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Wireless Power Transfer on Road for Electric Vehicles

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Abstract—**The project "Wireless Power Transfer on Road for Electric Vehicles" aims to design and implement a dynamic charging system that enables continuous power delivery to electric vehicles (EVs) using inductive power transfer (IPT) technology. In this system, transmitting coils embedded beneath the road surface generate a magnetic field when supplied with high- frequency AC power. Receiver coils mounted on the underside of EVs capture this magnetic field and convert it into usable electrical energy to charge the battery in real time. This approach eliminates the need for stationary charging infrastructure, reduces battery size requirements, and extends the driving range of EVs. The proposed method enhances charging efficiency, supports sustainable transportation, and addresses challenges such as range anxiety and charging downtime.**

I. INTRODUCTION

Wireless power transfer (WPT) corresponds to electrical energy transfer from an energy source to an electronic system without the use of continuous wire conductors. The transfer of electrical power to different electronic devices has developed since the introduction of electrical techniques in the 18th century. In the 19th century when Maxwell's equations were developed, radio wave phenomenon was demonstrated and the WPT concept was introduced. Nikola Tesla at the end of the 19th century examined the principle of WPT. While the experiment of Tesla had not been successful, Tesla's idea has become a possibility with the advent of semiconductor technology. Because of its simplicity, WPT technology can be used in many applications. This technology has a potential to change the way of life and create a whole new range of electronic equipment. Several forms of WPT technology such as laser transfer, photoelectric transmission, radio, microwave transmission, capacitive and inductive coupling have been developed. Inductive coupling techniques based on the theory of resonance have received increased attention because they provide power with acceptable efficiency that is useful for a wide array of applications. Researchers also concentrate on the complexities of architecture of wireless power transfer devices focused on the resonance inductive coupling technique.

A typical WPT setup comprises of a transmitter (Tx) coil connected to a high frequency (HF) source and a receiver (Rx) coil connected to the electrical load. The electromagnetic field is generated and combined with the Rx, which induces voltage in the Rx side, when HF current passes through the Tx. A major gap should be rendered between Tx and Rx in a practical application, contributing to a loosely coupled condition. By means of a magnetic coupling between transmitting and receiving coils, the WPT technique can distribute electrical energy from the source to the load without any electrical wire. During the power transfer, when Rx is put in a fixed spot, this scheme is known as stationary WPT which is the conventional case of many WPT systems. Recently, WPT systems have evolved into a number of multi-Tx and multi-Rx schemes with a single Tx and Rx. A dynamic WPT which seeks to wirelessly control a moving receptor (Rx) is a groundbreaking extension of WPT stationary systems. A broad variety of devices where conventional WPT can be applied, such as biomedical implants electrical vehicles consumer and electronic devices. On the other side, dynamic WPT's successful application covers hybrid vehicles.

II. EASE OF USE

"Wireless Power Transfer on Road for Electric Vehicles" involves the systematic design and implementation of an inductive power transfer system embedded within road infrastructure. The process begins with a detailed study of electromagnetic induction principles to design primary transmitter coils that are integrated beneath the road surface. Corresponding receiver coils are mounted on the underside of electric vehicles to capture the transmitted power. Power electronics circuits, including rectifiers and inverters, are developed to convert and regulate the transferred power efficiently. Simulation and modeling tools are used to analyze coil alignment, energy transfer efficiency, and electromagnetic field distribution. A prototype setup is then constructed, where a scaled roadway section with embedded coils is tested under different operating conditions. Finally, performance evaluation is carried out by measuring parameters which provide insights into optimizing the technology for real-world applications.

III. LITERATURE SURVEY

The electric vehicle charging technology can be classified as conductive or wireless, stationary or dynamic, and slow or fast. The fast charging in the range of 100 kW of power capacity and wireless dynamic charging concept is described. The design concept, system architecture and development process of optimizing the magnetic flux field for the higher power transfer efficiency are described in this paper. The dynamic charging technology is also compared with the stationary conductive charging for electric vehicles, in view of its development concept and status, and practical feasibility of the innovative technology.

The technology operates on the mutual inductance principle. One of the future uses can be found in the automobile sector, particularly in electric vehicles. Because electric vehicles are a superior solution for reducing pollution, it is very impossible to make changes to the battery charging procedure to achieve greater reliability. The primary purpose of this WPT is to transmit power via coupling and to construct charging systems. The systems deal with an alternating current source, a transmission coil, a converter, and an electric load, which is a battery.

Charging an electric car battery can be accomplished through plug-in charging at charging stations or through wireless power transmission. WPT, in particular, gives an assessment on how future EV development and wireless charging technologies can be accomplished.

In paper [4] the authors Mayank Chawla, Aditya Zade, Travis Newbolt, Paras Mandal, Abhilash Kamineni, "Modelling and Comparative Analysis of Power Distribution Architectures for Large-scale Electric In-motion Wireless Charging Infrastructures" In Wireless Power Week (WPW),2022. A new power electronics control method has been proposed for dynamic wireless power transfer power sharing to maximize the number of cars charged when traffic slows down. Improved second-based synthetic load generation was used to capture quick variability in traffic- related load and highlight how large variance in speeds can significantly increase maximum and average power demand. Power transferred can be reduced sufficiently, up to 20%, without reducing the maximum achievable efficiency below 90%. Power sharing or reducing power transmitted to cars reduces the variability of DWCS load and ensures consumers receive the same maximum charging energy.

It is clear that vehicle electrification is unavoidable because of environment and energy related issues. Wireless charging will provide many benefits as compared with wired charging. In particular, when the roads are electrified with wireless charging capability, it will provide the foundation for mass market penetration for EV regardless of battery technology. With technology development, wireless charging of EV can be brought to fruition. Further studies in topology, control, inverter design, and human safety are still needed in the near term.

IV. COMPONENTS AND DESCRIPTION

4.1 IR Sensor:

Fig 4.1 An IR (Infrared) sensor is an electronic device that uses infrared light to detect objects, measure distance, or identify motion without physical contact. It works using an IR transmitter (IR LED) that emits infrared light and an IR receiver (photodiode or phototransistor) that detects the reflected light from an object.

Fig 4.1: IR Sensor

4.2 Transmission Coil:

The Transmission coil shown in fig 4.2, is a copper coil that carries AC high-frequency current. When current flows through it, the coil produces an oscillating magnetic field. This magnetic field couples with the receiver coil allowing energy transfer without any wire. The transmission coil (also called primary coil or Tx coil) is one of the most important components in a WPT system. It is placed on the road surface or ground, and it generates the magnetic field required to transfer electrical energy wirelessly to the receiver coil in the vehicle.

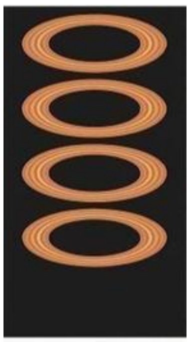

Fig 4.2: Transmission Coil

4.3 Relay Module:

The fig 4.3 shows the relay, a device that uses an electromagnet to open or close electrical contacts. It works like a remote-controlled switch. A relay is an electromechanical switch used to turn ON or OFF a circuit using a low-power control signal (like from Arduino, sensor, or microcontroller).

Fig 4.3: Relay Module

When an object comes in front of the sensor, the infrared light reflects back and the receiver senses it, generating an electrical signal. This output is sent to a microcontroller for further action.

4.4 Microcontroller:

In the Wireless Power Transfer (WPT) system for electric vehicles, the microcontroller Arduino Uno plays the central role of controlling, monitoring, and coordinating the entire operation of the system. It acts as the brain of the project.

In this WPT the microcontroller controls the operation of the wireless charging system. It reads the IR sensor input to detect the vehicle, drives the relay to activate the required transmitting coil, controls the timing of power transfer, and ensures safe and efficient operation of the system

Fig 4.4: Microcontroller (Arduino Uno)

4.5 Capacitor:

In fig 4.5 The Capacitor is an electronic component used to store and release electrical energy in the form of an electric field. In a WPT system, capacitors play a very important role in tuning, filtering, and stabilizing the circuit.

Fig 4.5: Capacitor

4.6 Mosfet:

The IRF540 which is in fig 4.6 is an N-channel enhancement- mode power MOSFET commonly used for switching and amplification in electronic circuits. It is known for high current handling, low ON-resistance, and fast switching speed, which makes it ideal for power-conversion circuits, motor drivers, SMPS, and RF/pulse circuits.

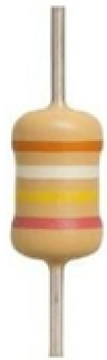

Fig 4.7: Resistor

Fig 4.8: Mosfet

V. WORKING

5.1 General Approach:

The Wireless Power Transfer on Road for Electric Vehicle system works on the principle of electromagnetic induction (inductive coupling) to provide continuous charging to an electric vehicle while it is in motion. Electrical power from an AC or DC source is supplied to a wireless power transmission circuit, which converts it into high-frequency alternating current suitable for generating a strong and stable magnetic field. Multiple transmitter coils are embedded beneath the road surface, each aligned with position-sensing infrared (IR) sensors. When the electric vehicle approaches, the IR sensors detect its presence and send signals to a microcontroller. The microcontroller analyses this position data and activates only the relay connected to the transmission coil located directly beneath the vehicle, while keeping all other coils switched OFF to avoid unnecessary power loss and electromagnetic radiation. The energized transmitter coil produces an alternating magnetic flux that couples wirelessly with the receiver coil mounted under the vehicle.

This magnetic field induces an alternating voltage in the receiver coil based on Faraday's law of electromagnetic induction. The induced AC voltage is then converted into DC using rectifier and voltage regulation circuits onboard the vehicle, which safely supply energy to charge the battery and feed the motor drive system. As the vehicle continues to move forward, a new set of IR sensors gets triggered, prompting the microcontroller to switch OFF the previous coil and simultaneously switch ON the next coil in sequence. This synchronized switching creates a dynamic charging pathway, ensuring uninterrupted power transfer along the road.

5.2 Block diagram and its Description:

A resistor is a passive electronic component that provides a precise amount of resistance to the flow of electric current. In a WPT circuit, resistors play an essential role in controlling current, stabilizing the oscillator, protecting sensitive components, and ensuring proper operation of both the transmitter and receiver stages.

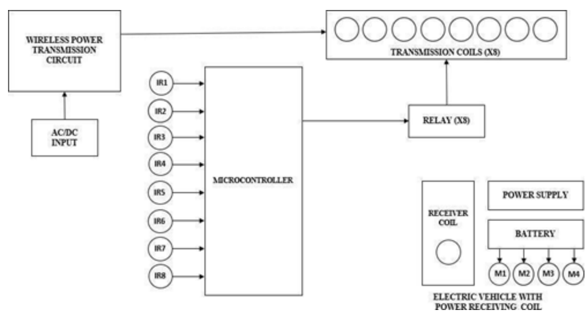

Fig 5.2: Block Diagram of Wireless Power Transfer on Road for Electric Vehicle

5.3 Block Diagram Description:

The Wireless Power Transfer on Road for Electric Vehicle system begins with an AC/DC input source that supplies power to the wireless power transmission circuit, where the input is converted into high-frequency alternating current suitable for wireless energy transfer. This high-frequency power is delivered to multiple transmission coils (X8) embedded along the road. At the same time, a set of IR sensors (IR1 to IR8) continuously monitor the vehicle's position as it moves along the roadway. These sensors send real-time detection signals to the microcontroller, which acts as the central control unit of the entire system.

Based on the signals received from the IR sensors, the microcontroller activates the corresponding relay (X8) to switch ON only the transmission coil located directly beneath the vehicle. This selective control prevents energy wastage and limits electromagnetic exposure by ensuring that unused coils remain OFF. The activated relay connects the selected coil to the transmission circuit, allowing the coil to generate a strong alternating magnetic field necessary for wireless power transfer through inductive coupling.

On the vehicle side, the receiver coil mounted underneath captures this magnetic field and induces an electrical voltage. The induced AC voltage is processed by the onboard power supply unit, which rectifies and regulates it into usable DC power. This regulated power is then stored in the battery and used to drive the vehicle's motors (M1–M4). As the electric vehicle moves forward, new IR sensors are triggered in sequence, and the microcontroller continuously switches the next set of transmission coils, ensuring smooth, uninterrupted wireless charging along the road.

VI. RESULTS

Wireless power transfer (WPT) on roads for electric vehicles (EVs) is an innovative technology aimed at charging EVs while they are in motion or parked, eliminating the need for frequent stops at charging stations. This system typically involves embedding electromagnetic coils beneath the road surface and equipping vehicles with compatible receiver coils. As the vehicle moves over these embedded transmitters, power is wirelessly transferred through magnetic resonance or inductive coupling, charging the vehicle's battery in real-time. This dynamic charging approach not only extends the driving range of EVs but also reduces battery size requirements and alleviates range anxiety. While still in development and pilot phases in many countries, WPT on roads represents a significant step toward sustainable and convenient electric mobility.

Fig 6.1: Wireless Power Transfer on Road for Electric Vehicles

VII. CONCLUSION & FUTURE SCOPE

The implemented wireless power transfer (WPT) system successfully demonstrates the transmission of electrical energy across an air gap using inductive coupling between a transmitter (TX) and receiver (RX) coil. The CD4047 pulse generator provides a stable high-frequency oscillation that drives the MOSFET, enabling efficient switching of the TX coil. The induced AC voltage in the RX coil is rectified, filtered, and regulated using a 7805-voltage regulator to obtain a stable 5V DC output.

Experimental results indicate that the prototype is capable of powering low-power loads such as LEDs and small electronic modules within a short distance. The system validates the fundamental principle of resonant inductive coupling and demonstrates that wireless power can be transferred safely and reliably without direct electrical contacts. Overall, the project achieves its objective by creating a simple, cost-effective, and functional wireless power transfer model suitable for basic consumer and educational applications.

The wireless power transfer system developed in this project can be further enhanced in several ways to improve performance and expand practical applications. Efficiency and transmission distance can be significantly increased by introducing resonant capacitors to achieve LC resonance between the transmitter and receiver coils. The use of optimized coil designs, ferrite cores, and higher-capacity MOSFETs would also enable the system to support higher power loads. Incorporating closed-loop feedback control can make the system more stable and energy-efficient by automatically adjusting the operating frequency based on load variations. Additionally, integrating microcontrollers would allow intelligent monitoring of voltage, current, and temperature, improving safety and adaptability. Future designs can also focus on multi-device charging, miniaturization using PCB-based coils, and enhanced protection mechanisms for reliable operation. Beyond inductive coupling, researchers can explore other wireless power transfer techniques such as capacitive or magnetic resonance methods to achieve longer ranges and support modern applications like IoT devices and electric vehicle charging systems.

REFERENCES

[1] Chunting Chris Mi, Giuseppe Buja, Su Y. Choi, and Chun T. Rim, "Modern Advances in Wireless Power Transfer Systems for Roadway Powered Electric Vehicles", IEEE Transactions on Industrial Electronics, pp. 278-346, March 3, 2016.

[2] Ankur Sarker, Chenxi Qiu, Haiying Shen, Andrea Gill, Joachim Taiber, Mashrur Chowdhury, Jim Martin, Mac Devine, and AJ Rindos, "An Efficient Wireless Power Transfer System To Balance the State of Charge of Electric Vehicles", 45th International Conference on Parallel Processing, pp.2332-5690, 2016.

[3] Donovin D. Lewis, Omer Onar, Veda Prakash Galigekere, Mostak Mohammad, and Dan M. Lonel, "Optimal Power Sharing Speed Compensation in On-road Wireless EV Charging Systems", IEEE Transportation Electrification Conference and Expo (ITEC), pp. 112- 119, 2023.

[4] Mrs. Sterlin Rani D, Haritha J C, Subhashri S, and Ashwini P, "Solar- Powered Wireless Dynamic Charging System for Electric Vehicles", International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET), vol. 7, Issue 11, pp. 16561- 16566, November 2024.

[5] Siqi Li and Chunting Chris Mi, "Wireless Power Transfer for Electric Vehicle Applications", IEEE Journal of Emerging and Selected Topics in Power Electronics, vol. 3, no. 1, pp. 4772-4780, March 2015.

[6] In-Soo Suh and Jedok Kim, "Electric Vehicle On-Road Dynamic Charging System with Wireless Power Transfer Technology", Journal of Integrated Design and Process Science, vol.15, no. 3, pp. 234-240, 2013.

[7] Omar Nezamuddin and Euzeli Cipriano dos Santos Jr., "Vehicle-to- Vehicle In-Route Wireless Charging System", IEEE Xplore, pp.371- 376, 2020.

[8] Rajat Marjive, Anjali Mahadule, Bhavna Gaware, Ashutosh Gajewar, Rithik Joshi, and Vaishali Dhumal, "Solar Wireless Electric Vehicle Charging System", International Journal of Advanced Research in Computer and Communication Engineering, vol. 13, Issue 4, pp. 2278- 1021, April 2024.

[9] Aganti Mahesh, Bharatiraja Chokkalingam, and Lucian Mihet-Popa, "Inductive Wireless Power Transfer Charging for Electric Vehicles", IEEE Multidisciplinary Journal, vol. 9, September 29, 2021.

[10] Adel El-Shahat, Erhuvwu Ayisire, Yan Wu, Mosfequr Rahman, Dylan Nelms, "Electric Vehicles Wireless Power Transfer State-of-The-Art", 6th International Conference on Emerging and Renewable Energy: Generation and Automation, pp. 24-37, 2019.

[11] Su Y. Choi, Byeong-Hwa Lee, Eun-Sung Lee, Jong-Soo Kim, Chun

[12] T. Rim, and Chunting Chris Mi, "Generalized Active EMF Cancellation Method for Wireless Electric Vehicles", IEEE Transactions on Power Electronics, vol. 29, no. 11, pp. 5770–5783, November 2014.

[13] Omer C. Onar, Jason M. Miller, Su Y. Choi, and Chun T. Rim, "A Novel Wireless Power Transfer System for In-Motion EV Charging", IEEE Transactions on Power Electronics, vol. 31, no. 9, pp. 6450– 6461, September 2016.

[14] H. H. Wu, A. Gilchrist, K. Sealy, and D. Bronson, "A Review on Inductive Coupling Wireless Power Transfer for Electric Vehicle Charging", IEEE Power Electronics Conference, pp. 143–149, 2011.

[15] J. M. Miller, P. T. Jones, J. M. Li, and O. C. Onar, "ORNL Experience and Challenges Facing Dynamic Wireless Power Charging of Electric Vehicles", IEEE Circuits and Systems Magazine, vol. 15, no. 2, pp. 40–53, Second Quarter 2015.

[16] Z. Pantic and S. Lukic, "Framework and Topology for Active Tuning of Resonant Inductive Power Transfer Systems", IEEE Transactions on Power Electronics, vol. 27, no. 11, pp. 4503–4513, November 2012.