

Wireless EV Charging Station with IOT Billing

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Abstract - This paper presents a Wireless EV Charging Station with IoT Billing based on inductive coupling technology. The system is designed to transfer electrical power wirelessly between transmitter and receiver coils without physical cable connections. An ESP32 microcontroller is used to control charging operations and communicate with the ThingSpeak cloud platform for real-time monitoring and billing. The system includes an ultrasonic sensor for vehicle detection, relay-based charging control, GSM communication, and an LCD display for status monitoring. Billing is calculated based on charging duration and updated through IoT connectivity. The prototype was tested successfully with an effective charging distance of approximately 2 cm. The proposed system provides a compact, safe, and user-friendly solution for future smart EV charging infrastructure

Key Words: Wireless Charging, Electric Vehicle, ESP32, IoT Billing, Inductive Coupling, ThingSpeak

1. INTRODUCTION

The use of electric vehicles is increasing as people become more aware of environmental pollution and the need for sustainable transportation systems. Electric vehicles are considered an effective solution for reducing harmful emissions and decreasing dependence on fossil fuels. As EV technology continues to grow, the development of efficient and convenient charging systems has become equally important.

Currently, most electric vehicles are charged using wired charging systems. Although these systems are widely used, they have certain limitations, including cable damage, maintenance issues, power losses, and safety concerns due to exposed electrical connections. In many cases, handling charging cables can also be inconvenient for users, especially at public charging stations. Because of these drawbacks, wireless charging technology has gained significant attention in recent years.

Wireless power transfer allows electrical energy to be transmitted without direct physical contact between the charger and the vehicle. This technology mainly operates on the principle of electromagnetic induction, in which power is transferred between the transmitter and receiver coils via a magnetic field. Wireless charging offers several advantages, including improved safety, reduced connector wear and tear, and greater user convenience.

At the same time, the Internet of Things (IoT) has become an important technology in modern automation and smart systems.

IoT enables devices to communicate and exchange data over the internet, enabling remote monitoring and control. When integrated with EV charging systems, IoT can help users monitor charging status, billing details, and system performance in real time.

This project presents a Wireless EV Charging Station with IoT-based billing using an ESP32 and the ThingSpeak cloud platform. The system uses inductive coupling to transfer power wirelessly and includes features such as automatic vehicle detection, real-time monitoring, and billing calculation based on charging duration. An ultrasonic sensor is used to detect the vehicle position, while charging information and billing details are displayed on an LCD module.

2. LITERATURE REVIEW

In recent years, wireless charging technology for electric vehicles has become an important area of research due to the growing demand for safer, more convenient charging methods. Traditional wired charging systems have several drawbacks, such as cable damage, maintenance issues, and safety risks. To overcome these problems, researchers have explored different wireless power transfer methods for EV charging applications.

Among the available wireless charging techniques, inductive coupling is one of the most commonly used methods due to its simple construction, reliability, and effective short-distance power transfer capability. In this technique, power is transferred wirelessly between transmitter and receiver coils through electromagnetic induction. Many researchers have successfully demonstrated wireless charging systems that reduce the need for physical charging cables and improve user convenience.

Many studies have also focused on integrating Internet of Things (IoT) technology into EV charging systems. IoT platforms such as ThingSpeak, Blynk, and other cloud-based services are widely used for real-time monitoring of charging parameters like voltage, current, battery condition, and charging duration. These systems allow users to access charging information remotely via the internet, making the charging process smarter and more efficient.

Researchers have also developed automated billing systems for EV charging stations based on charging time or energy consumption. IoT-based billing systems improve transparency and reduce manual work by automatically calculating charging costs. Microcontrollers such as the ESP32, Arduino, and

Raspberry Pi are commonly used to control charging operations and handle wireless communication.

Some recent works have included sensors and automation features to improve the intelligence of charging systems. Ultrasonic sensors are used for vehicle detection and positioning, while relay modules are used for automatic switching and charging control. GSM modules are also integrated into certain systems for communication and notification purposes.

3. OVERVIEW

The Wireless EV Charging Station with IoT Billing is a smart charging system that provides contactless charging for electric vehicles via inductive coupling technology. The system wirelessly transfers electrical energy between the transmitter and receiver coils, eliminating the need for physical charging cables. This approach improves safety, reduces cable-related maintenance issues, and increases user convenience.

The proposed system uses a 230V AC supply as the input source and an ESP32 microcontroller to control charging operations and enable IoT communication. The transferred power charges a demo battery via wireless power transfer. An ultrasonic sensor is integrated for vehicle detection, while a relay module automatically controls the charging process.

For smart monitoring and billing, the system uses the ThingSpeak cloud platform to display charging information and calculate billing based on charging duration. An LCD module displays charging status and billing details locally, while a GSM module provides communication and notification support.

The developed prototype demonstrates wireless charging, automatic monitoring, and IoT-based billing in a compact and efficient system. The project represents a practical step toward future intelligent EV charging infrastructure and smart transportation technology.

1. Objective

The main objective of the proposed project is to develop a Wireless EV Charging Station with IoT Billing using inductive coupling technology. The system aims to provide wireless power transfer for electric vehicles without using physical charging cables, thereby improving safety and user convenience. Another objective of the project is to implement real-time monitoring and IoT-based billing using the ESP32 microcontroller and ThingSpeak cloud platform. The system is also designed to automatically detect vehicle positioning using an ultrasonic sensor and to control the charging process through a relay module. In addition, the project focuses on displaying charging status and billing information on an LCD module and developing a compact, efficient, and user-friendly prototype suitable for future smart EV charging infrastructure.

2. Core Components

The proposed Wireless EV Charging Station with IoT Billing comprises several key hardware and software components that work together to enable wireless charging and smart monitoring. The ESP32 microcontroller serves as the system's main control unit, managing charging operations and IoT communication. A transmitter coil and a receiver coil are used for wireless power transfer via inductive coupling.

A MOSFET switching circuit generates the high-frequency signals required by the transmitter coil, while a rectifier circuit converts AC power into the DC voltage needed to charge the battery. The system operates on a 230V AC power supply as its main input.

An ultrasonic sensor is included for vehicle detection and positioning, which helps automatically activate the charging process. A relay module is used to automatically control the charging operation. The LCD display module shows charging status and billing information to the user in real time.

The system also uses a GSM module for communication and notification purposes. For IoT-based monitoring and billing, the ThingSpeak cloud platform is used to store and display charging data remotely via the internet.

4. Working Principle

The Wireless EV Charging Station with IoT Billing operates on the principle of electromagnetic induction, in which electrical energy is transferred wirelessly between two coils without direct physical contact. The system uses a transmitter coil and a receiver coil for wireless power transfer.

Initially, a 230V AC power supply is provided to the circuit. The input supply is converted into the required DC voltage using a rectifier circuit. A MOSFET switching circuit generates high-frequency alternating signals and supplies them to the transmitter coil. The transmitter coil produces an alternating magnetic field around it.

When the receiver coil is placed near the transmitter coil at a distance of approximately 2 cm, electromagnetic induction occurs. Due to this process, electrical energy is transferred wirelessly from the transmitter coil to the receiver coil. The received voltage is rectified and used to charge the demo battery.

An ESP32 microcontroller controls the entire charging operation and manages communication with the ThingSpeak cloud platform via Wi-Fi. An ultrasonic sensor is used to detect the vehicle's presence and position near the charging station. Once the vehicle is detected, the relay module automatically activates the charging process.

The charging status and billing information are displayed on the LCD module. Billing is calculated based on charging duration and updated to the ThingSpeak platform in real time. A GSM module is also integrated into the system for communication and notification purposes.

The developed system successfully demonstrates wireless charging, automatic monitoring, and IoT-based billing in a compact, efficient prototype.

5. System Architecture

The proposed Wireless EV Charging Station with IoT Billing comprises several interconnected modules that work together to enable wireless charging, automatic monitoring, and smart billing. The overall system includes a power supply unit, transmitter section, receiver section, control unit, sensing unit, display unit, and IoT communication system.

The system starts with a 230V AC power supply, which is converted into the required DC voltage using a rectifier circuit. The MOSFET switching circuit generates high-frequency alternating signals and supplies them to the transmitter coil. The transmitter coil creates an alternating magnetic field for wireless power transfer.

The receiver coil is placed near the transmitter coil and receives electrical energy through electromagnetic induction. The received voltage is rectified and used for charging the demo battery.

An ESP32 microcontroller serves as the system's main controller. It manages charging operations, controls data processing, and communicates with the ThingSpeak cloud platform via Wi-Fi. The ultrasonic sensor is connected to the ESP32 for vehicle detection and positioning. Once the vehicle is detected, the relay module automatically initiates the charging process.

An LCD display module is used to display charging status and billing information locally. A GSM module is also integrated into the system for communication and notification purposes. The billing system calculates the charging cost based on the charging duration and continuously updates the data to the ThingSpeak platform for real-time monitoring.

The complete system architecture provides wireless power transfer, automatic charging control, IoT-based monitoring, and smart billing in an efficient, compact setup.

6. Innovation and Advantages

The proposed Wireless EV Charging Station with IoT Billing offers a modern, smart solution for electric vehicle charging by integrating wireless power transfer with IoT. Unlike traditional charging systems that use physical cables, the proposed system wirelessly transfers electrical power via inductive coupling. This helps in reducing cable-related problems and makes the charging process safer and more convenient for users.

One of the important features of the system is the integration of the ESP32 microcontroller with the ThingSpeak cloud platform for real-time monitoring and automatic billing. The charging status and billing information can be monitored remotely via internet connectivity, making the system more efficient and user-friendly.

The system also includes an ultrasonic sensor for automatic vehicle detection. Charging starts only when the vehicle is

correctly positioned near the charging pad, improving automation and reducing unnecessary power consumption. Additional components such as the relay module, GSM module, and LCD display improve system control, communication, and monitoring.

7. Accessibility and future Adaptability

The proposed Wireless EV Charging Station with IoT Billing is designed to provide an easy, safe, and convenient charging solution for electric vehicles. Since the system uses wireless power transfer, there is no need for physical charging cables, which makes the charging process simpler and more user-friendly. The automatic charging operation and smart monitoring features also reduce manual effort and improve overall accessibility for users.

The integration of ESP32 with ThingSpeak allows users to monitor charging status and billing information remotely via the internet. This makes the system more flexible and better suited to modern smart applications.

The developed prototype can also be upgraded in the future to charge actual electric vehicles with higher capacity and greater efficiency. Additional technologies, such as mobile applications, online payment systems, solar energy integration, and AI-based charging management, can be added to further improve system performance.

The compact and modular design of the system makes it suitable for future smart cities and intelligent transportation infrastructure. Overall, the proposed system provides a flexible and future-ready solution for advanced EV charging applications.

8. Impact and significance

The proposed Wireless EV Charging Station with IoT Billing plays an important role in improving modern electric vehicle charging systems. The system provides a safer and more convenient charging method by removing the need for physical charging cables. This helps in reducing problems such as cable damage, maintenance issues, and safety risks caused by direct electrical connections.

The integration of IoT technology makes the system smarter by enabling real-time monitoring and automatic billing features. Users can easily monitor charging status and billing information via the ThingSpeak platform, thereby improving system efficiency and user convenience.

The project also supports the growing demand for smart and eco-friendly transportation systems. Wireless charging technology can make EV charging simpler and more comfortable for users, potentially encouraging wider adoption of electric vehicles.

In addition, the project demonstrates the practical implementation of wireless power transfer and IoT in a compact, efficient prototype. The system can contribute to

future smart EV charging infrastructure, smart city applications, and intelligent transportation systems.

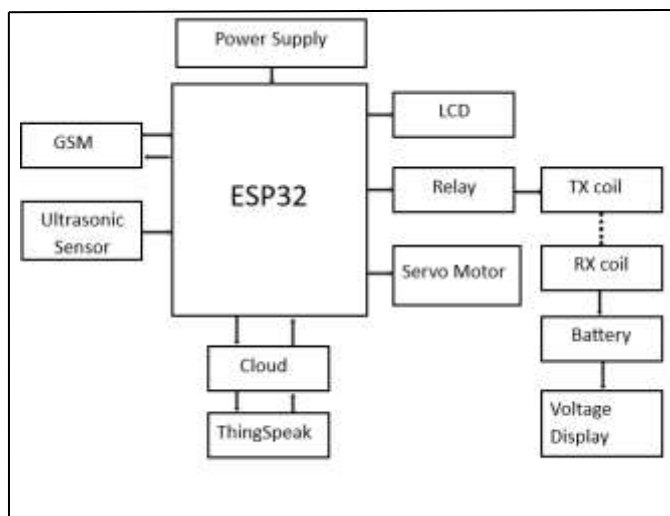


Fig.1. Block Diagram of System

9. METHODOLOGY

The proposed Wireless EV Charging Station with IoT Billing is designed to provide a smart, contactless charging solution for electric vehicles. The system operates on the principle of inductive coupling, in which electrical power is transferred wirelessly between two coils without a direct wire connection. The complete setup includes a power supply section, transmitter and receiver coils, control unit, sensing unit, and an IoT-based monitoring and billing system.

The system uses a 230V AC power supply as the input source. This input supply is converted into the required DC voltage using a rectifier circuit. A MOSFET switching circuit is used to generate high-frequency signals, which are supplied to the transmitter coil. The transmitter coil produces an alternating magnetic field around it.

When the receiver coil is placed close to the transmitter coil at a distance of around 2 cm, electromagnetic induction occurs. Through this process, electrical energy is transferred wirelessly from the transmitter to the receiver. The received voltage is then rectified and filtered before being used to charge the demo battery.

An ESP32 microcontroller is used as the main controller of the system. It manages the charging operation, processes charging data, and communicates with the IoT platform through Wi-Fi. The charging information and billing details are continuously updated to the ThingSpeak cloud platform for real-time monitoring.

To improve automation, an ultrasonic sensor is used for vehicle detection and positioning. The sensor checks whether the vehicle is properly placed near the charging pad. Once the vehicle is detected, the ESP32 activates the charging system through a relay module, which controls the ON and OFF operation of the charging circuit automatically.

A servo motor is also included in the setup for automatic movement and positioning control. An LCD display module is used to display charging status and billing information directly to the user.

The billing system is based on charging duration. The ESP32 calculates the charging cost according to the charging time and sends the updated data to the ThingSpeak platform. A GSM module is additionally used for communication and notification purposes.

The prototype was tested successfully, and effective wireless charging was achieved within the required coil distance. The developed system demonstrates wireless power transfer, automatic charging control, IoT-based monitoring, and smart billing features in a compact and efficient prototype.

10. APPLICATIONS

The proposed Wireless EV Charging Station with IoT Billing can be used in various electric vehicle charging applications where safe, smart, and contactless charging is required. The system can be implemented in public EV charging stations, smart parking areas, residential charging setups, and commercial charging infrastructure. It can also be used for charging electric bikes, scooters, and small electric vehicles.

The integration of IoT technology makes the system suitable for smart city and intelligent transportation applications, where real-time monitoring and automatic billing are important. The proposed model can also support future automated charging platforms and wireless power transfer research applications.

In addition, the system can be used in shopping malls, office parking areas, airports, railway stations, and university campuses where automated EV charging facilities are required. It can also be implemented in fleet management systems for electric buses and delivery vehicles. The project may further support future autonomous vehicle charging systems and sustainable green energy infrastructure.

Overall, the proposed system has wide applications in modern transportation, smart infrastructure, and advanced wireless power transfer technologies.

11. CONCLUSION

The Wireless EV Charging Station with IoT Billing successfully demonstrates a smart and efficient approach for charging electric vehicles without the need for physical charging cables. The system works using inductive coupling technology, where electrical power is transferred wirelessly between transmitter and receiver coils. During testing, the prototype was able to charge a demo battery successfully with a coil separation distance of nearly 2 cm.

The use of the ESP32 microcontroller along with the ThingSpeak platform enabled real-time monitoring and IoT-based billing functionality. The system continuously monitored charging activity and calculated billing information based on charging duration. The ultrasonic sensor helped in automatic vehicle detection, while the relay module controlled the charging operation automatically. The LCD display and GSM

module improved communication and allowed users to monitor system status easily.

Compared to traditional wired charging systems, the proposed model provides better safety, less maintenance, and greater convenience for users. The project also demonstrates the practical use of wireless power transfer combined with IoT technology for smart monitoring and automated billing.

In the future, the system can be improved further by increasing charging efficiency, extending the charging distance, and integrating renewable energy sources such as solar power. Overall, the project presents a promising solution for future smart EV charging infrastructure and advanced transportation systems.

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