commands.
- IR Sensors – Used for detecting objects, movement, or user inputs.
- L298N Motor Driver – Controls the speed and direction of DC motors.
- Relay Module – Acts as an electronic switch to turn devices on/off based on the Arduino’s instructions.
- Remote Control – Sends signals to the Arduino for wireless operation.
- 9V Battery – Powers the entire system.

The provided image depicts a flowchart outlining an error-checking algorithm, likely for a system utilizing an Arduino and IR sensors. The algorithm works as follows start: The process begins Initialize the IR sensor and relay: The system prepares the IR sensor and relay for operation. Wait for IR sensor to get trigger: The system monitors the IR sensor, waiting for a signal. f IR sensor activated: A decision point. If the IR sensor is triggered, the process moves to the next step. If not, it looks back to step 3, continuing to wait.

Turn on the relay corresponding to IR sensor: Once the IR sensor is activated, the corresponding relay is turned on. Stop: The process ends. This flowchart illustrates a basic error detection and response system. Error detection often involves redundancy, where extra bits are added to data for checking integrity. Techniques like parity checks, checksums, and cyclic redundancy checks (CRC) are used to detect errors. In this case, the "trigger" from the IR sensor serves as the signal that is being checked. If the signal is received (sensor activated), it's considered valid, and the relay is activated. If no signal is received, the system continues to wait, implying a potential error or absence of the expected input. Error correction is a related concept where the system not only detects errors but also attempts to reconstruct the original data.

V. RESULT

The transmitting coils are buried under the road at certain distance, and that can selectively on/off for charging vehicles while EVs are in motion. The transmitting coils are connected by the relays to the cable. The Vehicle communication module will detect the entry of vehicle by use of sensors which are connected to Arduino module. The Arduino signals the relay to open the transmitting coil when the EV runs to the transmitting coil L1, the sensor will signal the contact of the relay S1 to on, and the transmitting coil L1 will be energized, resonating with the receiving coil, transmitting energy wirelessly to the EV.

Meanwhile, transmitting coil L2 is standing by. When the EV runs on the interval between two transmitting coils, L1 and L2 will be connected in series. This charging method can avoid the impact caused by suddenly energizing of transmitting coils on the wireless charging system. While the EV pulls away, S1 will be open and L1 will be de- energized. The transmitting coils can have staged charge the EV by selective on/off.

VI. CONCLUSION

We have discussed and reviewed charging of electric vehicles using wireless power transmission. Wireless charging is considered a better alternative to traditional wired charging systems as it is user and environment friendly. Furthermore, it eliminates the need for wires and mechanical connectors, and therefore, avoids the associated Wireless charging systems for electric vehicles hassles and hazards. Wireless charging systems also reduce the range anxiety and enhance the system efficiency. The wireless power transmission, in general, takes place using micro wave, laser or mutual coupling. However, only mutual coupling based techniques are generally used for wireless charging. The mutual coupling based techniques, inductive and capacitive power transfer are employed for contactless power transfer and charging of electric devices. Both these techniques are discussed, compared and contrasted, and it is concluded that the inductive power transfer has advantages and is the prime method for wireless charging of electric vehicles.

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