IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 2, September 2025
Impact Factor: 7.67

IoT-Based Wireless Solar EV Station

Dr. Shiva Kumar V[1] and M Raghavendra[2]
Associate Professor, Department of Computer Science and Engineering[1]
PG Student, Department of Computer Science and Engineering[2]
Kishkinda University, Ballari, India

Abstract: *To promote sustainable transportation and reduce reliance on polluting fossil fuels, this project aims to develop an eco-friendly electric vehicle (EV) charging system. With the increasing adoption of EVs, the need for clean and efficient charging solutions has become imperative. However, current EV charging systems often rely on grid electricity generated from fossil fuels and use cumbersome cables that wear out over time. Moreover, these systems lack real-time monitoring and optimization capabilities. To address these issues, we have implemented a smart EV charging system that harnesses solar energy and utilizes wireless charging technology controlled by an Arduino microcontroller. The system enables efficient and cable-free power transfer to EVs. This innovative solution has applications in sustainable transportation systems, offering advantages such as reduced greenhouse gas emissions, increased convenience, and improved energy efficiency. By optimizing EV charging, our system contributes to a cleaner and more sustainable future*

Keywords: Electric Vehicles (EVs), Wireless Charging, Solar Energy, Photovoltaic (PV) Panels, IoT, Arduino UNO, ESP8266, ThingSpeak, MPPT Controller, DC-DC Booster, Copper Coils, IR Sensor, LCD Display, Renewable Energy, Sustainable Transportation, Real-time Monitoring, Smart Charging Infrastructure, User Convenience, Scalability, Eco-Friendly Design

I. INTRODUCTION

Electric vehicles (EVs) have become a promising alternative for sustainable transportation, driven by the urgent global need to cut carbon emissions. Their successful adoption, however, is closely linked to the development of reliable and accessible charging infrastructure. Traditional charging systems that rely on physical connectors present several drawbacks, such as inconvenience for users, limited scalability, increased maintenance requirements, and negative impacts on urban aesthetics. These issues highlight the necessity for more advanced charging solutions that are efficient, practical, and environmentally sustainable.

Wireless power transfer technology has emerged as a viable approach to overcoming these challenges. By enabling electric vehicles to charge without direct physical contact, it offers enhanced convenience, flexibility, and ease of use. When combined with renewable energy sources such as solar power, wireless charging systems not only reduce dependence on grid electricity but also contribute to environmental sustainability. In this context, the present work proposes the design and development of a solar rooftop wireless charging station for electric vehicles, incorporating Arduino-based control technologies to ensure intelligent and efficient operation.

The system makes use of photovoltaic (PV) panels to capture solar energy and employs wireless charging coils for energy transfer. Arduino microcontrollers and power management modules are integrated to allow real-time monitoring and intelligent adjustment of charging parameters. This design enables the station to adapt dynamically to variations in sunlight availability and battery status, resulting in improved efficiency, reliability, and adaptability.

Applications of this model extend across multiple domains, including efficiency through optimized protocols, scalability to support growing EV adoption, reliability with backup systems, data security, compatibility with different EV models, and compliance with regulatory requirements.

Despite the advantages, several challenges remain to be addressed. These include the limited availability of charging stations in many regions, the relatively higher cost of electric vehicles and batteries compared to conventional vehicles, and the lower driving range of mid-range EVs. Furthermore, while EVs significantly reduce direct emissions, they are not entirely free from environmental impact, as battery production and electricity generation can still contribute to indirect pollution. Overcoming these barriers is critical to ensuring widespread adoption of EVs and their supporting infrastructure.

The development of a solar rooftop wireless charging station represents a meaningful step toward integrating renewable energy with intelligent control systems for sustainable mobility. By combining innovation with environmental stewardship, this approach has the potential to transform charging infrastructure and support the transition to cleaner, more efficient transportation solutions.

II. OBJECTIVE OF THE PROJECT

- To develop a solar-powered wireless charging system that utilizes photovoltaic (PV) panels to harness renewable energy for electric vehicle charging.
- To eliminate the need for physical connectors, thereby improving user convenience, reducing wear and tear of charging equipment, and enhancing system reliability.
- To reduce dependence on fossil fuels by incorporating clean and renewable energy sources, thus contributing to environmental sustainability.
- To enable real-time IoT-based monitoring and control, using Arduino microcontrollers for intelligent energy management, efficient utilization of solar power, and improved system adaptability.

An easy way to comply with the Journal paper formatting requirements is to use this document as a template and simply type your text into it.

III. LITERATURE SURVEY

TITLE: A Comprehensive Evaluation of Solar Powered Electric Vehicle Charging Station Design Using Internet of Things

Chun T. Rim and Chris Mi (IEEE Press / Wiley, 2017) provide a comprehensive foundation on wireless power transfer (WPT) technologies for electric vehicles (EVs) and mobile devices, covering inductive coupling, magnetic resonance, and capacitive coupling techniques while analyzing system design principles, coil structures, alignment tolerances, and power electronics integration. The book discusses both static and dynamic wireless charging methods, supported by case studies and practical design examples, making it a valuable resource for understanding the theoretical and practical aspects of WPT. However, its limitations include the fact that it predates recent advancements in high-efficiency WPT technologies that achieve over 90% efficiency at higher kW levels, and it does not address IoT integration or real-time communication systems, which have become increasingly critical in EV charging research between 2023 and 2025.

TITLE: Integrated Technologies in Electrical, Electronics and Biotechnology Engineering

Aggarwal, Gaurav, along with co-editors, present a comprehensive volume titled Integrated Technologies in Electrical, Electronics and Biotechnology Engineering published by Taylor & Francis Group in 2025. The book brings together advancements across multiple disciplines, highlighting how integrated approaches in electrical and electronic engineering can be applied to address emerging challenges in power systems, automation, and sustainable energy solutions. It discusses theoretical concepts, applied case studies, and technological frameworks that connect electrical and electronic engineering with biotechnology, providing an interdisciplinary perspective. While the work delivers broad insights into integrated technologies, it is not specifically tailored to electric vehicle (EV) charging infrastructure, and therefore lacks focused design and implementation strategies for EV-based applications. Nonetheless, the resource offers a valuable foundation for adopting cross-disciplinary methods, and its principles can be extended to EV charging by integrating solar energy systems, IoT-based monitoring, and wireless power transfer to create efficient, modern, and sustainable charging solutions.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 2, September 2025
Impact Factor: 7.67

TITLE: A Comprehensive Review on Internet of Things Applications in Power Systems

Majhi, Abhilash Asit Kumar, and Sanjeeb Mohanty, in the IEEE Internet of Things Journal (2024), review IoT applications in power systems, focusing on smart grids, renewable integration, demand management, and reliability. The study highlights how IoT enables real-time monitoring, predictive analytics, and intelligent control for efficient power operation. While comprehensive, it is generalized for power systems and does not directly address EV charging. Its insights, however, provide a strong basis for extending IoT into EV charging infrastructure, enabling real-time monitoring, predictive maintenance, and optimized energy use.

Table I: Literature Survey Review

Paper Title / Source	KEY FINDINGS / WORK DONE	LIMITATIONS	PROPOSED UPGRADATION IN OUR PROJECT
Chitra, K., et al. A Comprehensive Evaluation of Solar Powered Electric Vehicle Charging Station Design Using IoT (ICECSP, IEEE, 2024)	Designed and evaluated a solar-powered EV charging station with IoT-based monitoring for better energy management.	Limited scalability; efficiency depends on solar availability; lacks wireless charging integration.	Add wireless charging, MPPT control, and advanced IoT analytics for fault detection and optimization.
Aggarwal, Gaurav, et al., Integrated Technologies in Electrical, Electronics and Biotechnology Engineering (Taylor & Francis, 2025)	Provides insights into integrated emerging technologies across power, electronics, and IoT applications.	Generalized framework; not specifically targeted at EV charging systems.	Apply integrated approaches directly to EV charging—combining IoT, solar PV, and wireless systems.
Majhi, Abhilash Asit Kumar, and Sanjeeb Mohanty, A comprehensive review on IoT applications in power systems (IEEE IoT Journal, 2024)	Reviewed IoT applications for smart grids, monitoring, and power optimization.	Focused more on power systems, less on EV-specific applications.	Adapt IoT-based monitoring and predictive analytics to optimize EV charging infrastructure.
Tripathi, Nishant, et al., Performance analysis of clustering algorithms in wireless camera sensor networks (Distributed Intelligent Circuits and Systems, 2024)	Analyzed clustering algorithms for energy-efficient communication in wireless sensor networks.	Focused on WSNs, not directly on EVs; no hardware implementation.	Use clustering algorithms to enhance energy efficiency and communication in IoT-enabled EV charging networks.
Solar Wireless EV Charging Design – IJSER, Bugatha Ram Vara Prasad	Gave a plan for wireless charging using solar.	No actual working system; no live monitoring.	Build a full working prototype with display and IoT features.

Summary:

The reviewed literature highlights significant progress in solar-powered charging, wireless power transfer, and IoT-based monitoring, each contributing to the development of modern EV charging systems. Chitra et al. (2024) demonstrate IoT-enabled solar charging stations but face scalability and efficiency challenges, while broader works like Aggarwal et al. (2025) and Majhi & Mohanty (2024) provide insights into IoT and power system integration without direct EV applications. Tripathi et al. (2024) focus on clustering algorithms for energy-efficient wireless sensor networks, offering methods adaptable to EV charging IoT frameworks. Foundational studies by Rim & Mi (2017) and Kurs et al. (2007) establish principles of wireless power transfer, yet remain limited by outdated efficiency benchmarks and lab-based demonstrations. Collectively, these works reveal that while solar, IoT, and wireless technologies are well explored individually, they lack an integrated, real-world, and cost-effective solution—gaps our project seeks to fill by combining solar energy harvesting, high-efficiency wireless charging, and IoT-driven real-time monitoring into a unified and scalable EV charging system.

IV. PROBLEM STATEMENT

To design and develop a smart, sustainable, and user-friendly EV charging infrastructure aimed at reducing reliance on fossil-fuel-based grid electricity by integrating renewable energy sources, minimizing the limitations and safety hazards of physical connectors, and enabling real-time operational insights to support the growing adoption of electric vehicles.

V. METHODOLOGY

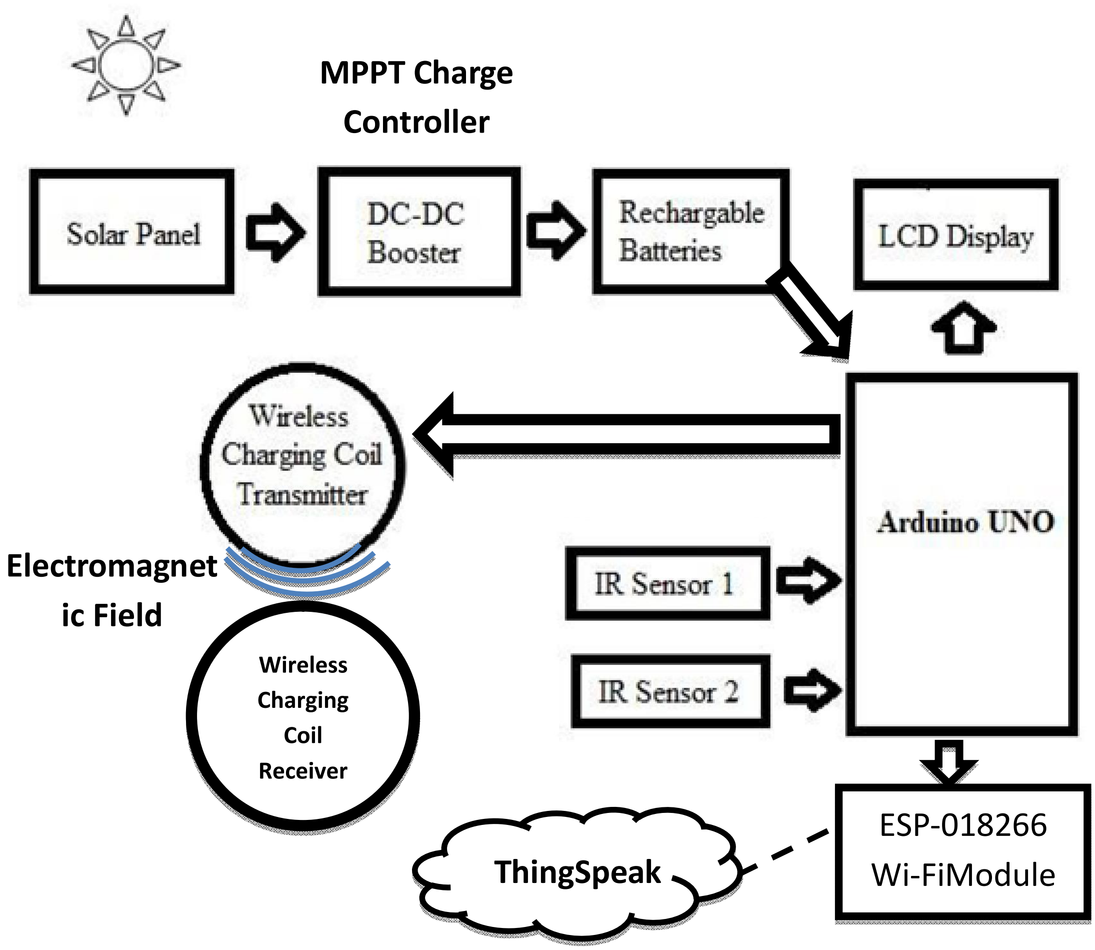

Fig. 1 Block Diagram

The proposed solar-powered wireless charging system for electric vehicles is designed to maximize renewable energy utilization while offering convenient real-time monitoring. The methodology is structured into four stages:

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 2, September 2025
Impact Factor: 7.67

Stage 1: Solar-Powered EV Charging

The EV battery is powered through photovoltaic (PV) panels that generate electricity from sunlight. To optimize energy transfer, the system incorporates a Maximum Power Point Tracking (MPPT) DC-DC booster converter, which continuously regulates and boosts the panel output to meet the required charging voltage. This ensures that the panels consistently operate at their optimal power point, even under varying sunlight conditions.

Stage 2: System Monitoring via Arduino UNO

An Arduino UNO R3 microcontroller acts as the central control unit. It receives operational data from the MPPT module and processes signals related to charging progress and system performance. The Arduino then drives an LCD display, which provides local real-time updates on the charging process, enabling users to easily monitor system activity without the need for additional sensors.

Stage 3: IoT-Based Real-Time Monitoring (ThingSpeak Application)

To extend functionality, the Arduino is connected to an ESP8266 Wi-Fi module, which transmits system data to the ThingSpeak IoT platform. Parameters such as charging progress, system uptime, and station availability are uploaded in real time. This allows users to remotely access information via the ThingSpeak dashboard or mobile application, ensuring improved accessibility and user convenience.

Stage 4: Charging Status and Station Availability Display

The system provides local feedback through the LCD screen, displaying details of charging progress and the operational condition of the station. At the same time, IoT integration enables remote users to check whether the charging station is available and active, supporting better planning and utilization of the infrastructure.

VI. REQUIREMENTS

Hardware Requirements

- Arduino Uno
- 16x2 LCD (Liquid Crystal Display)
- DC_DC Booster
- Copper Coils
- Solar panel
- Rechargeable Battery
- ESP-01 8266 is a Wi-Fi module

Software Requirements

- Arduino Ide
- Embedded C
- ThingSpeak IoT Platform

Functional Requirements

- The system should charge EV batteries wirelessly using inductive coupling.
- The MPPT controller must ensure maximum efficiency in power transfer from solar panels.
- The Arduino UNO should control and monitor charging operations in real time.
- The ESP8266 Wi-Fi module must upload key charging data to the ThingSpeak IoT platform.
- The LCD screen should display local charging progress and station availability.
- The system must ensure safe charging, with protective mechanisms against overcharging, under-voltage, or short circuits.

Non-Functional Requirements

- Scalability – The design should allow expansion to larger charging networks.
- Reliability – Continuous operation under varying sunlight conditions.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 2, September 2025
Impact Factor: 7.67

- User Friendliness – Easy access to charging status locally and remotely.
- Eco-Friendliness – Reduced dependency on grid power and fossil fuels.
- Cost-Effectiveness – Affordable design to encourage widespread adoption

VII. SYSTEM FLOWCHART

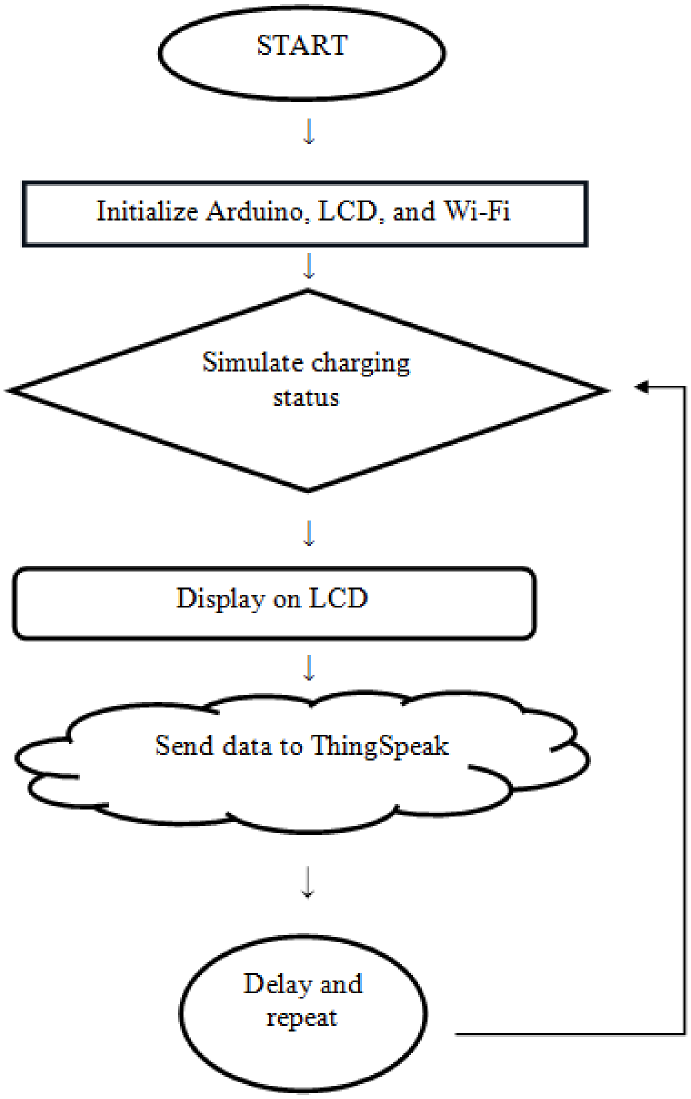

Fig. 2 System Flow Diagram

VIII. RESULTS & DISCUSSIONS

The IoT-based solar EV station collects solar energy through photovoltaic panels, converts it into electrical energy, and stores it in rechargeable batteries. Arduino acts as the central controller, coordinating all devices in the system. When a vehicle arrives at slot 1, the IR sensor detects its presence and signals the system to draw power from the rechargeable batteries to charge the vehicle. Once the vehicle battery is fully charged, the system automatically stops charging, and the slot becomes available for the next vehicle. The same operation takes place in slot 2, where the IR sensor identifies the vehicle, initiates charging, and terminates once the charge cycle is completed.

To enhance functionality, the system is integrated with an ESP-01 Wi-Fi module that connects to the ThingSpeak IoT platform. This enables real-time monitoring of charging station activity remotely. Users can check the availability of parking slots, identify which slots are engaged, and track the charging progress through ThingSpeak's online dashboard. Additionally, the system generates a time vs. charge status graph for the current day, providing insights into charging patterns and station usage. This integration improves accessibility, user convenience, and transparency, making the solar EV station smarter and more reliable.

The results of the IOT Based EV Station is as shown below

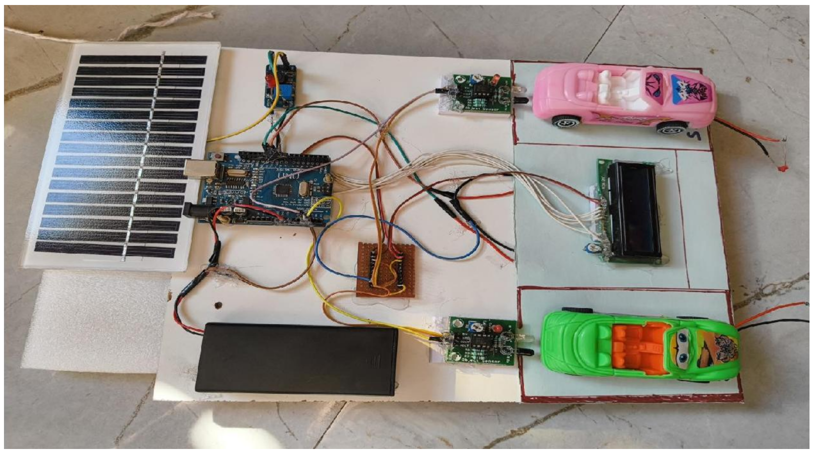

Fig. 3 Model for the proposed System

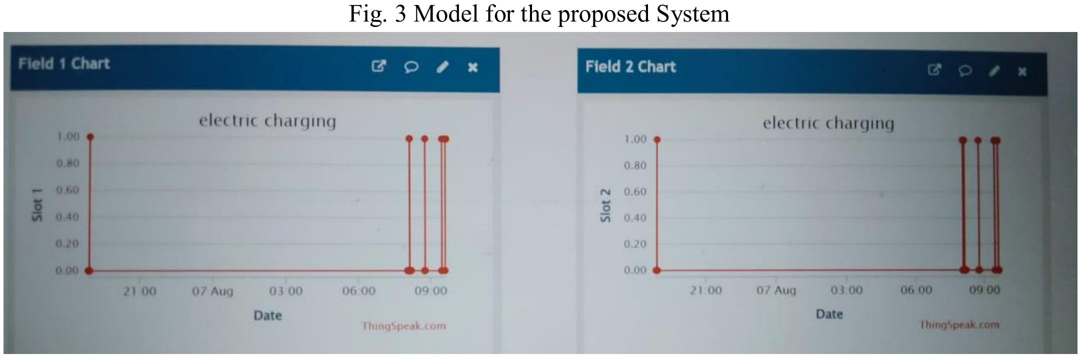

Fig. 4 parking slots 1 and 2 on ThingSpeak IoT platform

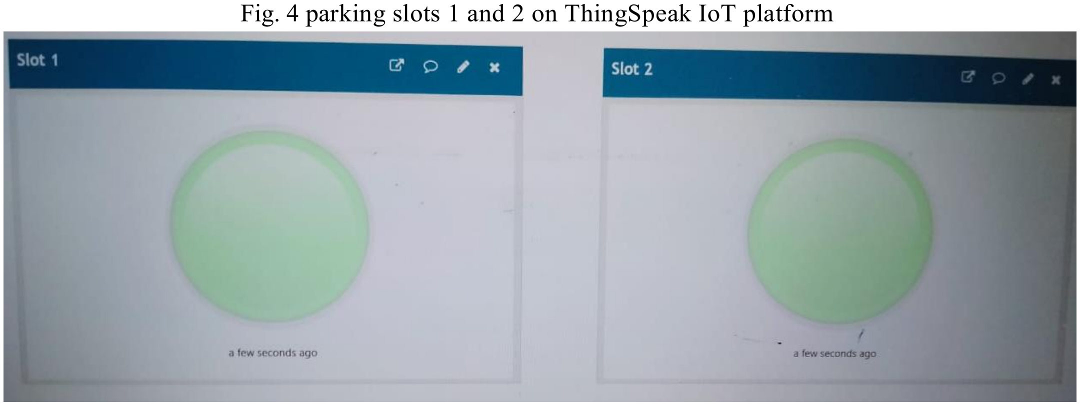

Fig. 5parking slots 1 and 2 on ThingSpeak IoT platform

DOI: 10.48175/568

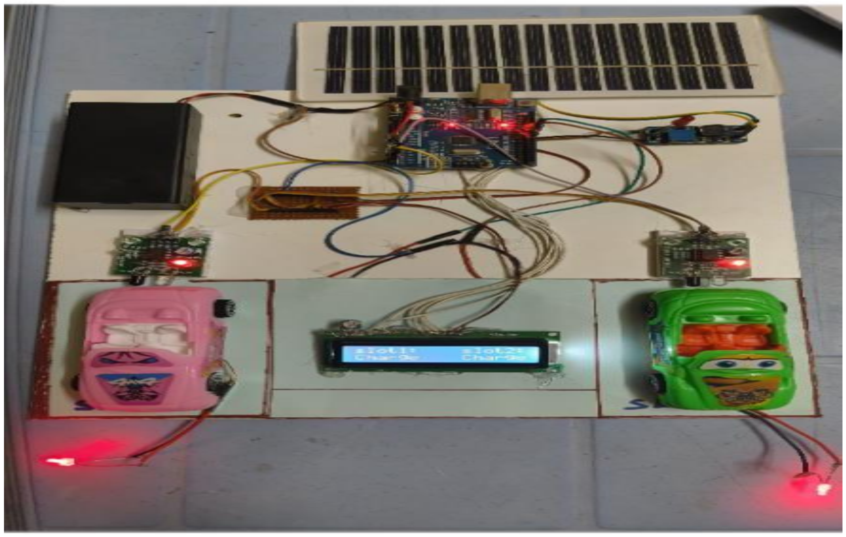

Fig. 5Final Prototype

VI. CONCLUSION

This project demonstrates the successful development of a solar-powered wireless charging system for electric vehicles by integrating photovoltaic (PV) panels, an MPPT-based DC-DC booster, Arduino UNO control, and IoT-enabled monitoring via the ESP8266 Wi-Fi module and ThingSpeak platform. The methodology ensures efficient utilization of solar energy, reliable local supervision through an LCD interface, and enhanced user accessibility with real-time remote monitoring. By combining renewable energy with wireless charging technology, the system offers an eco-friendly, contactless, and scalable solution that reduces dependence on fossil fuels and addresses the limitations of conventional wired charging infrastructure. Although challenges such as solar dependency, limited charging distance, and system efficiency require further optimization, the work establishes a strong foundation for the advancement of smart, sustainable, and user-friendly electric vehicle charging solutions.

REFERENCES

[1] Chitra, K., et al. "A Comprehensive Evaluaion of Solar Powered Electric Vehicle Charging Station Design Using Internet of Things." 2024 First International Conference on Electronics, Communication and Signal Processing (ICECSP). IEEE, 2024.

[2] Aggarwal, Gaurav, et al., eds. Integrated Technologies in Electrical, Electronics and Biotechnology Engineering. Taylor & Francis Group, 2025.

[3] Majhi, Abhilash Asit Kumar, and Sanjeeb Mohanty. "A comprehensive review on internet of things applications in power systems." IEEE Internet of Things Journal (2024).

[4] Tripathi, Nishant, Charanjeet Singh, and Kamal Kumar Sharma. "Performance analysis of clustering algorithms in wireless camera sensor networks for energy-efficient cooperative communication." Distributed Intelligent Circuits and Systems. 2024. 249-287.

[5] Rim, Chun T., and Chris Mi. Wireless power transfer for electric vehicles and mobile devices. John Wiley & Sons, 2017.

[6] Kurs, Andre, et al. "Wireless power transfer via strongly coupled magnetic resonances." science 317.5834 (2007): 83-86.