IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.311 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 4, April 2026

DOI: 10.17148/IARJSET.2026.134123

Smart Dynamic Wireless Electric vehicle Charging Road Using Radio Frequency Identification and Solar Energy

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Abstract: This project presents an innovative solution for Electric Vehicle (EV) on-road wireless charging using Arduino-based embedded technology. The system aims to overcome the limitations of conventional plug-in charging by enabling dynamic wireless energy transfer while the vehicle is in motion or at specific charging zones. In this project, a robot is used as a prototype of an electric vehicle, demonstrating real-time wireless charging functionality. The system incorporates wireless power transmission coils embedded beneath the road surface, which act as transmitting coils. Corresponding receiving coils are mounted on the electric vehicle to receive energy inductively. The activation of these charging coils is intelligently controlled using an RFID-based vehicle detection mechanism. Each electrical vehicle is equipped with an RFID tag, and when it passes over the road section, the RFID reader detects it and triggers the system. Once detected, relay modules activate the wireless charging coils, ensuring energy is transferred only when required, thereby improving efficiency. Additionally, the system integrates IR sensors to detect vehicle presence and movement, enhancing accuracy in real-time operation. This stored energy is then utilized for wireless charging, making the system environmentally sustainable. A voltage sensor module continuously monitors the voltage levels of the system, ensuring safe and efficient operation while preventing overcharging or power loss. The Arduino microcontroller serves as the central processing unit, coordinating sensor inputs, relay control, RFID detection, and energy management.

Keywords: Wireless Power Transfer, Electric Vehicles (EVs), Arduino-Based System, Radio Frequency Identification Detection, Infrared (IR) sensors, Solar-Powered system, Embedded Technology Dynamic Charging.

I. INTRODUCTION

Electric Vehicles (EVs) are emerging as a sustainable alternative to conventional fuel-based vehicles due to increasing environmental concerns and depletion of fossil fuels. However, one of the major challenges in EV adoption is the lack of efficient and convenient charging infrastructure. Traditional charging systems require vehicles to remain stationary for long durations, which reduces usability and flexibility.In this project, an advanced wireless charging road system is designed using Arduino technology, RFID-based vehicle identification, and solar energy integration. The system ensures automatic charging only when required, reducing power wastage and improving efficiency.

II. BACKGROUND AND MOTIVATION

A. Overview of Electric Vehicle Charging Systems

Electric Vehicles (EVs) are becoming an essential part of modern transportation due to their eco-friendly nature and reduced carbon emissions. However, the current charging infrastructure mainly depends on plug-in systems, which require vehicles to stop and connect physically. These systems are time-consuming and may not be convenient for users, especially during long journeys.Wireless power transfer technology offers a promising alternative by enabling energy transfer without direct contact. When integrated with embedded systems and sensors, it can improve charging efficiency and user experience.

B. Challenges in Existing Charging Methods

Despite the advancements in EV technology, several challenges still exist in current charging systems. Traditional methods involve long waiting times and limited availability of charging stations. Additionally, the dependency on grid electricity increases load and affects sustainability.

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C. Need for Smart and Sustainable Solution

To support the increasing demand for EVs, there is a need for an advanced charging system that is automatic, efficient, and environmentally friendly. A dynamic wireless charging system can provide continuous power supply without requiring vehicles to stop.By integrating technologies such as RFID for vehicle identification, IR sensors for detection, and solar energy for power generation, the system ensures optimized energy usage and reduced wastage. This approach contributes to the development of smart transportation and sustainable energy solutions.

III. LITERATURE REVIEW

The development of efficient charging systems for Electric Vehicles (EVs) has been widely researched in recent years, focusing on improving convenience, efficiency, and sustainability. Various technologies such as wireless power transfer, dynamic charging, RFID-based automation, and renewable energy integration have been explored.

A.Wireless Power Transfer (WPT) Technologies

Wireless charging for EVs is primarily based on inductive coupling and resonant inductive coupling. Inductive coupling works effectively over short distances and is widely used in stationary wireless charging systems. However, its efficiency decreases with distance and misalignment between coils. To overcome this, resonant inductive coupling has been introduced, which improves energy transfer efficiency and allows slight misalignment between transmitter and receiver coils.Several studies demonstrate that WPT systems can achieve efficiencies between 80%–90% under optimized conditions.

B. Dynamic Wireless Charging Systems

Dynamic charging systems are designed to charge EVs while they are in motion by embedding transmitting coils beneath road surfaces. Research shows that such systems can significantly reduce battery size requirements and eliminate range anxiety.Projects like dynamic charging lanes have been tested in some countries, proving the feasibility of continuous charging. However, these systems require complex infrastructure, precise vehicle alignment, and efficient control mechanisms to avoid unnecessary power transfer.

C. RFID-Based Vehicle Identification Systems

Radio Frequency Identification (RFID) technology is widely used in smart transportation systems for automatic vehicle identification. In EV charging applications, RFID helps in:

- Identifying authorized vehicles
- Enabling selective charging
- Monitoring energy usage

Research indicates that RFID improves system automation and prevents unauthorized access. However, it must be integrated with a reliable control system to ensure accuracy and security.

D. Research Gaps Identified

From the above studies, the following gaps are identified:

- Lack of integration of multiple technologies in a single system
- High cost and complexity of dynamic charging infrastructure
- Energy losses in wireless power transfer
- Limited use of renewable energy in dynamic systems
- Insufficient automation in existing charging methods

IV. EXISTING SYSTEM

Current EV charging systems are mainly categorized into:

1. **Level 1 Charging:** Slow charging using household power supply
2. **Level 2 Charging:** Faster charging using dedicated stations
3. **DC Fast Charging:** Rapid charging but expensive and not widely available

V. PROPOSED SYSTEM

The system charges electric vehicles wirelessly without using cables. Coils are placed under the road and on the vehicle to transfer power. When a vehicle comes, RFID identifies it and IR sensors detect it. Then the Arduino turns on the charging automatically. Solar panels provide power, and a battery stores it. A voltage sensor keeps charging safe. This method is simple, automatic, and eco-friendly.

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Working Principle:

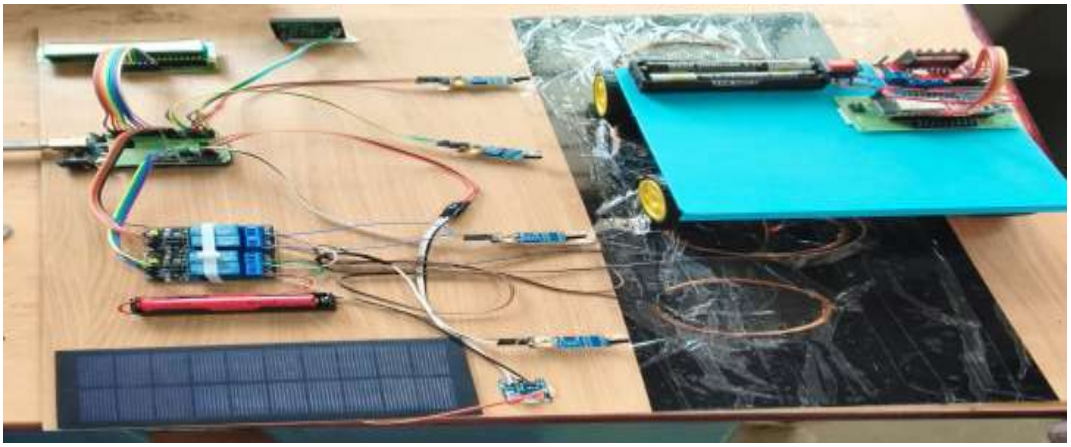
When a vehicle enters the charging zone:

1. RFID identifies the vehicle
2. IR sensors detect its presence
3. Arduino activates the relay
4. Power is transferred wirelessly
5. Voltage sensor ensures safe charging

This system is automatic, efficient, and reduces energy wastage.

VI. RESULTS

The system worked well and showed that wireless charging is possible. The vehicle model was able to receive power while moving. RFID helped identify the vehicle, and IR sensors detected its presence correctly. The solar panel provided power, and the system charged safely without energy loss. Overall, the project was successful and works as a simple and efficient EV charging solution. Impact on Develops and Continuous Delivery: A more thorough examination of the effects of micro front ends on DevOps and continuous delivery can yield some pretty profound insights into dealing with scalability and maintenance problems more efficiently.



VII. CONCLUSION

The proposed smart dynamic wireless EV charging system provides an effective solution to the limitations of traditional charging methods. It allows vehicles to charge wirelessly without the need for physical connections, improving convenience and saving time. By using RFID for identification, IR sensors for detection, and solar energy as a power source, the system ensures efficient, automatic, and eco-friendly operation. The successful implementation of the prototype shows that the system is reliable and suitable for future development. Overall, this project supports the advancement of smart and sustainable electric vehicle charging infrastructure.

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