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ZigBee-Based Self-Service Charging Framework for Plug-in Electric Vehicles

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Abstract: This research presents a self-service charging structure for plug-in type electric vehicles, which includes multiple charging stations, a data service centre, and a mobile communication service centre. Each charging station is equipped with ZigBee networking devices, a charging station computer monitoring centre, and several chargers. The ZigBee networking equipment establishes a wi-fi connection with a ZigBee terminal node device in the electric vehicle. Each charger comprises a charger information management unit, an IC magnetic card identification device, a touch screen, a printer, and a charging device. The proposed self-service charging structure overcomes the issues of unstable electrical connection and high networking complexity associated with both wired and wi-fi communication procedures. It enables user-friendly, safe, auto, and intelligent charging processes without the need for manual intervention. Additionally, the structure supports multiple charging service modes. The research also presents a self-service charging procedure for plug-in type electric vehicles.

***Keywords**: Self-service charging structure, plug-in type electric vehicle, ZigBee networking, wi-fi communication, charging station, user operation, auto charging, intelligent charging, charging service modes.*

Introduction

The widespread adoption of plug-in type electric vehicles (PEVs) has led to an increasing demand for efficient and convenient charging infrastructure. Traditional charging structures often rely on wired or wi-fi communication connections between the charging station and the PEV, which can result in unstable electrical connections, high networking difficulties, and implementation costs. To address these challenges, this research proposes a self-service charging structure for PEVs based on ZigBee networking technology. The self-service charging structure comprises multiple charging stations, a data service centre, and a mobile communication service centre. Each charging station is equipped with ZigBee networking equipment, a charging station computer monitoring centre, and multiple chargers. The ZigBee networking equipment establishes a ZigBee wi-fi communication network with a ZigBee terminal node device in the PEV. Each charger within the structure includes a charger information management unit, an IC magnetic card identification device, a touch screen, a printer, and a charging device. The primary objective of this research is to overcome the limitations of existing charging structures by providing a self-service solution that offers stable electrical connections and reduces networking difficulties and implementation costs. By utilizing ZigBee wi-fi communication, the proposed structure ensures reliable connectivity between the charging station and the PEV, eliminating the issues associated with wired or traditional wi-fi connections. Furthermore, the self-service charging structure enables users to conveniently and autonomously charge their PEVs without the need for manual intervention. The figure (Fig.1) below exhibits a basic diagram of Capacitive Wi-fi Power Transfer.[4]

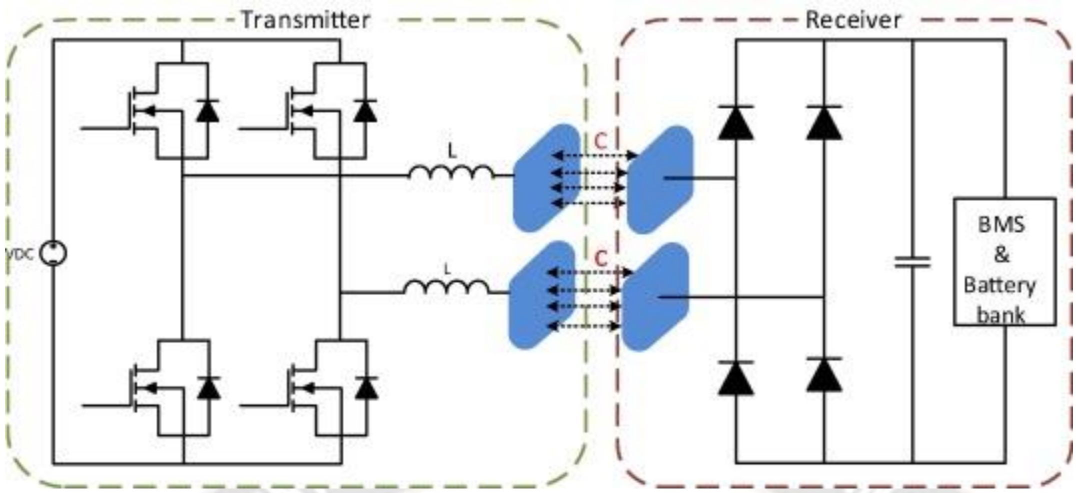

Fig.1: Diagram of Capacitive Wi-fi Power Transfer.

The user-friendly interface, coupled with auto and intelligentized charging processes, enhances the overall charging experience. The structure also supports multiple types of charging service modes, accommodating various user preferences and requirements. In addition to presenting the self-service charging structure, this research also introduces a self-service charging procedure for PEVs. The procedure outlines the step-by-step procedures for utilizing the structure effectively and maximizing its benefits. By developing this innovative self-service charging structure and procedure, this research aims to contribute to the advancement of electric vehicle charging infrastructure, promoting the widespread adoption of PEVs by addressing the challenges associated with traditional charging structures.

Related Work

The increasing concern over pollution caused by exhaust emissions from traditional fuel-engined vehicles and the excessive consumption of petroleum resources has driven the development and focus on electric vehicles (EVs) as a promising solution.[1] EVs offer significant environmental benefits and energy conservation potential, making them a focal point of international automotive development efforts. As the commercialization of EVs continues to expand, the establishment of electric vehicle charging stations has become an essential component of the EV energy service infrastructure. Currently, plug-in electric vehicles rely on charging stations to replenish the power battery pack within the vehicle. However, due to the potential risks of overcharging, such as battery damage or explosion accidents, it is crucial to monitor the real-time status of each battery during the charging process.[2] While vehicle-mounted battery management structures (BMS) have the capability to monitor the battery status, charging stations lack the ability to access this real-time information. Therefore, establishing a communication link between the charging station and the vehicle-mounted BMS is necessary. In some laboratory simulations, the CAN bus has been employed as a communication medium to connect the charging station with the vehicle-mounted BMS. However, the use of a wired medium like the CAN bus in the actual charging operations poses several challenges.[3] The repeated plugging and unplugging of the charging connection can result in unstable electrical connections, leading to technical issues such as charging malfunctions, uncontrolled charging, or communication failures. Therefore, there is a need to explore alternative communication procedures that can address the limitations of wired connections in charging operations.[4] This research aims to develop a self-service charging structure for plug-in type electric vehicles that utilizes ZigBee wi-fi communication technology. By leveraging ZigBee networking equipment, the proposed structure aims to establish a reliable and stable communication link between the charging station and the vehicle-mounted BMS.[5] This wi-fi communication approach offers improved safety, convenience, and efficiency in the charging process, overcoming the challenges associated with wired connections. The successful implementation of a self-service charging structure with ZigBee wi-fi communication can significantly contribute to the advancement and wider adoption of electric vehicles, ensuring a more sustainable and efficient transportation ecostructure.

Research Objective

The objective of this research is to design and implement a self-service charging structure for plug-in type electric

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vehicles using ZigBee networking technology. The research aims to address the challenges associated with unstable electrical connections, high networking difficulties, and implementation costs. The main goals include achieving self-service charging functionality, ensuring user convenience and safety, automating the charging process, and providing multiple charging service modes. The research also aims to develop a comprehensive self-service charging procedure for plug-in type electric vehicles.

ZigBee-Enabled Self-Service Charging Structure for Electric Vehicles

The self-service charging structure for plug-in electric vehicles (PEVs) is composed of several charging stations, a data service centre, and a mobile communication service centre. Each charging station is equipped with various components. Firstly, the ZigBee networking equipment establishes a wi-fi connection with the ZigBee terminal node device in the plug-in electric vehicle through a ZigBee cordless communication network. This ensures seamless communication between the charging station and the vehicle. The charging station also includes a charging station computer monitoring centre, which is connected to both the ZigBee networking equipment and the data service centre. This monitoring centre serves as the control hub for the charging station, allowing it to communicate and exchange data with the other components of the structure. Additionally, each charging station is equipped with multiple chargers. Each charger consists of a charger information management unit, an IC magnetic card recognition device, a touch-screen interface, and a charging device. The charger information management unit is connected to the charging station computer monitoring centre, enabling real-time monitoring and control of the charging process. The IC magnetic card recognition device is responsible for identifying and authenticating the user's card for billing purposes. The touch-screen interface provides a user-friendly interaction platform for initiating and managing the charging process, while the charging device supplies the necessary electrical power to charge the electric vehicle.

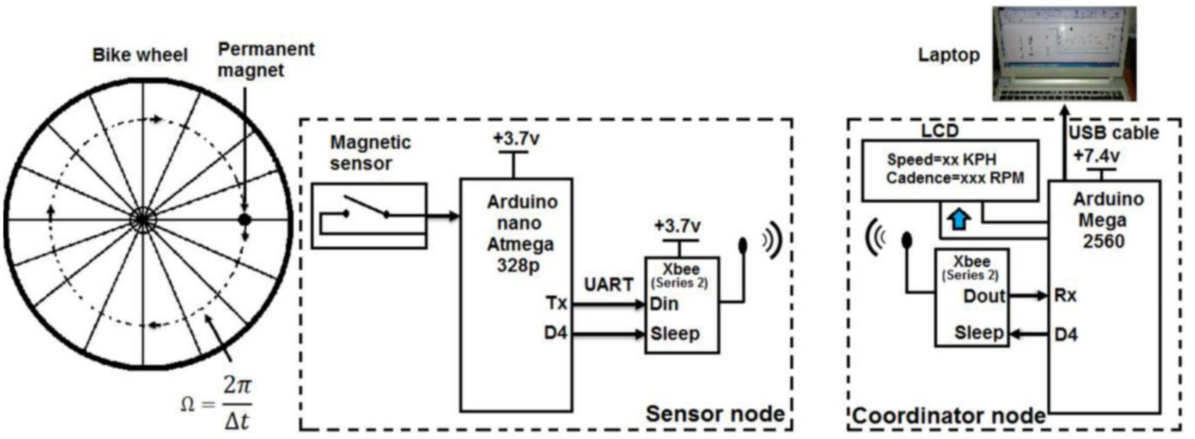

Fig. 2: ZigBee-Based Wi-fi Sensor Network for Track Bicycle Performance Monitoring

This self-service charging structure aims to address various challenges associated with traditional charging procedures. One challenge is the unstable electrical connections that can occur with wired communication connections between the charging structure and the plug-in electric vehicle. By utilizing the ZigBee cordless communication network, the self-service charging structure ensures a reliable and stable connection, eliminating issues caused by unstable electrical connections. Another challenge is the high networking difficulty and implementation cost associated with wi-fi communication connections. The integration of ZigBee networking equipment in each charging station simplifies the networking process and reduces implementation costs, making it more feasible and cost-effective to deploy the self-service charging structure. The diagram above (**Fig**.2) portrays a ZigBee-Based Wi-fi Sensor Network for Track Bicycle Performance Monitoring.

The self-service charging structure provides several advantages. Firstly, it enables users to charge their plug-in electric vehicles conveniently and autonomously without the need for manual intervention. The user-friendly touch-screen interface allows users to initiate and monitor the charging process easily. Secondly, the structure ensures safety through auto and intelligentized charging processes. The real-time monitoring capabilities of the charging station computer monitoring centre, coupled with the charger information management unit, provide comprehensive control and oversight of the charging process, ensuring safe and efficient charging operations. Additionally, the self-service charging structure offers flexibility by providing multiple types of charging service modes. Users can choose the charging mode that best suits their needs and preferences, enhancing the overall user experience and convenience.

In summary, the self-service charging structure for plug-in electric vehicles consists of charging stations, a data service centre, and a mobile communication service centre. Each charging station incorporates ZigBee networking equipment, a charging station computer monitoring centre, and multiple chargers. This structure addresses the challenges of unstable electrical connections, high networking difficulty, and implementation cost, enabling self-service charging with easy user operation, enhanced safety, auto and intelligentized charging processes, and support for various charging service modes. The integration of ZigBee wi-fi communication technology ensures a reliable and efficient connection between the charging station and the plug-in electric vehicle, facilitating the widespread adoption of electric vehicles and contributing to a sustainable transportation ecostructure.

Conclusion

In conclusion, this research has presented a self-service charging structure for plug-in electric vehicles (PEVs) that utilizes ZigBee wi-fi communication technology. The structure comprises multiple charging stations, a data service centre, and a mobile communication service centre. Each charging station is equipped with ZigBee networking equipment, a charging station computer monitoring centre, and multiple chargers. The implementation of this self-service charging structure addresses the limitations and challenges of traditional charging procedures. By leveraging ZigBee wi-fi communication, the structure ensures a stable and reliable connection between the charging station and the PEV, overcoming the issues associated with unstable electrical connections and high networking difficulty.

The self-service nature of the structure allows users to charge their PEVs conveniently and autonomously without manual intervention. The user-friendly touch-screen interface and auto charging processes enhance the overall charging experience, promoting ease of use and user satisfaction. Moreover, the structure prioritizes safety by incorporating real-time monitoring and control capabilities, ensuring the secure and efficient charging of the PEV. Furthermore, the self-service charging structure offers flexibility through its support for multiple charging service modes. This accommodates the diverse needs and preferences of users, promoting a personalized charging experience. The successful development and implementation of this self-service charging structure contribute to the advancement of electric vehicle charging infrastructure. By providing a reliable, convenient, and efficient charging solution, the structure promotes the wider adoption of PEVs, thereby reducing pollution from traditional fuel-engined vehicles and conserving petroleum resources. Future research directions may involve further optimization of the self-service charging structure, considering factors such as scalability, interoperability with other charging structures, and integration with renewable energy sources. Additionally, the structure could benefit from continuous enhancements to its user interface and charging management algorithms to ensure seamless and intuitive operation. In conclusion, the self-service charging structure presented in this research represents a significant step towards establishing a sustainable and user-friendly charging infrastructure for plug-in electric vehicles. By addressing the limitations of traditional charging procedures, the structure contributes to the ongoing global effort to transition towards a cleaner and more energy-efficient transportation ecostructure.

References:

1. Liu, Xiaochen, et al. "PEDF (photovoltaics, energy storage, direct current, flexibility), a power distribution system of buildings for grid decarbonization: Definition, technology review, and application." CSEE Journal of Power and Energy Systems (2022).
2. Toward social equity access and mobile charging stations for electric vehicles: A case study in Los Angeles M Nazari-Heris, A Loni, S Asadi, B Mohammadi-ivatloo - Applied Energy, 2022 – Elsevier
3. Charging electric vehicles today and in the future J Leijon, C Boström - World Electric Vehicle Journal, 2022 - mdpi.com
4. Design and Application of Customer Services Business Middle Platform for Opening Service Capabilities of Electric Power Marketing - H Lin, Q Zhang, W Yang, Z Wu, C Zhang - 2021 7th Annual - 2021 - ieeexplore.ieee.org
5. Innovation cognizance and acceptance: The case of electric vehicles adoption in Ontario, Canada - R Singh, P Walsh, J Goodfield - Journal of Innovation - 2021 - journalengineering.fe.up.pt

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6. Commercialization of Electric Vehicles in Hong Kong T Mo, K Lau, Y Li, C Poon, Y Wu, PK Chu, Y Luo - Energies, 2022 - mdpi.com
7. External benefits calculation of sharing electric vehicles in case of Chongqing China S Lefeng, L Chunxiu, D Jingrong, L Cipcigan - Utilities Policy, 2020 – Elsevier
8. Self-controlling resource management model for electric vehicle fast charging stations with priority service EA Kakillioglu, MY Aktaş, N Fescioglu-Unver - Energy, 2022 – Elsevier
9. Service failure risk assessment and service improvement of self-service electric vehicle D Zhang, Y Li, Y Li, Z Shen - Sustainability, 2022 - mdpi.com
10. Electric vehicle aggregate power flow prediction and smart charging system for distributed renewable energy self-consumption optimization F Lo Franco, M Ricco, R Mandrioli, G Grandi - Energies, 2020 - mdpi.com