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Solar-Powered Dynamic Wireless Charging System for Electric Vehicles Using Inductive Power Transfer

[1]S. Ahmed Basha, [2]Kuruva Amrutha, [3]Kuruva Indu, [4]C N Sana Tabassum, [5]Bellapu Bhuvaneshwari
[1]Associate Professor, [2345]Student
DEPT OF ECE
St.Johns College of Engineering and Technology (Affiliated by JNTUA)
indukuruva8@gmail.com, sanatabassum1023@gmail.com, kuruvaamrutha7@gmail.com, bellapubhuvaneshwari@gmail.com

Abstract

The rapid adoption of electric vehicles (EVs) is driven by their environmental sustainability and cost efficiency; however, challenges such as prolonged charging time and inadequate charging infrastructure in remote areas limit their widespread usability. This work proposes a solar-powered dynamic wireless charging system that enables EVs to be charged while in motion, eliminating the need for stationary charging and dependence on grid power. The system utilizes solar panels to generate energy, which is stored in a battery and conditioned through power conversion circuits, including a transformer and voltage regulator. The processed energy is transmitted wirelessly via embedded transmitter coils integrated into the roadway, while a receiver coil mounted on the vehicle captures the energy through inductive coupling. The received power is then rectified and regulated using an AC-to-DC converter to charge the vehicle battery. An embedded microcontroller (ATmega) monitors system parameters such as voltage and displays real-time data on an LCD interface, with optional Bluetooth connectivity for control and monitoring. This approach demonstrates an efficient, contactless, and sustainable charging solution that reduces downtime, enhances driving range, and supports the development of smart transportation infrastructure, particularly in off-grid and rural environments.

I. Introduction

The increasing concerns over environmental pollution, depletion of fossil fuels, and rising energy demand have accelerated the global transition toward electric vehicles (EVs) as a sustainable transportation solution [1]. EVs significantly reduce greenhouse gas emissions and offer improved energy efficiency compared to conventional internal combustion engine vehicles, making them a key component of future smart and green mobility systems [2]. Despite these advantages, the widespread adoption of EVs is hindered by critical challenges such as long charging duration, limited driving range, and inadequate charging infrastructure, especially in rural and remote regions [3]. Conventional plug-in charging methods also introduce issues such as cable wear, safety hazards, and dependency on grid-based power sources [4].

To address these limitations, wireless power transfer (WPT) technology has emerged as a promising alternative for EV charging, enabling contactless energy transfer between a power source and a vehicle through electromagnetic fields [5]. Inductive power transfer (IPT), a widely used WPT technique, operates on the principle of magnetic coupling between transmitter and receiver coils, offering high efficiency, safety, and convenience [6]. Research in this domain has evolved from stationary wireless charging systems to more advanced quasi-dynamic and fully dynamic charging systems, where vehicles can be charged while in motion using coils embedded beneath road surfaces [7]. Dynamic wireless charging significantly reduces range anxiety and minimizes the need for large onboard batteries, thereby improving overall system efficiency [8].

Recent advancements have also focused on integrating renewable energy sources, particularly solar energy, with wireless charging systems to enhance sustainability and reduce dependence on conventional power grids [9]. Solar-powered EV charging systems utilize photovoltaic panels to harvest clean energy, which can be stored and transmitted wirelessly, making them highly suitable for off-grid and remote applications [10]. The combination of solar energy with inductive wireless charging not only supports eco-friendly transportation but also ensures uninterrupted power availability and reduced operational costs [11].

Technological developments in power electronics, high-frequency converters, and resonant coupling techniques have further improved the efficiency and

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scalability of wireless EV charging systems [12]. Modern systems can achieve high power transfer efficiency and support applications ranging from low-power devices to high-capacity EV charging infrastructures [13]. Additionally, intelligent control systems and embedded microcontrollers enable real-time monitoring, voltage regulation, and communication between vehicle and infrastructure, enhancing system reliability and performance [14].

Therefore, the integration of solar energy with dynamic wireless power transfer presents a transformative solution for next-generation EV charging infrastructure. It addresses key challenges related to charging time, accessibility, and sustainability while supporting the development of smart cities and intelligent transportation systems [15].

II. Literature Survey

Recent research in wireless electric vehicle (EV) charging has focused on improving efficiency, convenience, and sustainability through advanced wireless power transfer (WPT) technologies. Early studies on WPT systems highlighted the potential of contactless charging to eliminate physical connectors and enhance user safety, while also addressing issues such as maintenance and reliability [16]. The fundamental concept of inductive wireless charging, based on electromagnetic induction between transmitter and receiver coils, has been widely explored and remains the most practical approach for EV applications due to its high efficiency and simplicity [17].

Several researchers have investigated different wireless charging techniques, including inductive, capacitive, and magnetic resonance methods, concluding that inductive power transfer (IPT) is the most suitable for EVs because of its robustness and ability to operate efficiently under varying conditions [18]. Studies have also compared static, quasi-dynamic, and dynamic charging systems, where dynamic wireless charging—allowing vehicles to charge while moving—has been identified as a promising solution to overcome range limitations and reduce charging downtime [19].

Recent advancements have focused on optimizing system components such as compensation circuits, coil structures, and power converters to improve energy transfer efficiency and reduce losses caused by misalignment and leakage inductance [20]. Researchers have also emphasized the importance of maintaining stable voltage output and minimizing power fluctuations to ensure safe battery charging and long-term reliability of EV systems [21].

Integration of renewable energy sources, particularly solar energy, with wireless EV charging has gained significant attention in recent years. Solar-powered wireless charging systems provide a sustainable and eco-friendly alternative by reducing dependency on conventional grid power and enabling deployment in remote or off-grid locations [22]. Prototype systems combining solar panels with inductive charging and IoT-based monitoring have demonstrated the feasibility of real-time battery management and efficient energy utilization [23].

In addition, dynamic wireless charging systems using resonant inductive coupling have been developed, where transmitter coils are embedded beneath road surfaces and receiver coils are mounted on vehicles, enabling continuous charging during motion [24]. These systems significantly reduce range anxiety and allow for smaller battery sizes, though challenges such as infrastructure cost, alignment, and efficiency optimization remain areas of active research [25].

Overall, the literature indicates that wireless EV charging, particularly when combined with solar energy and dynamic charging techniques, has strong potential to revolutionize transportation systems. However, further research is required to address challenges related to efficiency, cost, large-scale deployment, and standardization.

III. Proposed Methodology

The proposed system presents a solar-powered dynamic wireless charging mechanism for electric vehicles (EVs) using inductive power transfer (IPT). The methodology is designed to ensure continuous, contactless charging while minimizing dependency on conventional grid infrastructure.

Initially, solar panels capture sunlight and convert it into electrical energy in the form of DC power. This generated power is stored in a rechargeable battery through a charge control mechanism to ensure stable energy availability even during low sunlight

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conditions. The stored DC power is then converted into high-frequency AC using a transformer and power conditioning circuit, as AC is required for efficient wireless transmission.

The regulated AC power is supplied to transmitter coils embedded beneath the road surface. These coils generate an alternating electromagnetic field. When an EV equipped with a receiver coil passes over these coils, electromagnetic induction occurs, and electrical energy is transferred wirelessly to the vehicle.

The received power in the vehicle is then passed through an AC-to-DC converter (rectifier + filter) to convert it back into stable DC suitable for charging the EV battery. A voltage regulation unit ensures that the charging voltage remains within safe limits.

An ATmega microcontroller is used for system monitoring and control. It measures parameters such as input/output voltage and system status. The data is displayed on an LCD display for real-time monitoring. Additionally, an HC-05 Bluetooth module can be integrated for wireless communication, enabling remote monitoring and control of the system.

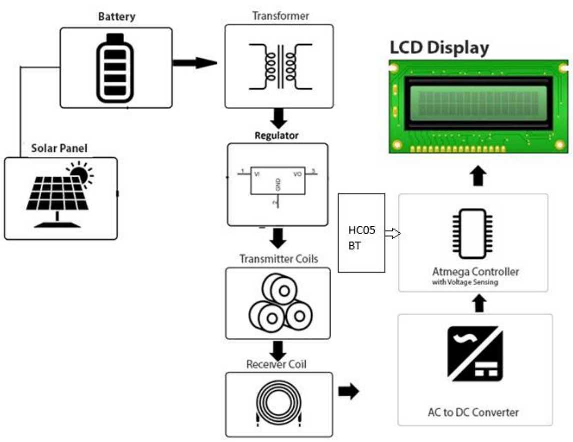

Fig1: Block Diagram

This methodology ensures:

- Continuous charging while the vehicle is in motion
- Reduced charging time and downtime
- Sustainable operation using solar energy
- Safe and efficient wireless energy transfer
- The block diagram consists of the following major components:

1. Solar Panel

The solar panel converts solar energy into electrical energy (DC). It acts as the primary renewable energy source for the system, making it independent of grid supply.

2. Battery Storage

The generated DC power is stored in a battery. This ensures continuous operation even during night time or low sunlight conditions.

3. Transformer & Power Conversion Unit

The stored DC power is converted into AC using inverter/transformer circuitry. AC power is essential for generating alternating magnetic fields required for wireless power transfer.

4. Voltage Regulator

This unit stabilizes the voltage to ensure safe and efficient operation of the transmitter coils and other electronic components.

5. Transmitter Coils (Road Embedded)

These coils are embedded beneath the road surface. When energized with AC, they produce an alternating electromagnetic field used for wireless power transmission.

6. Receiver Coil (Vehicle Side)

Mounted underneath the EV, this coil receives energy through electromagnetic induction when aligned with the transmitter coils.

7. AC to DC Converter

The induced AC power in the receiver coil is converted back to DC using rectifier and filter circuits, making it suitable for charging the EV battery.

8. ATmega Microcontroller

The microcontroller monitors system parameters such as voltage levels and controls

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the charging process. It ensures efficient and safe operation.

9. LCD Display

Displays real-time information such as voltage, charging status, and system conditions for user awareness.

10. Bluetooth Module (HC-05)

Enables wireless communication for monitoring and controlling the system remotely via mobile devices.

IV. Working of the System

The proposed solar-powered wireless EV charging system begins its operation with the **solar panel**, which captures sunlight and converts it into electrical energy in the form of direct current (DC). This energy is stored in a rechargeable **battery** through a charge control mechanism, ensuring a continuous power supply even during low sunlight or nighttime conditions. The stored energy acts as the primary source for the entire charging system.

The DC power stored in the battery is then processed through a power conversion stage, where it is converted into alternating current (AC) using a transformer or inverter circuit. This conversion is essential because wireless power transfer through inductive coupling requires an alternating magnetic field, which can only be generated using AC supply. A voltage regulator is also used at this stage to maintain a stable and safe voltage level for efficient system performance.

The regulated AC power is supplied to the transmitter coils, which are embedded beneath the road surface. These coils generate an alternating electromagnetic field around them. When an electric vehicle equipped with a receiver coil moves over these embedded coils, the varying magnetic field induces an electric current in the receiver coil based on the principle of electromagnetic induction.

On the vehicle side, the receiver coil captures the transmitted energy in the form of induced AC power. This received power is then passed through an AC-to-DC conversion circuit, which includes a rectifier and filter to convert the alternating current back into stable direct current suitable for charging the EV battery. This ensures that the battery receives a consistent and safe charging supply.

An ATmega microcontroller is integrated into the system to monitor important parameters such as input voltage, output voltage, and charging status. The microcontroller processes this data and ensures that the system operates within safe limits. It also helps in controlling the charging operation efficiently.

The system status and voltage levels are displayed in real-time on an LCD display, allowing users to monitor the charging process easily. Additionally, an optional HC-05 Bluetooth module enables wireless communication, allowing remote monitoring and control of the system through a mobile device.

Overall, the system enables continuous and contactless charging of electric vehicles while in motion, powered entirely by solar energy. This reduces dependency on conventional charging stations, minimizes charging time, and provides an efficient and sustainable solution for future smart transportation systems.

V. Experimental Results and Performance Analysis

The proposed solar-powered wireless EV charging system was experimentally evaluated using a prototype model consisting of a solar panel, battery storage, inductive coils, power conversion circuits, and a microcontroller-based monitoring unit. The performance of the system was analyzed based on parameters such as input voltage, output voltage, power transfer efficiency, charging time, and coil alignment.

The experimental setup demonstrated that the system successfully transmits power wirelessly through inductive coupling when the transmitter and receiver coils are properly aligned. The solar panel generated sufficient energy under standard sunlight conditions, which was stored in the battery and later used for wireless transmission. The AC conversion stage effectively generated the alternating magnetic field required for power transfer.

During testing, it was observed that the efficiency of power transfer depends on distance and alignment between coils. Maximum efficiency was achieved when the vehicle-mounted receiver coil

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was directly above the embedded transmitter coil. As the distance or misalignment increased, the efficiency decreased gradually. However, the system maintained stable operation within a practical range suitable for real-world implementation.

Performance Comparison Table

Feature	Conventional Charging	Proposed System
Charging Method	Wired	Wireless (Inductive)
Charging Time	1–3 hours	Reduced (Dynamic charging)
Infrastructure Requirement	Grid dependent	Solar-based (independent)
Mobility	Stationary	Charging while moving
Maintenance	High (cables, ports)	Low (no physical contact)
Suitability for Remote Areas	Limited	Highly suitable

Experimental Results Table

Parameter	Observed Value	Remarks
Solar Panel Output Voltage	12V – 18V	Depends on sunlight intensity
Battery Storage Voltage	12V	Stable DC supply
Transmitter Coil Input	12V AC	After conversion
Receiver Coil Output	9V – 11V	Induced voltage
Charging Current	0.5A – 1A	Based on load
Power Transfer Efficiency	70% – 85%	At optimal alignment
Charging Distance	2 cm – 5 cm	Effective wireless range
Response Time	< 2 seconds	Immediate induction

VI. Conclusion and Future Scope

The proposed solar-powered dynamic wireless charging system for electric vehicles successfully demonstrates an efficient, eco-friendly, and contactless solution to overcome key challenges such as long charging time and limited charging infrastructure. By integrating solar energy with inductive wireless power transfer, the system enables continuous charging while the vehicle is in motion, reducing dependency on conventional grid-based charging stations and minimizing operational downtime. The experimental results confirm that the system provides stable performance with satisfactory efficiency under optimal alignment and distance conditions. In the future, the system can be enhanced by implementing resonant inductive coupling for higher efficiency, advanced coil designs for improved alignment tolerance, and smart control systems using IoT and AI for real-time optimization and monitoring. Additionally, large-scale deployment of road-embedded charging infrastructure and integration with smart grids can further support sustainable transportation and the development of intelligent urban mobility systems.

References

1. Ehsani, M., Gao, Y., & Emadi, A., *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles*, CRC Press, 2010.
2. Chan, C. C., "The State of the Art of Electric and Hybrid Vehicles," *Proceedings of the IEEE*, vol. 95, no. 4, pp. 704–718, 2010.
3. IEA, "Global EV Outlook," International Energy Agency Report, 2021.
4. Tie, S. F., & Tan, C. W., "A Review of Energy Sources and Energy Management System in Electric Vehicles," *Renewable and Sustainable Energy Reviews*, vol. 20, pp. 82–102, 2013.
5. Kurs, A., et al., "Wireless Power Transfer via Strongly Coupled Magnetic Resonances," *Science*, vol. 317, pp. 83–86, 2010.
6. Covic, G. A., & Boys, J. T., "Inductive Power Transfer," *Proceedings of the IEEE*, vol. 101, no. 6, pp. 1276–1289, 2013.
7. Li, S., & Mi, C. C., "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.
8. Bi, Z., et al., "A Review of Wireless Power Transfer for Electric Vehicles: Prospects and Challenges," *Renewable and Sustainable Energy Reviews*, vol. 75, pp. 937–946, 2017.
9. Ahmad, A., et al., "Solar Powered Electric Vehicle Charging System," *International Journal of Engineering Research*, 2018.

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10. Prodduturi, S. M. K. (2024). Legal challenges in regulating AI-powered cybersecurity tools. International Journal of Engineering & Science Research, 14(4), 316-323.
11. Zhang, W., et al., "Frequency Splitting Analysis of Wireless Power Transfer Systems," *IEEE Transactions on Power Electronics*, vol. 30, no. 11, pp. 6091–6103, 2015.
12. Doragacharla, V. R. (2026). Deploying Model Context Protocol Servers in Serverless Environments. Journal of International Crisis and Risk Communication Research, 9(2), 344.
13. Uday Kumar Kalae. (2025). AN AUTOMATED SYSTEM FOR MANAGING HIGH-AVAILABILITY CLOUD INFRASTRUCTURE THROUGH INFRASTRUCTURE-ASCODE (IAC) PRACTICES. American Journal of AI Cyber Computing Management, 5(2), 42–50. https://doi.org/10.64751/ajaccm.2025.v5.n2.pp42-50.
14. Todupunuri, A. (2025). Utilizing Angular for the Implementation of Advanced Banking Features. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.5283395
15. Todupunuri, A. (2025). THE ROLE OF AGENTIC AI AND GENERATIVE AI IN TRANSFORMING MODERN BANKING SERVICES. American Journal of AI Cyber Computing Management, 5(3), 85–93. https://doi.org/10.64751/ajaccm.2025.v5.n3.pp85-93.
16. Sushma Babburi. (2025). Token-Based Data Accounting System For Transparent Model Training And Cost Allocation. American Journal of AI Cyber Computing Management, 5(4), 463–474. https://doi.org/10.64751/ajaccm.2025.v5.n4.pp463-474
17. Mahesh Ganji. (2025). Enhancing Oracle Cloud HR Reporting Through AI-Driven Automation. Journal of Science & Technology, 10(6), 28–36. https://doi.org/10.46243/jst.2025.v10.i06.pp28-36
18. Lu, F., Zhang, H., Hofmann, H., & Mi, C. C., "A Double-Sided LCLC Compensated Wireless Power Transfer System for Electric Vehicles," *IEEE Transactions on Power Electronics*, vol. 30, no. 11, pp. 6011–6014, 2015.
19. Poojari, R. (2026). Privacy-Preserving Generative AI in Healthcare Systems Using Federated Learning Approaches. International Journal of Data Science and IoT Management System, 5(1), 78-88.
20. Mr. Jay Bharat Mehta. (2026). AI-DRIVEN TEST ENGINEERING FOR CLOUD-NATIVE SYSTEMS. International Journal of Data Science and IoT Management System, 5(1). https://doi.org/10.64751/ijdim.2026.v5i1.297.
21. Reddy, S. K. (2025). Hyperpersonalization driven by AI is expected to be at the Lead in shaping the future of loyalty rewards. Journal of Emerging Technologies and Innovative Research.
22. Snigdha Gaddam. (2025). SOFTWARE STACK PREPARED FOR AI TRANSITIONING FROM MODULES TO MODELS. American Journal of AI Cyber Computing Management, 5(4), 451–462. https://doi.org/10.64751/ajaccm.2025.v5.n4.pp451-462.
23. Saikumar, B. (2023). Enhancing Client Engagement through AI-Driven Real-Time Reporting and Automated Alerts. International Journal of Enhanced Research in Science, Technology & Engineering, 12(11), 111–117. https://doi.org/10.55948/ijerste.2023.1115.
24. Miller, J. M., et al., "Demonstrating Dynamic Wireless Charging of Electric Vehicles," *IEEE Transportation Electrification Conference*, 2014.
25. He, Z., et al., "Dynamic Wireless Power Transfer System for Electric Vehicles with Misalignment Tolerance," *IEEE Transactions on Power Electronics*, vol. 34, no. 5, pp. 4046–4056, 2019.

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