International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Wireless Electric Vehicle Power Charging Station

Ratnakar Yadav [1], Himanshu Singh [1], Abhishek Tiwari [1], Abhinav Tiwari [1], Hemangi Satam [2]

[1]Electronics and Telecommunication Engineering Department, Student, Shree L.R Tiwari College of Engineering, Mira Road, Mumbai, Maharashtra, India 401107

[2] Electronics and Telecommunication Engineering Department Faculty, Shree L.R Tiwari College of Engineering, Mira Road, Mumbai, Maharashtra, India 401107

DOI : https://doi.org/10.55248/gengpi.5.0424.1061

A B S T R A C T

For performance, an electric car must be fast, economical and reliable. Compared to traditional power cords, wireless charging solutions eliminate the hassle of plugging in things that need charging. Additionally, wireless payment is considered ecological and consumer-friendly as it does not require cables, mechanical connectors or other infrastructure.

Methods and techniques used by electric car companies for wireless charging Two types of wireless charging are compared and contrasted. In this project, wireless charging technology for electric vehicles is classified and discussed. We examine and evaluate non-conductive and sustainable wireless charging technologies.

The design uses Arduino's capabilities to control all functions, including power management and communication with the GSM module. This GSM integration allows remote monitoring and control of payment facilities, allowing users to receive SMS notifications of payment and completion. This approach is in line with the interest in user-friendly and efficient electric vehicle charging equipment.

Keywords: Wireless EV Charging Station, Inductive Charging for Electric Vehicles, Electric Vehicle Wireless Power Transfer (WPT) Public Wireless EV Charging Stations, In-Home Wireless EV Charging Systems GSM Communication SMS Alerts

Introduction

Nicola Tesla performed efforts to transfer power a century ago wirelessly [1,2]. WPT has been the subject of extensive study in recent decades to speed up the widespread adoption of electric devices. Examples include EVs, cell phones, implanted medical devices, robots, and household electronics.

In most cases, an electromagnetic field is used to transmit energy. The WPT is becoming increasingly popular for several reasons, the most important of which is the inherent simplicity of the technology and the possibility of a continuous operation with no interruptions for recharging.

However, magnetic coupling WPT, whether inductive-based or resonant-based, is the method of choice for near-field transmission since it causes significantly less damage to the surrounding environment. In addition, power transmission for any long distance between the Earth and solar power satellites can be accomplished using a wireless power transfer that uses electromagnetic radiation. This radiation can take the form of microwaves or lasers. This study focuses on the magnetically coupled WPT for any electric vehicle charging application and has made the subject of a significant amount of research [3–8]. In terms of its operational modes, a WPT can be of two categories: (1) static WPT, which involves charging the battery while the vehicle is parked, and (2) dynamic WPT, which involves the battery being charged while the vehicle is moving down a roadway that is enabled for WPT.

The WPT for electric vehicles has the potential to remove some of the barriers that prevent vehicle electrification and achieve sustainable mobility [9]. This would cantle reduce the size of the onboard battery in an electric vehicle, meaning it offers much more convenience. In the case of electric transit buses with a stationary WPT, for instance, the onboard [10,11] charging station can be reduced by approximately two-thirds of the size due to the many situation charges made while waiting for and unloading the passengers at bus stops. It is acceptable to bear a significantly small onboard battery because these charges en-route still meet the vehicle route requirements. There is a considerable reduction in the vehicle weight because the weight of the battery pack can be as much as one-fourth of the total weight of an electric bus which is built for continuous operation during the daytime [12]. Reducing the size of the battery has substantial ramifications in terms of lowering the overall weight of the vehicle and raising the economical operation of the car [10]. Theoretically, in the case of passenger cars on significant highways based on a dynamic WPT, widespread charging stations could make it possible for EVs to have an unlimited range with a small battery capacity [13,14].

Project Background.

One of the sectors with the quickest rate of growth is wireless communications. The need for wireless communication has increased dramatically in the last several years. Internal combustion engine vehicles are frequently viewed as less harmful to the environment than electric automobiles. By lessening the overall environmental effect of charging infrastructure, wireless charging can support a more environmentally friendly transportation ecology.

By providing incentives and subsidies for the development and implementation of electric car charging infrastructure, including wireless charging stations, numerous governments worldwide are aiding in the shift to electric transportation.

Literature Survey

Pradeep Vishnuram, Suresh P., Narayanamoorthi R., Vijayakumar K, Benedetto Nastasi. [14] This research paper examines the current state of electrical power transmission (WPT) in transportation. Identifies areas for improvement, challenges, and opportunities for improvement. This article also explores static electricity charging stations and the electrical energy process.[2023]

Gowresudarshan Ashok, Vikas, Sindhu Reddy, Abinezer, T. Vinay Kumar.[15] This article focuses on inductive conversion, the preferred method of charging electric vehicles, and compares it to capacitive conversion. It also explores different charging modes (static, semi-dynamic, dynamic) and basic systems such as charging, communication and battery types.[2023]

Savitra C T, Hemanth Kumar E Naik, Hoysala Bise, Sachin K R, Kiran J Y.[16] This article discusses the popularity of electric vehicles (EVs) and the growing interest in wireless charging technology. Wireless charging provides electric vehicle users with advantages such as efficiency, environmental benefits, reduced costs, increased convenience and safety.[2022]

Jahnavi Bn, Sowmya HM, Jashwanth Sinha S, Manoj M, Prof. Yathish Babu Am. [17] This work presents a wireless charging system for electric vehicle that integrates with ZigBee communication to achieve automatic charging. Since the system uses static charging for stationary vehicles and dynamic charging for moving vehicles, there is no need for any physical connection. This method is designed to increase convenience and usability.[2022]

Oyediran Mayowa Oyedepo, Akande Noah Oluwatobi.[18] The paper highlights a compact and user-friendly system for controlling home appliances via SMS. This success suggests potential for similar systems controlling complex, high-voltage electronics and even enabling voice-based remote control through calls.[2016]

Project Application

<u>Home and Garage Charging</u>: Imagine pulling into your garage and parking over a charging pad, eliminating the need to fumble with cables every time. WEVCS can significantly enhance the ease of charging at home.

<u>Public Parking Lots:</u> WEVCS can transform public parking experiences. Drivers simply park over designated spots and charging begins automatically. This can be particularly beneficial in crowded urban areas.

<u>Alignment:</u> Magnetic fields for charging need proper alignment between the vehicle and the charging pad. Explore mechanisms to ensure optimal positioning.

<u>Charging Speed:</u> While WEVCS can provide Level 2 charging speeds, super-fast charging like DC charging stations might not be feasible in the near future.

<u>Infrastructure Costs:</u> WEVCS require installation of charging pads and in-vehicle receivers, which may be a cost consideration initially.

Objectives

- Design and develop a prototype WEVCS with safe and efficient wireless power transfer for EVs.
- Evaluate the performance of the WEVCS in terms of charging speed, efficiency, and operational range.
- Investigate the feasibility of integrating WEVCS into various applications, such as home charging, public parking lots.
- Analyze the economic and environmental benefits of WEVCS compared to conventional plug-in charging systems.
- Develop a safe and efficient WEVCS prototype: This involves designing a system that meets safety regulations for electromagnetic fields (EMF) and achieves high power transfer efficiency with minimal energy loss.
- Evaluate charging performance: Measure and analyze factors like charging speed, operational range, and compatibility with different EV models.

- Optimize power transfer: Utilize simulation tools to refine the design for maximum efficiency and minimal energy loss between the transmitter pad and receiver coil.
- Investigate feasibility for various applications: Assess the suitability of WEVCS for different scenarios, such as home charging, public parking lots, fleet operations, public transportation, and highway rest stops.
- Develop integration plans: Consider factors like grid connection, infrastructure modifications, user interfaces, and safety protocols for integrating WEVCS into existing environments.
- Analyze cost-benefit compared to conventional charging: Evaluate the economic viability of WEVCS considering factors like initial investment, maintenance costs, and potential cost savings on energy consumption.
- Assess environmental benefits: Analyze the impact of WEVCS on the environment, including reduced reliance on fossil fuels and potential environmental considerations with material sourcing.
- Scalability and future-proofing: Design the WEVCS with the potential for future upgrades and scalability to accommodate advancements in technology and changing demands.
- Standardization and interoperability: Consider alignment with emerging standards for WEVCS technology to ensure compatibility with various EV models.
- User experience: Focus on designing a user-friendly system that is easy to understand and operate for EV drivers.

Proposed Methodology

Designing and implementing a wireless electric vehicle (EV) charging station involves a multi-step methodology that considers the technology, safety, and usability aspects. Below is a general methodology for creating a wireless EV charging station.

Project Scope and Requirements:

- Identify the purpose of the charging station (public, private, commercial, residential).
- Determine the power level (kW) and compatibility with EV models.
- Define safety and regulatory requirements.

Select Wireless Charging Technology:

- Choose the wireless charging technology to implement (e.g., resonant inductive coupling, magnetic resonance).
- Select the appropriate charging frequency and power level.
- Ensure compatibility with common EV standards).

Figure 1 Wireless Charging Technology

Hardware Selection and Procurement:

Choose the key components, including transmitter and receiver coils, inverter, current sensors, relays, microcontrollers (Arduino or similar), and safety equipment. Procure high-quality and reliable components from reputable suppliers

Block Diagram

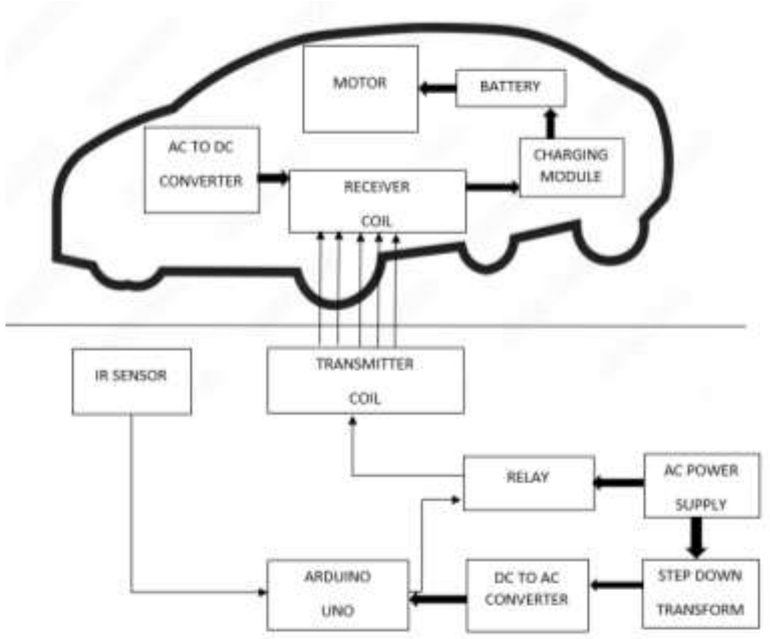

Figure 2 Block Diagram

- Motor: This likely represents the electric motor of the vehicle that will be charged.
- Battery: This symbolizes the EV battery that will receive power wirelessly.
- AC to DC Converter: This component converts incoming AC (alternating current) electricity from the power grid to DC (direct current) for use in the charging system.
- Charging Module: This block likely represents circuitry that regulates and manages the charging process, including features like overcharge protection.
- Receiver Coil: This coil on the underside of the vehicle will receive electromagnetic waves transmitted by the charging pad to wirelessly transfer energy.
- IR Sensor (Infrared Sensor): This sensor might be used to detect the presence of a vehicle over the charging pad and initiate the charging process.
- Transmitter Coil: This coil embedded in the charging pad transmits electromagnetic waves to the receiver coil on the vehicle.
- Relay: This electronic switch controls the power flow to the transmitter coil based on signals from the Arduino
- AC Power Supply: This represents the source of AC electricity that powers the entire charging station.
- Arduino Uno: This microcontroller likely controls various functionalities of the system, including communication, power management, and monitoring.
- GSM Module: This module enables the Arduino to connect to a cellular network and potentially send SMS alerts about the charging status or any faults.

Overall, the diagram depicts a wireless charging system where an AC power source is converted to DC and regulated for charging. The Arduino controls the system, and the GSM module allows for remote monitoring (potentially through SMS)

Flow Chart

Figure 3 Flow Chart

This flowchart likely illustrates the process of charging an electric vehicle (EV) using a wireless charging station. Here's a breakdown of the possible steps:

- Start: The process begins.
- Vehicle Detection: Sensors (like ultrasonic or infrared sensors) detect if a vehicle is parked over the charging pad.
- Alignment Check:
- Proper Alignment: If the vehicle is positioned correctly over the charging pad, the flowchart proceeds to the next step.
- Alignment Not Proper:
- An alert might be sent to the user (optional) indicating misalignment.
- The system might wait for proper alignment or terminate the process depending on the design.
- Start Charging: The charging process commences by energizing the transmitter coil in the charging pad.
- Charging: Wireless power transfer takes place between the transmitter coil and the receiver coil on the vehicle.
- Monitor Battery Level: The system continuously monitors the battery voltage of the EV.
- Charging Complete:
- Fully Charged: Once the battery reaches full capacity, the charging process stops.
- Not Fully Charged: The system might indicate an error or continue monitoring if full charge isn't achieved.
- Power Stop Transmit: The power transfer process is halted.
- SMS Alert : A text message might be sent to the user informing them that charging is complete (or potentially about any errors).
- End: The process ends.

Result

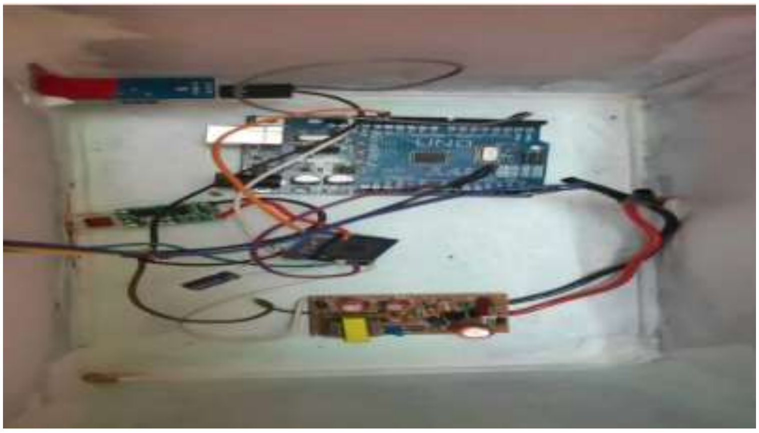

Figure 4 Internal Circuit of Power Station

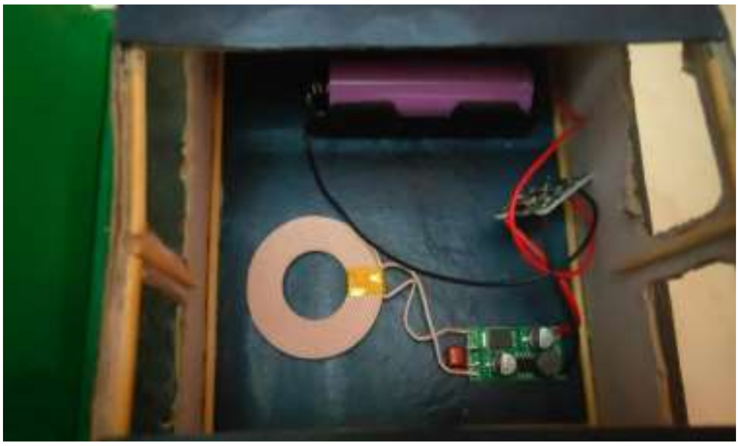

Figure 5 Internal Circuit of Car

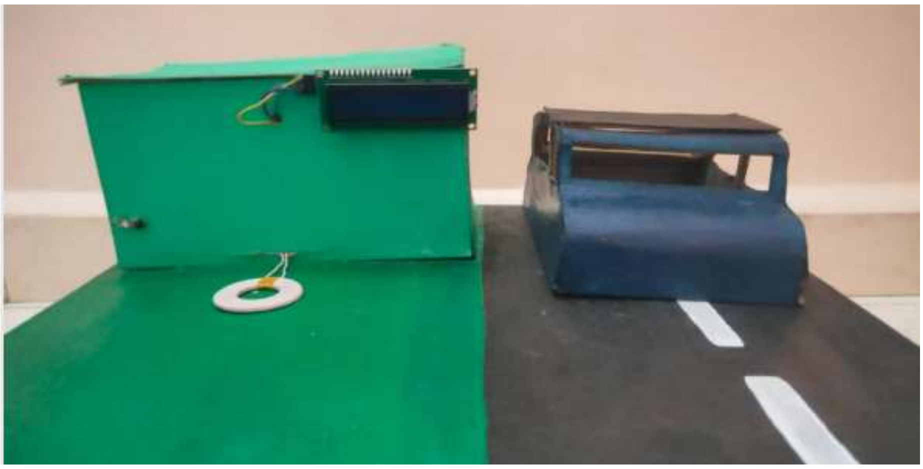

Figure 6 Power Station

Conclusion

In conclusion, a wireless EV charging station that makes use of GSM and Arduino represents a major improvement in EV infrastructure. Through remote monitoring via SMS alerts and cable-free charging, the system enhances user convenience and safety. Furthermore, the possibility of integration with driverless cars and smart grids opens the door to more sustainable mobility practices and efficient energy use. Future transportation and environmental advancement will be greatly influenced by the ongoing research and development of this technology.

References

[1]. Tesla, N. Art of Transmitting Electrical Energy through the Natural Mediums. U.S. Patent 787,412, 18 April 1905.

[2]. Tesla, N. Apparatus for Transmitting Electrical Energy. U.S. Patent 1,119,732, 1 December 1914.

[3]. Zhang, Y.; Zhao, Z.; Chen, K. Frequency-Splitting Analysis of Four-Coil Resonant Wireless Power Transfer. IEEE Trans. Ind. Appl. 2014, 50, 24 36–2445.

[4]. Zhang, W.; White, J.C.; Abraham, A.M.; Mi, C.C. Loosely Coupled Transformer Structure and Interoperability Study for EV Wireless Charging Systems. IEEE Trans. Power Electron. 2015, 30, 6356–6367.

[5]. Bi, Z.; Kan, T.; Mi, C.C.; Zhang, Y.; Zhao, Z.; Keoleian, G.A. A review of wireless power transfer for electric vehicles: Prospects to enhance sustainable mobility. Appl. Energy 2016, 179, 413–425.

[6]. Li, S.; Zhao, P.; Gu, C.; Li, J.; Cheng, S.; Xu, M. Battery Protective Electric Vehicle Charging Management in Renewable Energy System. IEEE Trans. Ind. Inform. 2023, 19, 1312–1321.

[7]. Shanmugam, Y.; Narayanamoorthi, R.; Vishnuram, P.; Bajaj, M.; AboRas, K.M.; Thakur, P.; Kitmo. A Systematic Review of Dynamic Wireless Charging System for Electric Transportation. IEEE Access 2022, 10, 133617–133642.

[8]. Kurs, A.; Karalis, A.; Moffatt, R.; Joannopoulos, J.D.; Fisher, P.; Soljaˇci´c, M. Wireless Power Transfer via Strongly Coupled Magnetic Resonances. Science 2007, 317, 83–86.

[9]. Lukic, S.; Pantic, Z. Cutting the Cord: Static and Dynamic Inductive Wireless Charging of Electric Vehicles. IEEE Electrif. Mag. 2013, 1, 57–64. .

[10]. Bi, Z.; Song, L.; De Kleine, R.; Mi, C.C.; Keoleian, G.A. Plug-in vs. wireless charging: Life cycle energy and greenhouse gas emissions for an electric bus system. Appl. Energy 2015, 146, 11–19..

[11]. Thornton, J. Pulling power from the road: Charged by the route it follows, an electric bus gets a real-world test. Mech. Eng. 2014, 136, 44–49. Page | 20

[12]. Reikes, J.; (BYD Motors Inc., Los Angeles, CA, USA). Personal Communication, 21 July 2014.

[13]. Miller, J.M.; Jones, P.; Li, J.-M.; Onar, O.C. ORNL Experience and Challenges Facing Dynamic Wireless Power Charging of EV's. IEEE Circuits Syst. Mag. 2015, 15, 40–53.

[14]. Pradeep Vishnuram, Suresh P., Narayanamoorthi R. ,Vijayakumar K. and Benedetto Nastasi. Wireless Chargers for Electric Vehicle: A Systematic Review on Converter Topologies, Environmental Assessment, and Review Policy. Front. Energy Res. 2023.

[15]. Gowresudarshan Ashok , Vikas , Sindhu Reddy , Abinezer , T. Vinay Kumar. Wireless Electric Vehicle Charging System May 2023 IRE Journals Volume 6 Issue 11 ISSN: 2456-8880.

[16]. Savitra C T , Hemanth Kumar E Naik, Hoysala Bise, Sachin K R , Kiran J Y. Wireless Charging and Battery Management for EV using Arduino International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 ICEI - 2022 Conference Proceeding.

[17]. Jahnavi Bn, Sowmya H M, Jashwanth Sinha S, Manoj M, Prof. Yathish Babu Am. Real Time Wireless Charging For Ev Using Arduino Microcontroller 2022 IJCRT Volume 10, Issue 6 June 2022 ISSN:2320-2882.

[18]. Oyediran Mayowa Oyedepo, Akande Noah Oluwatobi. Design and Implementation of a GSM based Electronic Appliances Monitoring andControlling System International Journal of Advanced Research in Computer and Communication Engineering Vol. 5, Issue 2, February 2016.