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Automatic Billing System for Electric Vehicle Charging

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Abstract: This abstract presents an innovative automatic billing system for electric vehicle (EV) charging, coupled with a battery monitoring system, to ensure efficient and seamless operations. The proposed system integrates advanced sensors and communication technologies to enable real-time monitoring of charging sessions and battery health. Key features include automatic billing based on usage metrics, such as charging duration and energy consumption, and comprehensive battery monitoring to optimize performance and longevity. Additionally, the system incorporates safeguards against overcharging and overheating, enhancing safety for both EV users and infrastructure. Data collected during charging sessions are transmitted to a centralized platform for billing and analysis, facilitating streamlined operations and maintenance. Overall, this solution aims to improve the user experience, promote EV adoption, and contribute to the sustainable mobility ecosystem.

Keywords: Electric Vehicle, Automatic EV Charging, Charging Network, Battery management System.

1. Introduction

In The automatic billing system for electric vehicle (EV) charging represents a significant advancement in simplifying payment procedures and improving the user experience within the growing EV market. By leveraging advanced technology, this system automates billing processes, easing administrative burdens for both EV users and charging station operators. It integrates features like user authentication, session tracking, tariff structures, payment processing, and billing generation to ensure accuracy and efficiency in billing operations. As EV adoption rises and sustainable transportation becomes increasingly important, this system plays a vital role in facilitating widespread access to EV charging infrastructure. It simplifies payment processes for EV drivers and enables charging station operators to effectively monetize their investments while promoting sustainable transportation practices. Designed with scalability in mind, it accommodates the growing number of EV users and charging stations without compromising performance. Additionally, the system employs data analytics to optimize pricing strategies and infrastructure investments. In summary, the automatic billing system for EV charging streamlines billing operations, enhances user experience, and supports revenue generation, contributing to the development of a robust EV charging network and the widespread adoption of electric vehicles.

2. Existing Methodology

Limmer (2019) [1] discusses the importance of time-varying pricing, particularly dynamic pricing, in optimizing EV charging and integrating renewable energy sources into the grid. This approach incentivizes users to charge their vehicles during off-peak hours, contributing to grid stability and sustainability.

Yong et al. (2023) explore destination charging [2] as a crucial mode of EV charging and assess various charging tariffs, business models, and coordination strategies. Understanding these factors is essential for establishing

sustainable destination charging infrastructure and promoting EV usage. Vallejo et al. (2024) presents an optimization model for EV [3] charging schedules considering factors like demand, renewable energy integration, and grid stability. By identifying optimal charging times, this model minimizes costs and maximizes the utilization of renewable energy sources, supporting the transition to sustainable transportation.

Uthaya selva raja and Ramprabhuba (2021) propose an IoT-based charging system [4]to address issues related to billing accuracy and manipulation. By storing charging data securely on a shared ledger, this system ensures transparency and prevents fraudulent activities, enhancing trust in the billing process. Jeong et al. (2020) introduces a blockchain-based billing system to [5]enhance the security and reliability of EV charging transactions. By leveraging blockchain technology, this system prevents data tampering and ensures immutable billing records, fostering trust and accountability in EV charging operations.

The existing methodology for an automatic billing system for electric vehicle (EV) charging with a battery monitoring system involves user authentication to initiate charging, tracking the charging session duration and energy consumption, applying appropriate tariff structures for billing, processing payments through various methods, generating billing statements detailing session data, monitoring battery health parameters concurrently, transmitting data to a central database for analysis, and optionally sending notifications to users. This comprehensive approach ensures accurate billing, efficient payment processing, optimal battery management, and a seamless EV charging experience.

3. Proposed Methodology

The implemented automatic EV charging billing system efficiently charges the electric vehicle (EV) battery while automatically calculating the tariff for the power consumed. Data collected by the microcontroller unit (MCU) is transmitted to the NODEMCU and stored in cloud storage, enabling users to access past and present charging details via a dedicated app or website. The circuit operates on AC power supply, with a rectifier converting it to 12V 5Amps DC power the battery charge is below 10V, activating the relay circuit. Voltage and current sensors measure battery parameters, with the A/D converter transmitting data to the PIC Microcontroller. Upon full charge, the relay circuit switches off automatically, and the charge percentage is displayed on an LCD display. Tariff calculation is displayed on the LCD and transmitted to the NODE MCU for IoT connection. Cloud-stored data is accessible through a mobile application, providing comprehensive charging information for EV owners.

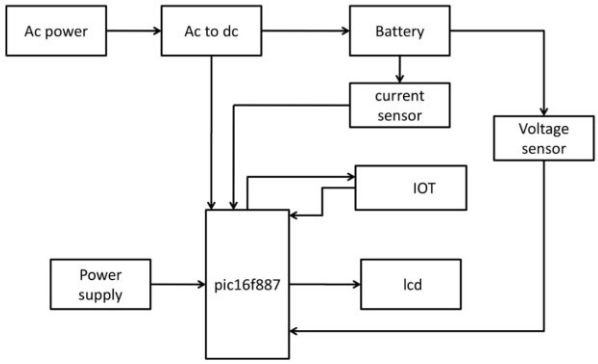

Figure 1: Block diagram of proposed ideology

The Block diagram of automatic billing system for electric vehicle charging with battery monitoring system employs an NODE MCU microcontroller connected to various components including a temperature sensor, A/D converter, LCD display, buzzer, and cloud. Power is supplied to the NODE MCU, while current and voltage sensors monitor the battery's electrical parameters. The A/D converter translates analog data from the sensors into digital format for transmission to the NODE MCU. Subsequently, the NODE MCU utilizes this data to display real-time information such as current, voltage, tariff, and battery management system (BMS) status on the LCD display. A buzzer signals the battery reaches full charge. Furthermore, the NODE MCU sends collected data to the cloud for storage and analysis. This data is then relayed to a dedicated mobile application developed by the system owner, providing users with instant access to detailed insights regarding battery performance, charging status, and tariff information. Overall, this integrated system offers comprehensive monitoring and control capabilities, enhancing the efficiency and convenience of electric vehicle charging operations.

4. Schematic structure of smart EV charging system

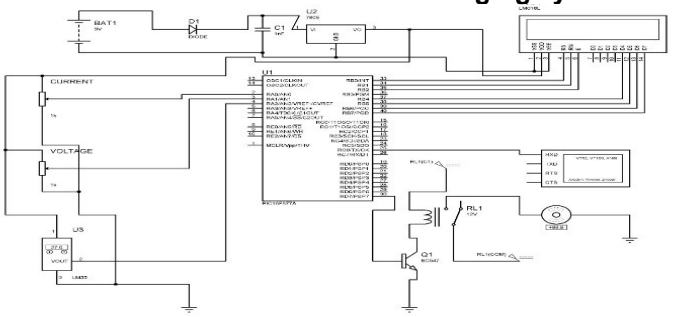

Figure 2: Circuit diagram of EV charging system

The circuit diagram of automatic billing system utilizes a PIC16F877A microcontroller, incorporating various

sensors and components for electric vehicle (EV) charging and monitoring. The PIC16F877A facilitates digital I/O operations, with pins 33, 34, 35, 37, 38, and 39 connected to an LM016L LCD display for visual output. Pins 2, 3, and 4 interface with current, voltage, and temperature sensors respectively, while pin 25 connects to a VT100 for data reception. A relay circuit, composed of a 12V relay switch (RL1), and a bipolar junction diode (BC547), controls battery charging. The LM35 temperature sensor measures battery temperature, facilitating safe charging. The LM35's output voltage regulates the charging process via the PIC16F877A. Additionally, the microcontroller interfaces with a cloud database via an NODE MCU module, transmitting charging data and tariff information to a mobile application for user accessibility. The battery reaches full charge, a buzzer alerts users, and charging is terminated. Overall, this integrated system ensures efficient EV charging, real-time monitoring, and user-friendly control through a mobile interface.

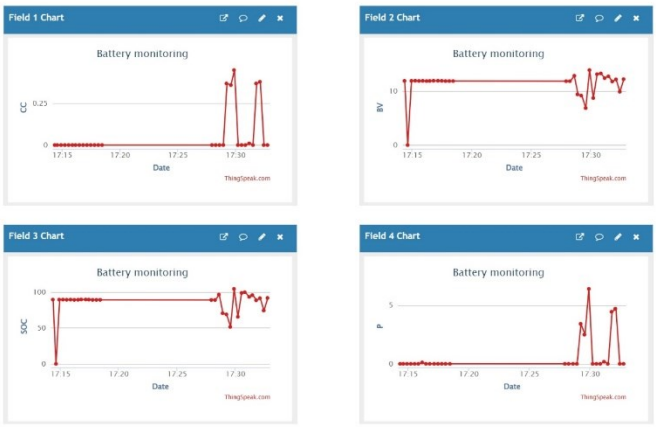

Figure 3:Output Image of smart charging

The above figure shows that the current and voltage measured by the sensor in the implemented system is measured and stored in the cloud and the BMS value of the battery is calculated automatically and the time taken for the implemented system to charge the battery and the battery is monitored for the voltage and current through the battery and the app developed by us is used to store the data in the cloud and can be viewed by the user. The past data of charging and the tariff amount for charging the battery is stored in the cloud with the date and time of charging is being displayed in the app or web link page of the developed software.

5. CONCLUSION

In conclusion, the automatic billing system that the ideas for implemented successfully in both the software and the hardware prototype module and by the development of the product is easy to implement and its cost is compactable. The communication also made too simple as compared to standing in a queue for a long time to pay the amount. In this system the architecture is easy to implement in electric vehicle system and it can save time, money and energy. The fast growth of electric vehicle with attached electricity charge billing statement will be more efficient in recent years. More over transferring of money and giving change for the particular rupee can be avoided and by growing the digital system all over the world to make our country grow better.

The electric vehicle charging not only can it provide convenient charging solution for car owners, but it can also reduce environmental pollution and reduce the energy costs. Electric vehicle charging piles play an important role in promoting sustainable transportation development. Automatic billing for electric vehicle charging offers convenience, efficiency, and transparency to both EV owners and charging station operators. By integrating seamless payment systems with charging infrastructure, users can enjoy hassle-free transactions while operators benefit from streamlined revenue collection processes. This approach promotes wider EV adoption, enhances user experience, and contributes to the growth of sustainable transportation infrastructure. Careful consideration of privacy, security, and interoperability standards is essential to ensure widespread acceptance and trust in automatic billing systems within the EV ecosystem.

In implementing billing for vehicle charging is a crucial step towards sustainable transportation infrastructure. By accurately charging users for the energy they consume, operators can maintain and expand charging networks while ensuring fair compensation for services rendered. Effective billing systems encourage responsible energy usage, promote investment in renewable energy sources, and support the widespread adoption of electric vehicles. It's essential to prioritize user convenience, affordability, and accessibility in billing processes to encourage EV adoption and facilitate the transition to a greener transportation future.

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