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Individual-Service Charging Structure for Pluggable Type EVs: Short Range Wi-fi-Based Approach

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Abstract:

This research paper presents individual-service charging structure for pluggable type EVs (PHEVs) that addresses the challenges associated with unstable electrical connections and high implementation costs. The proposed structure comprises a network of charging points, a information centre, and a mobile exchange centre. Each charging station is equipped with short range wi-fi networking equipment, a charging station computer monitoring centre, and multiple chargers. The Short-range wi-fi networking equipment establishes a wi-fi exchange network with the Short range wi-fi terminal node apparatus of the PHEV. Furthermore, each charger is equipped with various components such as a charging station management unit, an IC magnetic card reader, a touch-sensitive screen, a printing apparatus, and a charging mechanism. The individual-service charging structure enables users to charge their vehicles while providing multiple types of charging service modes conveniently and safely. Additionally, individual-service charging procedure for PHEVs is introduced.

Keywords: Individual-service charging, Pluggable type EV, Short range wi-fi networking, Charging station, Wi-fi exchange.

Introduction:

The increasing popularity of pluggable type EVs (PHEVs) demands a reliable and user-friendly charging infrastructure. This paper introduces a individual-service charging structure that overcomes the limitations of traditional wired and wi-fi exchange connections.[1] The proposed structure utilizes Short range wi-fi

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networking technology to establish a robust and efficient exchange network between the charging points and PHEVs. By eliminating the need for manual intervention during the charging process, the structure offers easy and convenient user process, enhanced safety, and an automated and intelligent charging process. Moreover, the structure supports multiple types of charging service modes, catering to the diverse needs of PHEV owners.

Related Work:

The growing concerns regarding pollution caused by traditional fuel-engined vehicles and the excessive consumption of petroleum resources have led to a significant focus on EVs (EVs) as a solution.[1] EVs offer good environmental protection and energy conservation characteristics, making them a key focus of international automobile development and research.[2,3] Governments, automotive companies, and research institutions worldwide are investing in the research and development of EV engineering and applications. It is predicted that EV charging points will become an essential infrastructure for EVs once they are widely adopted.[4,5]

Currently, pluggable EVs recharge their power battery packs by connecting to charging points. 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 to ensure safe charging.[6] Vehicle-mounted battery management structures (BMS) have the capability to monitor the status of each battery within the power battery pack. However, charging points lack the ability to monitor the real-time status of each battery. Therefore, there is a need to establish a exchange link between the charging station and the vehicle-mounted battery management structure.[7,8]

In some laboratory simulation charging measurements, the CAN bus has been used to establish exchange between the charging station and the vehicle-mounted battery-management structure. However, the CAN bus is a wired medium, and the repeated plugging and unplugging during actual charging operations can result in unstable electrical connections. This instability can lead to technical issues such as charging failures, charging out of control, or exchange failures.[9] Additionally, before a charging station can charge a pluggable EV, the user needs to understand the performance of the vehicle's power battery pack. During the charging process, the charging station staff or the user must manually input the power battery pack information, which can introduce errors and potentially lead to charging failures or accidents, impacting the quality of the charging service. Furthermore, the manual nature of the charging process restricts the ability to carry out intelligent and automated charging.

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Therefore, there is a need for a individual-service charging structure that addresses these limitations. Such a structure would provide stable and reliable electrical connections, eliminate manual input errors, and enable automated and intelligent charging processes. This research aims to develop a individual-service charging structure for pluggable type EVs that utilizes Short range wi-fi networking technology. The structure will allow for easy and convenient user operation, enhanced safety, and multiple types of charging service modes to meet the diverse needs of EV owners. By overcoming the challenges of wired and wi-fi exchange connections, the proposed structure will contribute to the widespread adoption and success of EVs.[6]

Research Objective:

The main objective of this research is to develop a individual-service charging structure for pluggable type EVs that addresses the drawbacks of existing charging structures. The specific research objectives are as follows:

- Designing a network of charging points equipped with Short range wi-fi networking equipment and chargers. (FIG. 1)
- Implementing a wi-fi exchange network between the charging points and PHEVs using Short range wi-fi technology.
- Developing a user-friendly interface for the individual-service charging structure, including touch screen controls and printer integration.
- Integrating an IC magnetic card identification apparatus for secure and convenient user authentication.
- Ensuring a stable and reliable charging process with automated and intelligentized features.
- Investigating and implementing multiple types of charging service modes to accommodate various user requirements.
- Evaluating the performance, usability, and effectiveness of the individual-service charging structure.

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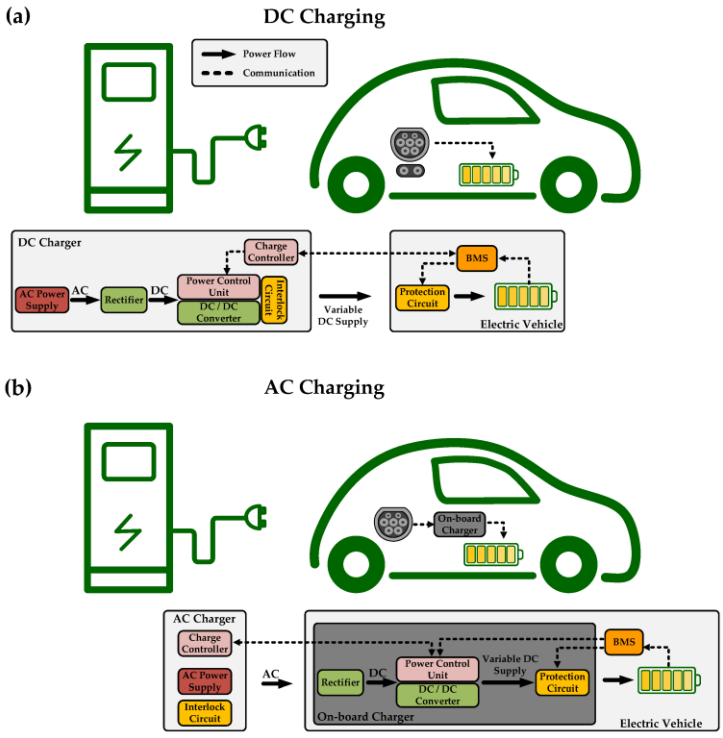

Fig. 1 basic architecture

Research:

The individual-service charging structure for pluggable EVs described in the research provides several key features and advantages:

Short range wi-fi Networking Equipment:

The structure is equipped with Short range wi-fi networking equipment, which allows exchange between the charging station and the vehicle-mounted battery management structure. This exchange is facilitated through the Short range wi-fi terminal node apparatus of the pluggable EV using a Short range wi-fi cordless exchange network. By utilizing Short range wi-fi, the structure enables real-time monitoring of the power battery pack's state in the pluggable EV. This overcomes the limitations of wired connections, instability, control issues, and exchange failures often experienced with traditional charging procedures.

Touch-screen Interface:

The structure incorporates a touch-screen interface, providing a simple and user-friendly interaction platform. Users can easily select the desired charging service through the touch-screen without needing to understand the internal workings of the power battery pack. This eliminates the need for manual intervention, making the entire charging process intelligent and automated for the pluggable EV.

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IC Magnetic Card Recognition:

To simplify charging operations and improve safety, the structure includes an IC magnetic card recognition apparatus. This apparatus can automatically read the user-automobile batteries group information stored in the IC magnetic card of the pluggable EV. By automatically retrieving this information, the structure eliminates the potential for input errors when manually entering power battery pack information. This significantly reduces the risk of charging failures and accidents, enhancing the overall quality of the charging service. The user can enjoy a simple, convenient, and individual-service charging experience.

Information Centre and Mobile Exchange Centre:

The structure comprises a information centre and a mobile exchange centre. The information centre is responsible for calculating the charging fees based on the charge transferred electric energy of the pluggable EV at each charging station. The user's electronic account is then deducted accordingly. Additionally, the mobile exchange centre sends informative service messages to the user's phone number. These messages include charging payment notifications, reminders of insufficient electronic account balance, and even remote troubleshooting assistance in case of charge faults.

Multiple Charging Service Options (COS):

The structure offers various charging service options to meet the diverse needs of users. These options include charging services based on charge capacity, charging interval, standard charging services, and individual-defined charging services. This flexibility ensures that users can choose the most suitable charging service based on their specific requirements.

The research proposes a individual-service charging structure for pluggable EVs that integrates Short range wi-fi networking, touch-screen interaction, IC magnetic card recognition, information centres, mobile exchange centres, and multiple charging service options. This structure enhances convenience, safety, efficiency, and user satisfaction in the charging process, overcoming the limitations of traditional charging procedures. The use of Short range wi-fi technology enables reliable exchange, the touch-screen interface simplifies user interaction, and the IC magnetic card recognition streamlines charging operations. Furthermore, the integration of information and mobile exchange services ensures accurate billing and provides users with timely notifications and assistance. Overall, this individual-service charging structure represents a significant advancement in pluggable EV charging technology.

1. Design the individual-service charging structure for pluggable EVs, which includes a plurality of charging points, a information centre, and a mobile exchange centre.

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2. Each charging station is equipped with Short range wi-fi networking equipment, a charging station computer monitoring centre, and multiple chargers.
3. Establish a Short range wi-fi exchange network to connect the Short range wi-fi networking equipment with the Short range wi-fi terminal node apparatus of the pluggable EV.
4. Connect the charging station computer monitoring centre with the Short range wi-fi networking equipment and the information centre.
5. Each charger consists of a charging station management unit, an IC magnetic card reader, a touch-sensitive screen, a printing apparatus, and a charging mechanism.
6. The charging apparatus includes rechargeable electrical energy metering units, charging circuits, and a charging control unit for controlling the charging process.
7. Store user basic information in the information centre, including unique electronic IDs for user identity, electronic account details, remaining account balance, and phone numbers.
8. The touch screen interface includes a user basic information modification interface for users to update their information.
9. Store charge information in the information centre, including unique electronic IDs for charging station titles, user identity, battery pack, individual-service charge mode, charging start time, charging termination time, charge transferred electric energy, and charge fault records.
10. The touch screen interface includes a historical query interface to access and display past charging information.
11. Each charger is equipped with a printer connected to the charger information management unit for printing historical charging inventories or payment vouchers.
12. Develop a individual-service charging procedure for pluggable EVs.
13. Establish a Short range wi-fi exchange link to obtain the unique electronic ID of the pluggable EV's battery pack and the IC magnetic card record's unique electronic ID.
14. Verify if the electronic IDs of the battery pack and the IC magnetic card match. If they do, proceed with the charging process.
15. Generate a charging instruction based on the user's individual-service charging operations information and initiate charging for the pluggable EV according to the instruction.
16. Obtain real-time battery pack status information through the Short range wi-fi exchange network and control the charging process based on this information.
17. Calculate the amount of charge transferred from the charger to the pluggable EV.
18. Calculate the charging fees based on the transferred charge and deduct the fees from the user's electronic account.

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19. Send a charging completion notification and the payment amount to the user's phone number via SMS.
20. Optionally, provide a historical query instruction to access and display past charging information.
21. Access the stored charge information based on the historical query instruction and generate and print historical charging inventories or payment vouchers.
22. Optionally, allow users to modify their basic information by providing a user basic information modification instruction.
23. Update the relevant fields in the user's basic information based on the modification instruction.
24. Optionally, implement a safeguard mechanism to check if the battery pack's electronic ID and the IC magnetic card record's electronic ID repeatedly fail to match within a preset time. If this occurs, prompt the user to seek manual assistance.
25. Implement intelligent charging control based on battery pack real-time status information, such as adjusting charging current based on battery state-of-charge and temperature.
26. Stop the charging process when the user's individual-service charging operations information requirements are met, such as reaching the desired state-of-charge or elapsed time.
27. Conclude that the proposed individual-service charging structure and procedure provide a convenient, automated, and intelligent solution for pluggable EV charging, addressing the limitations of wired and wi-fi exchange connections, manual input errors, and lack of automation in existing charging structures.

Conclusion:

This research presents a individual-service charging structure for pluggable type EVs that leverages Short range wi-fi networking technology to overcome the limitations of traditional charging structures. The proposed structure offers a convenient and user-friendly charging experience, eliminating the need for manual intervention and reducing implementation costs. By providing multiple types of charging service modes, the structure caters to the diverse needs of PHEV owners. The integration of secure user authentication and automated charging processes ensures safety and reliability. Future work may focus on the scalability and interoperability of the structure, as well as exploring additional advanced features to further enhance the charging experience for PHEV users.

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