JSRT JOURNAL
PAGES: 112-117
26/06/25
JOURNAL OF SCIENTIFIC RESEARCH AND TECHNOLOGY VOLUME-3 ISSUE-6 JUNE

Wireless Solar Electric Vehicle Charging System

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ABSTRACT

As the global demand for electric vehicles (EVs) continues to rise, the infrastructure supporting these vehicles must evolve to meet the growing need for efficient, user-friendly, and sustainable charging solutions. Traditional wired charging systems present several challenges, including cable wear and tear, manual connection inconvenience, and vulnerability to environmental hazards. To address these issues, a solar wireless EV charging system is proposed, integrating wireless charging technology with renewable energy sources to provide an innovative and eco-friendly charging solution. The system utilizes solar panels to capture and store energy, ensuring an environmentally friendly power supply independent of the grid. A key feature of this system is its use of inductive wireless charging, which eliminates physical connectors, thereby reducing maintenance costs and minimizing exposure risks. RFID technology is incorporated to provide secure user authentication and payment processing, enabling an automated and frictionless user experience. Ultrasonic sensors are employed to detect the presence of vehicles at the charging station, triggering system readiness without handling vehicle alignment. An automated gate control mechanism powered by servo motors ensures that only authorized vehicles gain access to the charging station. Real-time charging progress is displayed on an LCD interface, allowing users to monitor their charging status conveniently. A buzzer provides distinct auditory feedback a single beep upon authorized RFID scanning, three quick beeps for unauthorized access attempts, and a long beep to indicate charging commencement or completion. Additionally, a smart relay controls the power flow. By integrating these advanced features, the proposed system enhances the EV charging experience, making it more efficient, secure, and user-friendly. Furthermore, this solution contributes to global sustainability goals by utilizing clean, renewable solar energy and reducing dependence on conventional power grids.

Keywords: Solar, EV's, Charging System.

I. INTRODUCTION

The rapid growth in the adoption of Electric Vehicles (EVs) is driven by increasing environmental awareness, governmental incentives, and advancements in battery technology. However, the supporting infrastructure, especially the charging systems, needs parallel innovation to keep pace with this surge. Conventional wired charging systems pose challenges such as cable wear and tear, manual plugging difficulties, and exposure to environmental hazards. To overcome these limitations, wireless charging technology has emerged as a promising alternative, offering convenience, safety, and reduced maintenance.

This project proposes a Wireless Solar EV Charging System that combines renewable solar energy with an advanced wireless charging mechanism. By integrating smart modules such as RFID for secure payment authentication, ultrasonic sensors to detect a vehicle, and servo motors for automated gate control, the system ensures an efficient and user-friendly charging process. The inclusion of a relay module for power control and an LCD with an I2C interface for real-time status updates, including charging percentage display, further enhances the user experience. This solution not only addresses the current limitations of EV charging but also aligns with global sustainability goals by promoting the use of clean energy sources.

II. LITERATURE SURVEY

1. State-of-the-Art Research on Wireless Charging of Electric Vehicles Using Solar Energy.

Seyed Ali Kashani, Alireza Soleimani, Ali Khosravi, Mojtaba Mirsalim. This paper provides a comprehensive review of the state-of-the-art technologies in wireless charging for electric vehicles (EVs) powered by solar energy. It delves into various wireless power transfer methods, such as inductive and resonant charging, and evaluates their efficiency when coupled with solar energy systems. The authors also discuss the potential for integrating these systems into smart grids and the future prospects of solar EV charging solutions.

2. Solar-Integrated Wireless Charging System for Electric Vehicles.

Harpreet Kaur Channi, Meena Malik, Chin-Ling Chen, Hsing-Chung Chen, Ramandeep Sandhu, Chander Prabha. This paper discusses the integration of solar power into wireless EV charging systems, highlighting the combination of

renewable energy and wireless power transfer technologies. The authors propose a solar-powered wireless EV charging station design, examining the technical architecture, system performance, and efficiency improvements. It also covers the environmental benefits of utilizing solar energy for EV charging.

3. Wireless Charging Technologies: Fundamentals, Standards, and Network Applications.

Xiao Lu, Ping Wang, Dusit Niyato, Dong In Kim, Zhu Han. This paper offers a detailed survey of wireless charging technologies, providing a strong foundational understanding of the principles of wireless power transfer (WPT). It covers various techniques for EV wireless charging and discusses the challenges, standards, and networking applications that integrate EV charging systems with broader smart city and grid frameworks. The review also addresses the potential future trends of WPT technology.

4. Wireless Power Transfer: Survey and Roadmap.

Xiaolin Mou, Hongjian Sun. This comprehensive survey covers the fundamentals and developments in wireless power transfer (WPT) technology, with a focus on wireless charging for electric vehicles. The paper examines the physics behind WPT, different types of power transfer systems, and their specific applications in EV charging. The authors also outline a roadmap for the development of wireless power systems, addressing scalability, efficiency, and integration challenges.

5. Wireless Electric Vehicle Charging System Using Solar Energy.

W. He, Z. Liu. This research explores the design and development of a wireless electric vehicle charging system that utilizes solar energy as a power source. The paper discusses the system's architecture, focusing on energy conversion and transfer efficiency, and provides simulations and performance analysis to demonstrate its viability. The authors highlight the potential of combining renewable solar energy with wireless charging to create sustainable EV charging stations.

6. Solar-Based Wireless Charging Station for EV.

Pooja S. Chobe, Munjal Piyush Nanasaheb, Jadhav Vaishnavi Sanjay, Raktate Sonal Bhausahab, Tayade Sangharsh Ashok, D. B. Pardeshi. This paper presents a detailed design for a solar-based wireless EV charging station. The authors discuss the system's components, including solar panels, wireless power transfer mechanisms, and energy storage systems. They evaluate the system's efficiency and cost-effectiveness in providing sustainable EV charging solutions, emphasizing the environmental benefits of reducing grid dependency and integrating solar power with wireless technologies.

7. Review on Wireless EV Charging Systems.

A.Sh. Safonov, T. A. Khasanov, Z. M. Shakurova, A. R. Safin, L. V. Dolomanyuk, V. A. Gavrilov. This review paper focuses on the different types of wireless EV charging systems, covering inductive and resonant charging technologies. It compares their efficiency, advantages, and challenges in integrating with solar energy sources. The paper also discusses the potential for wireless charging infrastructure in smart cities, addressing technical and regulatory hurdles.

8. Solar Wireless Electric Vehicle Charging System.

O.P. Suresh, Salava V. Satyanarayana, P. Hema Bindu, K. Anand, N. Srujith Kumar, V. Sujith. This paper explores a solar-powered wireless EV charging system, focusing on how solar panels can be integrated with wireless charging technology to power electric vehicles. The authors present a design for an efficient energy conversion and storage system that ensures continuous charging even under variable sunlight conditions. They evaluate the performance and potential scalability of such systems in urban environments.

9. Solar-Driven Wireless Charging: Innovations in Electric Vehicle Energy Systems.

Ali Nofal Abd Ali Al-Musawi, Divya Shree V, Ashish Nema, D. Little Femilinjana, Ankita Joshi, R. Vimala Devi.This paper discusses innovations in solar-driven wireless charging systems for EVs, focusing on energy efficiency, sustainability, and the integration of solar power into wireless charging technologies. The authors examine different designs for wireless charging pads and energy management systems that optimize solar energy utilization for EVs.

10. Wireless EV Charging System Integrated with Smart Streetlight.

Preeti Bhat, Nithin N S, Rohan Satish, Pavan C A. This paper explores the integration of wireless EV charging systems with smart streetlights. The authors propose a novel design in which streetlight poles are equipped with wireless charging pads for EVs, utilizing solar panels to power both the streetlight and the EV charging system. The paper discusses the feasibility, benefits, and challenges of such an integration in smart city environments.

11. Solar-Powered Wireless Charging of Electric Vehicles

S. S. Rajput, M. R. Khan, M. S. Al-Haddad. This comprehensive review explores the principles, system components, and control strategies of solar-powered wireless charging for EVs. It discusses the current state of research and development in this field, highlighting challenges and future prospects.

12. Optimal Design of Solar-Powered Wireless Charging System for Electric Vehicles.

M. N. Islam, S. S. Rajput, M. R. Khan. This research presents an optimal design methodology for a solar-powered wireless charging system, considering factors like system efficiency, cost, and environmental impact. A case study demonstrates the effectiveness of the proposed methodology.

13. Wireless Solar Charging Systems for Electric Vehicles: Technology, Design, and Implementation Challenges.

Arya Shukla, Smita S. Palnitkar, Avdhut Ranaware, Swapnil Gurme This paper discusses the technology, design considerations, and implementation challenges of wireless solar charging systems for EVs. It emphasizes the need for efficient energy conversion and addresses issues related to environmental conditions.

14. Design and Analysis of Solar-Powered Wireless Charging System for Electric Vehicles.

H. S. A. Rahman, M. I. K. Ahamed, R. M. S. T. P. S. Kumar. This paper discusses the design, analysis, and performance evaluation of a solar-powered wireless charging system for electric vehicles. It covers the technical challenges in achieving efficient energy transfer and highlights potential solutions to enhance system performance, including power electronics and energy management strategies. The authors also evaluate the cost-effectiveness and scalability of the system for large-scale implementation.

15. A Review on Solar-Powered Wireless EV Charging System and Its Integration with Smart Grid.

M. A. G. Abolhasani, M. Z. S. Rajabi, A. M. S. H. H. Maleki. This review explores the integration of solar-powered wireless EV charging systems with smart grid technology. The authors delve into the challenges of system integration, including power distribution, energy storage, and the role of renewable energy in grid management. They also review advancements in wireless power transfer (WPT) techniques and their impact on smart cities and sustainable energy solutions.

III METHODOLOGY

3.1 Existing System:

The current EV charging systems are predominantly wired solutions where users manually plug their vehicles into a charging station. These setups are often dependent on grid power, leading to higher operational costs and increased dependency on non-renewable energy sources. Payment is typically handled through mobile apps or point-of-sale devices, which can sometimes be cumbersome for users. Moreover, existing systems lack automated vehicle alignment, which is critical for efficient wireless charging. Gate control and security measures are minimal, leading to possible misuse or unauthorized access.

3.2 Proposed System:

The proposed Wireless Solar EV Charging System addresses the limitations of existing models by integrating solar energy, wireless charging technology, and automation features. Using RFID technology, users can authenticate and process payments securely. An ultrasonic sensor detects vehicle presence. A servo motor automates gate operation for authorized vehicles, enhancing security. Charging progress, including real-time percentage, is displayed on an LCD screen via an I2C interface. A relay module controls the safe transfer of power from the solar-charged battery to the vehicle. This system minimizes human intervention, enhances user convenience, promotes renewable energy, and ensures secure transactions.

3.3 System Study

3.3.1 Feasibility Study

- **Technical Feasibility:** The system components — RFID modules, ultrasonic sensors, servo motors, LCD displays, relay circuits, and wireless charging coils are readily available and can be integrated using a microcontroller platform. Solar energy harvesting is technically viable with existing photovoltaic panel technologies.

- **Economic Feasibility:** Initial setup costs are balanced by long-term savings through solar energy use. The system is designed to reduce maintenance costs by minimizing moving parts and eliminating plug-in mechanisms.
- **Operational Feasibility:** Automated processes make the system user-friendly and efficient. RFID authentication and real-time feedback reduce user errors and improve transaction reliability.
- **Schedule Feasibility:** Given the availability of components and modular system design, the project can be implemented within a reasonable timeframe.

3.3.2 System Design:

- **Block diagram:**

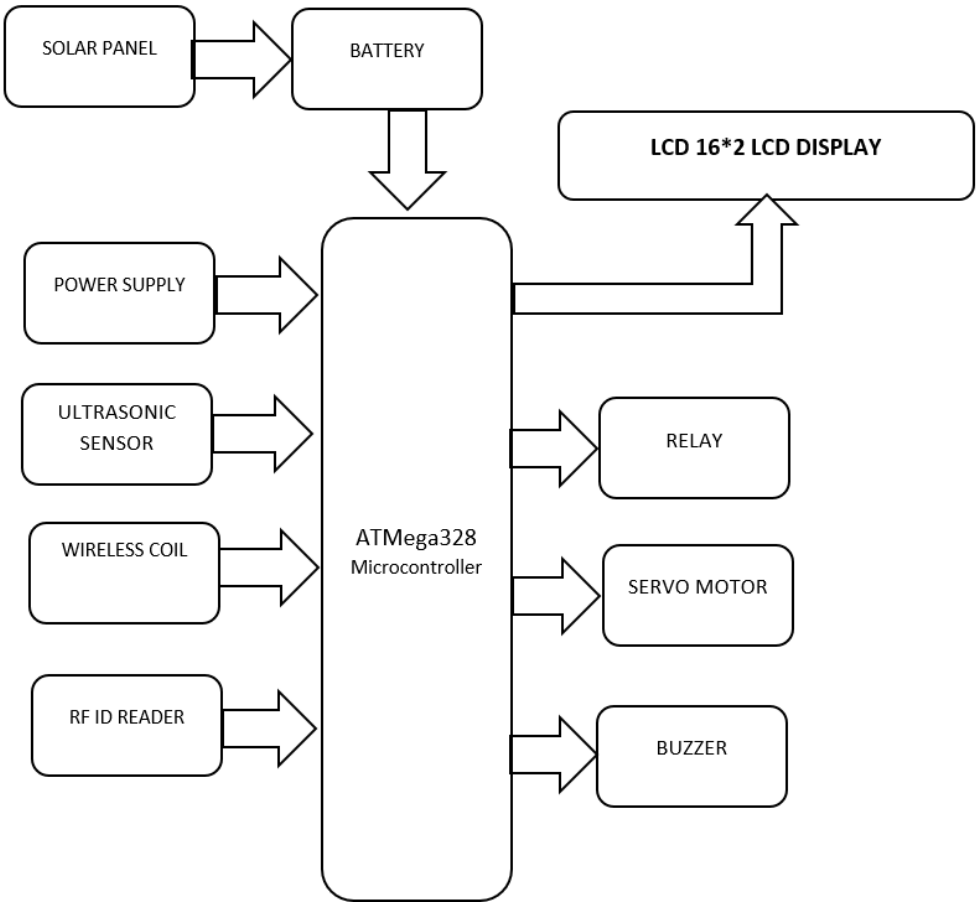

Figure.3.3.1: Block diagram

- **Flow Chart**:

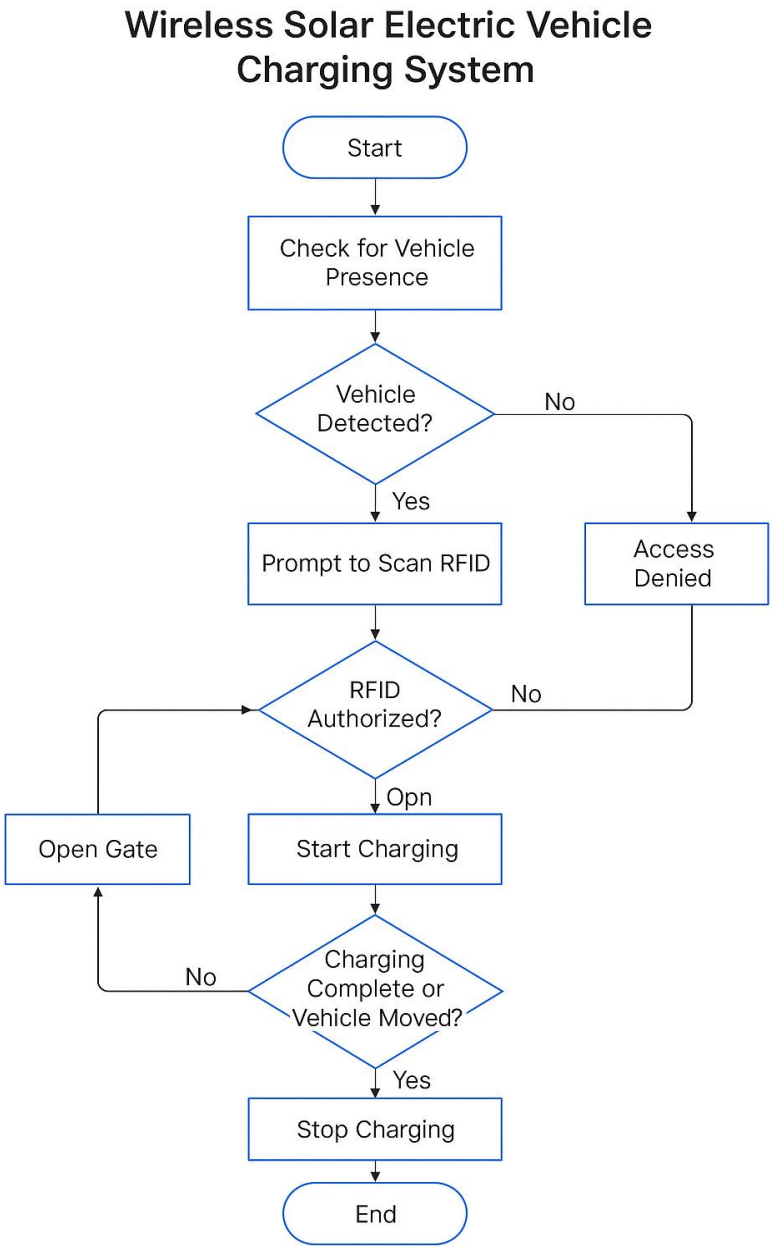

Figure.3.3.2: Flow Chart

IV. ADVANTAGES AND DISADVANTAGES

4.1 Advantages:

- Eco-Friendly: Uses renewable solar energy.
- Wireless: No physical plug needed, reducing wear and tear.
- Smart & Secure: Uses RFID for authentication and payment.
- Automated: Servo and sensors ensure gate operation and alignment without manual intervention.
- User Feedback: LCD displays real-time charging percentage.

4.2 Disadvantages:

- Weather Dependency: Solar power generation is affected by weather conditions.

- Limited Range: The system is suitable for static (stationary) charging, not for dynamic on-road charging.

V. POSSIBLE OUTCOMES

The Solar Wireless EV Charging System is expected to deliver several positive outcomes, benefiting both users and the environment:

1. Enhanced Convenience: Eliminates manual plugging, offering a user-friendly wireless charging experience.
2. Eco-Friendly Operation: Uses solar energy, reducing carbon emissions and grid dependency.
3. Secure Payment Process: RFID integration ensures secure and automated transactions.
4. Automated Gate and Alignment: Servo motors and sensors minimize manual intervention.
5. Real-Time Feedback: LCD displays charging percentage for efficient user monitoring.
6. Improved Charging Efficiency: Wireless transfer reduces wear and enables remote charging.
7. Cost Savings for Users: Solar energy lowers operational costs.

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