SMART PARKING AND GREEN CHARGING

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ABSTRACT

The rapid urbanization of cities worldwide has led to significant challenges, particularly in traffic congestion and environmental pollution. Traditional transportation systems, heavily reliant on fossil fuels, exacerbate these issues, leading to deteriorating air quality and increased greenhouse gas emissions. The urgency to find sustainable solutions for urban mobility is paramount. This research paper presents an innovative approach to addressing these challenges through a smart parking and green charging system. The proposed system integrates renewable energy sources and advanced Internet of Things (IoT) technologies to optimize urban mobility, enhance efficiency, and reduce environmental impact. The smart parking system utilizes a combination of IR sensors, RFID technology, and IoT devices like Arduino and NodeMCU to streamline parking management. IR sensors detect vehicle presence in parking slots, while RFID tags and readers facilitate secure access control, ensuring only authorized vehicles can park. An LED display provides real-time information to users about parking slot availability, enhancing user experience and reducing the time spent searching for parking. Central to this system is the green charging infrastructure for electric vehicles (EVs). Solar panels generate renewable energy, which is stored in a 12-volt battery system. This stored energy powers the entire smart parking system and is used for wireless EV charging through resonant coils. The integration of MOSFETs and IC4047 timers allows for the generation of precise pulse-width modulation (PWM) signals, which drive the transmitter coils. These coils create an alternating magnetic field that induces a current in the receiver coils embedded in the EVs, enabling efficient wireless charging through electromagnetic induction. The control circuitry, managed by microcontrollers such as Arduino, regulates the operation of MOSFETs and monitors the charging process. Feedback from sensors ensures optimal charging efficiency and safe operation, making the system both user-friendly and reliable. Additionally, the NodeMCU ESP8266 module facilitates remote monitoring and control, allowing users to manage parking and charging through a mobile application seamlessly. This research highlights the potential of integrating renewable energy with advanced IoT technologies to create a holistic solution for urban transportation challenges. The smart parking and green charging system not only addresses the immediate issues of traffic congestion and pollution but also promotes the adoption of sustainable transportation methods. By improving air quality, reducing greenhouse gas emissions, and enhancing the overall user experience, this system represents a significant step towards creating smarter, greener cities. This paper underscores the need for continued innovation in this field and suggests avenues for further research and development to refine and expand these technologies.

KEYWORDS: *IoT, Electric Vehicles (EV), Smart Parking, Renewable Energy Source, Wireless Charging, Magnetic Induction*

1. INTRODUCTION

1.1. Overview

We are living in a world full of technological advancements. As urbanization continues to surge, the demand for efficient and sustainable urban mobility solutions has become paramount. The increasing prevalence of electric vehicles (EVs) presents a transformative opportunity to address the environmental challenges associated with traditional transportation systems. In this context, the integration of green charging infrastructure and smart parking solutions emerges as a crucial nexus, promising to revolutionize the way we power and manage urban transportation.

The reliance on fossil fuels in traditional transportation has led to concerns about air quality, carbon emissions, and overall environmental sustainability. The urgency to transition towards cleaner alternatives has spurred the adoption of electric vehicles, which rely on electricity as a power source. However, the effective integration of renewable energy sources into the charging infrastructure is essential to fully realize the sustainability potential of EVs.

In the context of technological advancements, the introduction of Wireless Power Transmission (WPT) has emerged as an efficient method for transmitting electric power without the use of wires, addressing issues associated with conventional charging systems. This technology, incorporating microwaves, solar cells, lasers, and electromagnetic wave resonance, eliminates clutter and inconvenience by wirelessly charging devices, offering a cleaner and more organized space around power sockets.

1.2 Objectives

The objective of this research delves into the design and implementation of an innovative system to revolutionize urban mobility. By seamlessly merging real-time monitoring, user-friendly mobile apps, and renewable energy integration, the study addresses pressing challenges like limited charging infrastructure and environmental impact. The feasibility analysis explores economic and technical aspects, examining issues such as infrastructure deployment, user adoption, energy reliability, and regulatory compliance, ultimately presenting a comprehensive solution to enhance the sustainability and efficiency of electric vehicles in urban settings.

2. LITERAL VIEW

In response to the challenges of urban parking, a Smart Parking Management System (SPMS) is introduced, leveraging technology to streamline parking availability searches and alleviate traffic congestion. The system incorporates sensors, automatic number plate recognition (ANPR) cameras, and IEEE standards for effective control, real-time monitoring, and user assistance. Another aspect addresses the growing demand for parking spaces in India, proposing a multilingual Android application for online parking space reservation based on user preferences and current location. Additionally, a reservation-based Smart Parking System is suggested to minimize traffic congestion, allowing users to reserve parking slots via a mobile app, providing efficient parking solutions through a client-server architecture and various payment methods.

Phadtare et al. (2019) examine the fusion of IoT technology with electric vehicle (EV) charging and parking systems, aiming to enhance user convenience and safety. Their research emphasizes the utilization of wireless charging systems and inductive power transfer techniques, highlighting the advantages of integrating smart parking and charging functionalities.

Lekshmi et al. (2020) proposes an IoT-driven smart parking system coupled with wireless charging capabilities for EVs, addressing the challenges of parking scarcity in urban areas. They advocate for the implementation of a Resonant Inductive Power Transfer System to facilitate efficient charging and reservation management, ensuring seamless parking and charging experiences.

Urooj et al. (2021) advocate for the integration of IoT technology into electric vehicles to enable sensor-based monitoring systems, thereby optimizing battery performance. Their study underscores the significance of continuous monitoring through platforms like Things Speak and MATLAB integration to enhance vehicle efficiency and prolong battery life.

Wireless Power Transmission (WPT) primarily utilizes resonant inductive coupling for efficient energy transfer over mid-range distances, with electromagnetic field inductance between two coils tuned to the same frequency. This method, emphasized in various research papers one such paper was “Wireless Power Transmission”, aims to minimize transmission and distribution losses by transmitting power as magnetic waves. By employing magnetic resonance, WPT systems achieve high efficiency and extend power transfer range, making them suitable for applications such as energy harvesting for wireless sensors and data transmission. WPT research spans interdisciplinary fields including material science, power electronics, and RF technology, reflecting its broad appeal and potential for innovation in sustainable energy solutions.

3. METHODOLOGY

3.1 Solar Power Integration

Harnessing the sun's immense power for industrial use has a long history dating back to Archimedes. However, traditional energy sources like coal, oil, and nuclear power have dominated the landscape. In recent decades, with mounting concerns over fuel costs, environmental impacts, and energy distribution challenges, there's a growing shift towards solar energy. Modern industrial economies are increasingly turning to solar power to meet their energy needs and mitigate these pressures. Introducing solar charging stations could serve as a small measure to promote the adoption of electric vehicles. With existing technology in operation, local car manufacturers might explore integrating it into their future vehicle designs. This initiative promises economic efficiency through self-generated energy from PV solar panels. The fig 3.1 shows how the parking systems can be made more efficient by integrating charging system. By redirecting fuel expenses towards electric vehicle systems, there's a potential for significant energy savings. Environmentally, the primary focus is on improving air quality and reducing CO_2 emissions, particularly from vehicles relying on liquid fuel. Electric cars offer a promising solution to mitigate transportation-related air pollution, with solar power emerging as a renewable and sustainable energy source compared to finite fossil fuels.

Fig 3.1 Renewable Charging Stations

Solar panel(12V) is integrated to provide power in an environmentally sustainable manner. The solar panel captures sunlight and converts it into electrical energy, which is then stored in batteries for consistent power supply. This renewable energy source ensures continuous operation of the IoT-based intelligent parking system and overall system management. The solar-powered solution reduces dependence on the grid, promoting energy efficiency and eco-friendly practices in smart parking infrastructure.

3.2. RFID Protection

3.2.1 Experimental Validation

To validate the effectiveness of the proposed RFID-based remote monitoring techniques, a case study was conducted in a large urban parking facility. The study involved the deployment of RFID-enabled sensors and ANPR cameras to monitor parking occupancy in real-time. Through extensive data collection and analysis, the system demonstrated a significant reduction in parking search time for users, thereby alleviating traffic congestion and improving overall parking efficiency.

Furthermore, simulations were conducted to assess the scalability and reliability of the RFID-based system across varying parking scenarios. These simulations replicated diverse parking conditions and user behaviours, allowing for comprehensive testing of the system's performance under different circumstances. Results indicated robustness and accuracy in parking space detection and reservation, validating the practical implementation of RFID-based remote monitoring techniques in smart parking systems.

In addition, a real-world example of the system's deployment in a busy commercial district showcased its seamless integration with existing infrastructure and user-friendly interface. Users reported enhanced convenience and reduced frustration in finding available parking spaces, affirming the system's effectiveness in addressing urban parking challenges.

3.2.2 Project Implementation

We propose a unique RFID-based theft prevention and detection method using passive RFID chips concealed within vehicles as identifying numbers. These RFID tags, specifically Hard tags made of durable materials like metal or plastic, are associated with theft, staff, and VIP cars. Utilizing IEEE standards, Arduino Uno, and NodeMCU ESP8266, the system enhances security through a centralized server managing RFID data and a network of scanners, demonstrating the effectiveness of RFID cards in smart parking.

3.3. Wireless Charging

One of the primary aim is to develop a wireless power transfer concept with applications, including the ability to wirelessly charge rechargeable batteries The study assesses current methods and aims to enhance low-performance areas. The hardware system involves designing transmitter and receiver modules for efficient power transfer. The main focus is on resonant inductive coupling (RIC) as a common and efficient approach. RIC utilizes electromagnetic field inductance between two coils tuned to the same frequency. The figure 3.2 shows how a resonating coil works for an electric vehicle in a smart parking system with charging integration. The project incorporates a resonating high-frequency coil as the primary in an air core transformer, achieving over 90% power transfer efficiency for perfectly coupled resonators. However, the efficiency drops for weakly coupled resonators. The system's circuit operation involves multiple blocks, including a power supply block, regulating pulse-width modulator, MOSFET driver, IRZ44 MOSFET operation, and primary coil. Additionally, calculations for coil inductance, resistance, leakage path resistance, and resonant frequency are provided to optimize system performance.

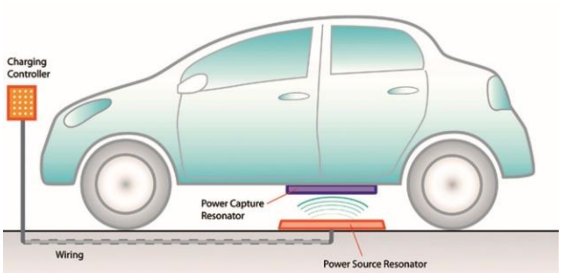

Figure 3.2 Magnetic Induction Through Resonating Coils

3.4.Overall Functioning

To initiate the charging process, a solar panel is employed along with two diodes, a Zener diode, and an IN4007 diode, aimed at regulating current smoothly into the main circuit. The circuit, powered by three 4V batteries in parallel, total of 12V, is equipped with a capacitor (1000 microfarad, 36V) to prevent equipment damage, aided by a 7805 voltage regulator to ensure a 3V-4V output. More than one Arduino has been integrated for the connection of several parts in order to maintain effective power supply to the various units such as the power convertor for wireless charging and circuit house etc. Color-coded

International Journal of Engineering Sciences & Emerging Technologies, Dec. 2024
ISSN: 22316604 Volume 11, Issue 4, pp: 703-709 ©IJESET

wiring distinguishes input/output (blue), power supply (red), and ground (green) connections. Figure 3.3 shows the model of proposed idea.

Fig 3.3 Prototype For Proposed Idea

In the designated parking area with four slots, each slot features an infrared sensor for vehicle detection, interfaced with an Arduino UNO. Upon vehicle presence, the Arduino signals a Node MCU ESP-32 WiFi module, which subsequently communicates with the remote-x,y application. The integration of IoT devices and sensors within the charging and parking infrastructure seamlessly connects with the Remote XY app. This app provides developers with flexible interface customization options, enabling them to craft layouts that suit the unique requirements of electric vehicle charging and parking systems. This customization empowers users to effortlessly navigate and engage with the system's diverse functionalities, enhancing usability and accessibility. Additionally, two infrared sensors situated at the gate monitor vehicle entry and exit and displays the information on the LCD display. Integration of RFID technology further enhances the system's functionality. Utilizing RFID cards in parking systems offers enhanced protection through secure access control, limiting entry to authorized personnel. Each RFID card provides unique identification, facilitating precise tracking of individuals' movements for accountability. The technology streamlines entry and exit processes, minimizing congestion and manual authentication methods. Integration with payment systems enables automated billing, reducing reliance on cash and mitigating risks associated with theft or fraud. Moreover, RFID cards offer heightened security compared to conventional keys or codes, with potential for integration with surveillance and alarm systems to bolster overall safety measures.

The working described emphasizes a comprehensive approach to charging and parking management, integrating solar panels, Arduino units, infrared sensors, and RFID technology. Unlike the IoT-based systems discussed earlier, this approach utilizes a combination of hardware components and sensors to regulate parking slots, monitor vehicle entry and exit, and facilitate wireless charging. The inclusion of RFID technology provides secure access control and enable precise tracking of individuals' movements. Moreover, the integration of payment systems streamlines billing processes and enhances user convenience. Overall, this system offers a robust solution for efficient charging and parking management with advanced security features and enhanced user experience.

4. ADVANTAGES

The key features of the proposed system include improved parking efficiency, reduced traffic congestion, pollution reduction, increased security, lower management costs, and an enhanced user experience. The research addresses the problem formulation, acknowledging the growing challenges in parking management, especially in large cities, where finding parking spaces is time-consuming and leads to increased congestion.

The novelty of the work lies in its multifaceted benefits, such as facilitating easy identification of empty parking slots, reducing search time, lowering fuel consumption, enhancing security through automation, and being applicable to large-scale parking areas like cinemas, airports, shopping malls, IT hubs, and offices.

5. CONCLUSIONS

This system aims to delve into the pivotal role played by green charging infrastructure, particularly those harnessing renewable energy sources, in enhancing the sustainability of urban mobility. Additionally, the paper explores the synergy between these charging solutions and smart parking technologies, emphasizing their combined impact on efficiency, convenience, and environmental preservation. By examining advancements in charging infrastructure and their interconnectedness with smart parking systems, the research aims to provide insights into a holistic approach for sustainable urban mobility.

REFERENCES

[1]. "IoT based Smart Parking System" published in the 2021 5th International Conference on Intelligent Computing and Control Systems (ICICCS).
[2]. "IoT based smart parking system" published in the 2016 International Conference on Internet of Things and Applications (IOTA). The paper presents an IoT-based cloud-integrated smart parking system2.
[3]. "IOT Based Smart Parking System" by ISROSET. The paper discusses traffic pattern forecasting using time series analysis between spatially adjacent sensor clusters3.
[4]. "A Review of Smart Parking System based on Internet of Things" discusses the smart traffic management and parking system using the internet4.
[5]. "A Review on Smart IOT Based Parking System" published on SpringerLink. The paper reviews some research papers from the recent work carried out in the year 2018 to 2019 related to IOT based smart parking5.
[6]. "Design and Analysis of a Solar-Powered Electric Vehicle Charging Station for Indian Cities" by Aanya Singh, Shubham Sanjay Shaha, Nikhil P G, Yendaluru Raja Sekhar, Shaik Saboor, and Aritra Ghosh. The paper presents results from the design of a solar-powered EV charging station for an Indian context6.
[7]. "Review of Renewable Energy-Based Charging Infrastructure for Electric Vehicles" by Gamal Alkawsi, Yahia Baashar, Dallatu Abbas U, Ammar Ahmed Alkahtani, and Sieh Kiong Tiong. The paper reviews studies related to alternative energy charging infrastructure7.
[8]. "Charging the Future: Challenges and Opportunities for Electric Vehicle Adoption" discusses the challenges and opportunities for electric vehicle adoption8.
[9]. "Design and Development of Solar Charging System for Electric Vehicles: An Initiative to Achieve Green Campus" discusses the design and development of a solar charging system for electric vehicles using a charge controller.
[10]. "IOT Based Smart Vehicle Parking System Using RFID" published in the 2021 International Conference on Computer Communication and Informatics (ICCCI). The paper discusses an automatic real-time system for automated Vehicle parking1.
[11]. "IoT based Smart Parking System" published in the 2021 5th International Conference on Intelligent Computing and Control Systems (ICICCS). The authors present a novel parking system with IoT over Wi-Fi and RFID2.
[12]. "RFID Based Remote Monitoring Techniques for IoT Smart Parking System" compares and evaluates highlighted methods based on the three important components, Data receiving, Monitoring and Displaying information (DMD)3.
[13]. "IoT Based Smart Parking System Using RFID" published in the International Journal of Computer Engineering in Research Trends discusses traffic pattern forecasting using time series analysis between spatially adjacent sensor clusters4.
[14]. Another paper titled "RFID Based Remote Monitoring Techniques for IoT Smart Parking System" discusses the same topic5.
[15]. Wireless Charging Through Resonating Coils:
[16]. "Design of Static Wireless Charging Coils for Integration into Electric Vehicle" by Subhadeep Bhattacharya and Y.K.Tan. The paper analytically discusses various factors that affect static wireless charging of an electric vehicle6.

[17]. "Analysis of resonant coupling coil configurations of EV wireless charging system: a simulation study" published in Frontiers in Energy. The paper is focused on analyzing electromagnetically coupled resonant wireless technique used for the charging of EVs7.
[18]. "An Efficient Wireless Charging Technique Using Inductive and Resonant Circuits" presents a novel wireless charging system by using the inductive and resonant circuits8.
[19]. "Magnetic Resonance Coupling Modelling for Electric Vehicles Wireless Charging" discusses how energy can be transferred efficiently between two magnetically coupled resonating coils.
[20]. Kesler, M. (2013). Highly Resonant Wireless Power Transfer: Safe, Efficient, and over Distance.
[21]. Phadtare, S., Wadkar, S. S., Thorat, S. S., Ghorpade, A. S., and Jadav, A. B. (2019). Examination of IoT-infused Electric Vehicle Charging and Parking System. International Journal of Engineering Research & Technology (IJERT), 9(08).
[22]. Lekshmi, M., Mayur, P., Manjunatha, B., Kavya, U., and Anil Kumar, J. H. (2020). Implementation of IoT-driven Smart Car Parking with Wireless Charging Capability for Electric Cars. International Research Journal of Engineering and Technology (IRJET), 07(08).
[23]. Urooj, S., Alrowais, F., Teekaraman, Y., Manoharan, H., and Kuppusamy, R. (2021). Application of IoT for Electric Vehicle Enhancement Using Boosting Algorithm in Smart Cities.

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