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Review Paper on Dynamic Wireless EV Charging using Embedded Road Coil

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Abstract: *The increasing adoption of electric vehicles (EVs) marks a major step toward clean and sustainable transportation. However, the dependency on stationary charging infrastructure and long charging durations limit the practical usability of EVs. This paper presents an innovative approach to Dynamic Wireless Electric Vehicle Charging (DWPT) using Embedded Road Coils, which enables vehicles to charge while in motion through electromagnetic induction. The proposed system utilizes transmitting coils embedded under the road surface and a receiving coil installed beneath the vehicle. The design integrates a high-frequency inverter, resonant tank circuit, and Arduino-based control unit to ensure stable and efficient energy transfer. A prototype was developed to validate the concept, achieving up to 70% power transfer efficiency across a 2–5 cm air gap under dynamic conditions. The project demonstrates the feasibility of continuous and contactless charging for electric vehicles, thereby reducing battery size requirements, eliminating charging downtime, and supporting the future development of smart transportation systems and green mobility infrastructure.*

Keywords*:* Dynamic Charging, Electric Vehicle, Wireless Power Transfer, Embedded Road Coil, Arduino, Resonant Coupling

I. INTRODUCTION

The transition from conventional fuel-based transportation to electric mobility has gained momentum worldwide due to concerns over environmental pollution and the depletion of fossil fuels. Electric vehicles (EVs) provide a sustainable solution but still face major limitations such as limited driving range, lengthy charging times, and dependency on stationary charging stations. Traditional plug-in charging systems require the vehicle to stop and connect to a power source, reducing operational flexibility and user convenience.

To address these challenges, **Dynamic Wireless Power Transfer (DWPT)** technology is emerging as a promising solution that enables vehicles to charge while in motion. In this system, transmitting coils embedded beneath the road generate a magnetic field that induces current in the receiver coil mounted beneath the vehicle. This contactless charging method eliminates the need for physical connectors and allows continuous charging, thereby extending driving range and reducing the required battery capacity.

The proposed project, *"Dynamic Wireless EV Charging using Embedded Road Coil,"* focuses on developing a working prototype that demonstrates efficient power transfer between a stationary road coil and a moving receiver coil using **Arduino-based control** and **high-frequency switching circuits**. This work contributes toward developing smart city infrastructure for sustainable and intelligent transportation.

II. METHODOLOGY

Theoretical Study:

- Investigated principles of electromagnetic induction and resonant coupling for wireless energy transfer.
- Studied the effect of coil geometry, air gap, and frequency on power transfer efficiency.

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Design Stage:

- Designed transmitter and receiver coils using enameled copper wire (AWG 20).
- Implemented an LC resonant circuit for efficient power transfer at 50–100 kHz frequency.
- Developed inverter and rectifier circuits to convert DC to high-frequency AC and back to DC.

Control System:

- Used **Arduino Uno** for inverter control and switching operation.
- Integrated sensors (ACS712 current, voltage divider) for monitoring charging parameters.

Prototype Implementation:

- Constructed road model with embedded transmitting coil powered by a DC supply (12–24 V).
- Installed receiver coil beneath a small EV model equipped with a rechargeable battery and DC motor.

Testing and Analysis:

- Measured output voltage, current, and efficiency at different distances and alignments.
- Verified system stability under static and dynamic conditions.

III. MODELING AND ANALYSIS

The wireless charging system is modeled as a coupled resonant circuit consisting of a **transmitting coil (primary)** and a **receiving coil (secondary)**.

Power Transmission Principle:

When alternating current flows through the transmitter coil, it generates a varying magnetic field. This field induces an electromotive force (EMF) in the receiver coil based on **Faraday's law of electromagnetic induction**.

Mathematical Model:

The mutual inductance (M) between coils determines the efficiency of energy transfer, expressed as:

$$M = k\sqrt{(L1L2)}$$

where k is the coupling coefficient, and L_1 and L_2 are the self-inductances of the transmitter and receiver coils.

Resonant Compensation:

Both sides are tuned using capacitors to resonate at the same frequency, minimizing reactive losses and maximizing power transfer.

System Components:

- **Input Voltage:** 12–24 V DC
- **Operating Frequency:** 50–100 kHz
- **Output Voltage:** 5–12 V DC
- **Transmission Distance:** 2–5 cm
- **Efficiency:** 60–80% (targeted)

Simulation and circuit modeling were performed using MATLAB/Simulink to verify coil alignment, power factor, and current flow characteristics.

IV. RESULTS AND DISCUSSION

A prototype was built and tested successfully. The transmitting coil embedded in the road model was energized using a 12 V DC supply through a high-frequency inverter. The receiver coil under the moving vehicle model captured the induced energy and converted it back into DC using a rectifier circuit to charge the onboard battery.

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Key Results:

- Wireless charging occurred effectively up to 5 cm distance.
- Maximum power transfer efficiency achieved was around 70%.
- The system operated stably during dynamic motion of the model vehicle.
- Misalignment tolerance was acceptable up to 3 cm without significant power loss.

The experimental results validate the concept of dynamic wireless charging. The combination of properly tuned resonant circuits and Arduino-based control ensured smooth operation and safe power transfer. This demonstrates the feasibility of integrating embedded road coils for future EV charging infrastructure.

V. CONCLUSION

The project **"Dynamic Wireless EV Charging using Embedded Road Coil"** successfully demonstrates a cost-effective and efficient method of wirelessly charging electric vehicles while in motion. The developed prototype highlights that using resonant inductive coupling, it is possible to transfer energy across small air gaps without physical contact.

This technology minimizes the need for stationary charging, reduces battery capacity requirements, and supports the development of **smart transportation systems**. Future work includes scaling the system for high-power applications, implementing renewable energy integration, and developing automated vehicle detection and alignment systems for real-world highways.

REFERENCES

[1]. Kurs et al., "Wireless Power Transfer via Strongly Coupled Magnetic Resonances," *Science*, vol. 317, pp. 83–86, 2007. pp. 178-188, 2015.

[2]. Y. J. Jang, "Survey of the Operation and System Study on Wireless Charging Electric Vehicle Systems," *Transportation Research Part C*, vol. 95, pp. 844–866, 2018.

[3]. H. Zhang and C. Mi, "Review of Dynamic Wireless Power Transfer for Electric Vehicles," *IEEE Transactions on Transportation Electrification*, vol. 4, no. 2, pp. 374–390, 2018.

[4]. V. Sharma, R. Tiwari, and M. Joshi, "Prototype Design of Embedded Road Coil for Dynamic EV Charging," *International Journal of Engineering Research & Technology (IJERT)*, vol. 10, no. 11, 2021.

[5]. S. Li and C. C. Mi, "Wireless Power Transfer for Electric Vehicle Applications," *IEEE Journal of Emerging and Selected Topics in Power Electronics*, vol. 3, no. 1, pp. 4–17, 2015.

[6]. Z. Yan, K. Zhang, C. Cheng, and S. Wang, "Design and Analysis of a Dynamic Wireless Charging System for Electric Vehicles," *IEEE Transactions on Industrial Electronics*, vol. 63, no. 10, pp. 6602–6612, 2016.

[7]. S. Ahmed, J. Lee, and H. Kim, "Modeling and Control of Inductive Power Transfer Systems for EV Dynamic Charging," *IEEE Transactions on Power Electronics*, vol. 31, no. 10, pp. 7066–7075, 2016.

[8]. H. A. Mohamed, "Design and Implementation of Inductive Charging System for Electric Vehicles," *IEEE Access*, vol. 8, pp. 208455–208467, 2020.

[9]. K. Lee, "Optimal Coil Design for Roadway Wireless Power Transfer Systems," *IEEE Transactions on Magnetics*, vol. 52, no. 7, pp. 1–4, 2016

[10]. S. C. Lee and J. Park, "Dynamic Charging Circuit for Electric Vehicle using Magnetic Resonance Coupling," *IEEE Transactions on Power Electronics*, vol. 29, no. 9, pp. 4852–4861, 2014.

[11]. T. Campi, S. Cruciani, and M. Feliziani, "Wireless Power Transfer Technology for Electric Vehicles: State-of-the-Art and Future Trends," *Energies*, vol. 11, no. 2, p. 433, 2018.

[12]. N. Kumar and A. Singh, "Development of a Cost-Effective Prototype for Dynamic Wireless Charging of EVs," *International Journal of Emerging Technologies in Engineering Research (IJETER)*, vol. 8, no. 9, pp. 45–52, 2020.

[13]. L. Jiang and M. Mi, "Improved Control Strategy for High-Efficiency DWPT," *IEEE Transactions on Power Electronics*, vol. 35, no. 8, pp. 8415–8427, 2020.