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Summary of Intelligent Charging Station Management Platform

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Abstract

This paper analyzes the design process of charging pile management platform, summarizes the design of charging device end, cloud server and client, expounds the transmission mode of charging information, analyzes the basic method of charging pile location, discusses the protection measures of system security, studies the design scheme of client, and analyzes the problems existing in the development process Finally, some suggestions for improvement are put forward, and the future development direction is prospected.

Keywords

Charging pile management platform; charging pile location; server platform; client design.

1. Introduction

Resource and energy issues are related to the lifeblood of international economic development, and the severe energy issues have become the prominent issues concerned by all countries in the world. In recent years, under the global climate warming and energy crisis, vigorously developing electric vehicles has become one of the important measures to reduce oil dependence and energy conservation and emission reduction in China. The general office of the State Council issued the guiding opinions on accelerating the construction of electric vehicle charging infrastructure, which pointed out: strive to basically build a moderately advanced, vehicle pile, intelligent and efficient charging infrastructure system by 2020 to meet the charging demand of more than 5 million electric vehicles [1]. Under the "intelligent" boom, the design of charging platform based on "Internet plus" has become a major trend in the development of the industry. However, due to the late development of new energy vehicles in China, the charging pile industry is in the initial stage of development, such as charging efficiency, charging pile site selection and user experience, there are still large defects, which need continuous market research and technology update.

2. Overall architecture of management platform

The management platform is mainly composed of software and hardware. At present, most of them use hierarchical architecture to design the whole platform. Hierarchical architecture model can greatly simplify the business logic, make the system run more secure and stable, reduce the coupling between various levels and functions, improve the portability and scalability of the system, and facilitate the modular development. So the whole system is divided into perception layer and control layer and other hardware parts, and transmission layer, business layer, database layer and customer layer and other software parts.

2.1. Perception layer

It is mainly composed of various sensors and monitoring equipment. The sensor is used to collect the relevant parameters during the operation of the charging pile, and the data is converted, and finally transmitted to the business layer through the transport layer.

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2.2. Transport layer

The transport layer is the interactive path between the terminal and the server. The wireless sensor network mainly sends the information collected by the sensing layer and all kinds of requests sent by the client layer to the business layer and database layer, and sends the response of the business layer to the corresponding control layer and client.

2.3. Business layer

Business layer is the core of the interaction between terminal and server. It is mainly used to realize the actual processing of business logic. When the transport layer transmits all kinds of information to the cloud server, the server transfers the program in the business layer to analyze and process, and sends the results to the corresponding terminal through the transport layer, so as to complete the whole response work.

2.4. Control layer

It is mainly responsible for the implementation of the response, that is to complete the specific control operations, such as controlling the start and stop of the charging pile, starting the alarm device and automatic fire extinguishing module when the various parameters of the charging pile reach the threshold.

2.5. Database layer

Data storage resources. It includes real-time data, user information, administrator information and other related information in the process of system operation. The amount of real-time information data is huge, such as user information, charging power, cost, various related parameters of charging pile, monitoring data, user orders and so on.

2.6. Customer layer

That is, the user can see the system interface, which is mainly used to meet the user's basic operations such as starting and stopping charging pile, querying order information and recharging.

The construction of management platform needs to establish "one platform, two insurance, three-level control" from data collection, transmission, storage, analysis and decision-making of charging equipment, so as to realize the control of "people and property" of charging station before, during and after the event. The so-called "one platform" means to build a big data platform; "double insurance" means that when the charging equipment is abnormal, the fire-fighting equipment can act in two ways: automatic and remote manual; "three level control" means to control the relevant charging equipment from the regional level, site level and equipment level. The control of "human property" refers to the control of human behavior in the charging station to ensure the traceability of behavior; the control of property refers to the control of assets in the charging station to ensure the recording of asset information; the control of material refers to the control of the status of equipment in the charging station to ensure the safe and stable operation of charging equipment [4].

3. Design of charging device end

The main body of charging device is charging pile, including sensing layer, transmission layer and control layer. At present, most of the built charging piles can meet the general charging demand, but to further promote the development of the electric vehicle industry, we must strengthen the safety of charging piles, optimize the location and improve the charging efficiency.

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3.1. Charging device information transmission

The charging pile can provide its own data to the cloud server in real time, which is the basic guarantee to ensure the charging safety. Most of the charging piles use various sensors to collect the charging pile related information, such as charging voltage, current, temperature, CO gas concentration, and then transmit it to the cloud server. In reference[2], it is proposed to transmit data through 4G network to ensure the real-time performance of data transmission, but this method is not applicable in areas where the network quality cannot be guaranteed normally. In reference[3], ZigBee and PLC (power line carrier communication technology) network are used for data communication to realize the redundancy of data link, so that the data can be safely and accurately transmitted to the service layer, which is conducive to further intelligent information processing [3]. ZigBee and PLC have the advantages of low power consumption, low cost, high security performance, but ZigBee is only suitable for short-range data transmission, And the research and development of related equipment is still in the primary stage. Reference [4] proposed the use of DTU (data transfer unit) wireless communication module to transfer the collected charging pile data from the transmission layer to the application layer. DTU has the advantages of always online link support, flexible networking, wide network coverage, high security and low user cost. Compared with 4G network, DTU is more flexible and effectively reduces the construction cost, which is suitable for the design of urban electric vehicle charging pile.

In order to solve the problem of information transmission delay caused by poor network conditions in remote areas, reference [5] proposed the application of nb-iot technology to transmit data. Nb-iot is the narrow-band Internet of things, which is built in the cellular network. Compared with the traditional GPRS network, the network of nb-iot has the advantages of wider signal coverage, faster transmission rate and lower power consumption. Nb-iot has stronger link ability. With the same base station, the access amount of equipment can theoretically reach 100 times of the traditional GPRS network, In areas with unstable network quality, such as remote roads and underground parking lots, nb-iot technology can ensure the normal real-time transmission of data, and the battery life of nb-iot equipment is further improved, reducing the project cost.

With the development of electric vehicles, the charging demand of users tends to be diversified. In reference [6], the idea of using two charging piles to charge an electric vehicle at the same time is proposed, and based on this, the group control operation management unit is designed to control and manage multiple charging piles [6], and the main pile and auxiliary pile are set in the charging pile for management operation, so as to further diversify the charging options and reduce the number of different charging stations, The design can be used in the scene of shopping malls and other vehicles with large mixture.

3.2. Charging pile site selection

At present, most of the charging pile location is determined according to whether the selected site meets the technical conditions, and does not take the number of electric vehicles and power resources in the station area as constraints. The imperfect location further restricts the development of the electric vehicle industry. Literature[7]puts forward three more effective site selection theories: queuing theory, center theory and center of gravity theory, and proposes the need to combine site selection theory with site selection principles to jointly promote the site selection of charging piles. Literature [8] elaborates and analyzes the three theories proposed in literature [7], including the theoretical queue length of queuing theory, the center size of center theory and the coordinates of gravity center theory. However, there are some errors in the calculation of user distribution and demand by uniform distribution. In reference [9], after the establishment of the charging pile location model, the genetic algorithm is selected to solve the optimal location problem, which is helpful to further achieve the optimal

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location. In reference [10], the grey model was used to predict the regional vehicles, and then the chicken swarm optimization algorithm (CSO) was used to solve the model. This method was improved on the basis of reference [9], and the problem of falling into local optimum too early was avoided.

In reference [11], the analytic hierarchy process (AHP) is used to study the location of charging station, which gives full play to the advantages of AHP in dealing with the complex system composed of multiple factors: it can analyze and solve the interrelated and restricting factors in the system with a relatively simple, practical and less workload method, which can better solve the problem of charging station location, It has certain reference and practical value. The paper also uses the p-median model to solve the location problem of the relatively flexible charging station, and uses the greedy take enlightenment algorithm to solve the p-median model, which has a good effect on the problem from the demand area to the alternative point.

3.3. Charging mode

At present, there are three main charging methods for electric vehicles in China, namely AC, DC and wireless charging [12]. Among them, AC charging mode has high safety factor and low construction cost, but it is mainly used in small car charging due to low charging efficiency; DC charging mode has high charging efficiency, but it has high security threat and great harm to battery due to serious heating, so it is mainly used in bus stations and other scenes requiring fast charging; Wireless charging mode has the characteristics of high safety performance and long battery life, but limited by the charging efficiency is less than DC charging, and China's development started late, the development is relatively slow, has not been large-scale commercial, wireless charging mode is the focus and difficulty of future charging mode.

4. Cloud server

The cloud server is mainly used to process all kinds of request information from the client and the charging pile, record and analyze the massive data, and timely respond to the abnormal situation of the charging pile, so as to ensure the stability and security of the system in the process of operation, including the transport layer, business layer and database layer. Cloud services provided by cloud service providers are often used to build server platforms. Combined with cloud computing and other technologies, the platform has perfect functions and good stability, but it has some shortcomings such as network delay and insufficient security.

4.1. Design of cloud server

Reference [2] abstracts the general functions of the system, such as equipment management, data collection, etc., into a general service platform. In the design process, the cloud service platform of alicloud is used. Alicloud service platform provides system running environment (IAAs service) and related data storage and analysis service (PAAS service), and mainly uses framework technologies such as spring MVC and spring data to build the system [2]. Using spring MVC framework to separate business model and user interface improves the rationality of development, but its security needs to be improved.

Document [13]designed a set of electric vehicle management network system based on Internet B / S architecture. Using B / S architecture can effectively simplify the development, use and maintenance of the management system, and the user does not need to install other terminal applications, and can request access through the browser. It provides distributed service and centralized management for electric bus and electric vehicle, realizes the charging service management system that can manage different types of users at the same time, and carries out comprehensive intelligent monitoring and management for other related facilities such as distributed charging pile and independent charging station, which has good guiding significance.

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4.2. Server security

While the network brings convenience, it also causes data leakage, information theft and other security problems. The security of charging management system is related to the property security and vital interests of each user. Therefore, it is very important to add data protection function into charging pile management platform. Literature [14] proposed to use AES (Advanced Encryption Standard) algorithm in symmetric algorithm to encrypt and decrypt. Due to its strong anti attack ability, fast operation speed, high security performance and less data consumption, this algorithm has the advantages of high security and high security. In the process of uploading all kinds of data collected by the sensor to the cloud server, AES is applied to change the internal data into ciphertext output, and then AES is used to decrypt at the receiving end to ensure the reliability of data transmission. On the basis of reference [14], reference [15] further proposes an information security protection scheme of charging pile background service management center based on authentication encryption, which combines AES with hmac-sha256 algorithm [14], and realizes authentication transmission and authentication encryption technology on the basis of reference [14]. Although the real-time performance is reduced, the security performance is greatly improved.

At the same time, a large number of electric vehicles charging into the grid will cause problems such as load growth of the power grid and increase the difficulty of power grid operation control. Literature [16] adopts the cluster mode based on load balancing server, and constructs the application architecture of collection, business and data server cluster, so as to ensure the stability and integrity of massive data access [16]. At the same time, MySQL Cluster technology is used to realize the concurrent storage of data, which improves the storage efficiency. The dual machine redundancy technology of database can realize the hot standby switch and ensure the stable operation of the system. Reference [17] further introduces multi-agent technology into charging management, combines agent coordination mechanism, jade multi-agent management platform and corresponding management strategies to manage charging network, and realizes system management of charging network. The load characteristics and economic operation of power grid are improved.

5. Client

The client is mainly used for users' login registration, information query, unlocking the charging pile and payment. For builders, this part can invest part of the advertising to bring benefits, and it is also the key part to optimize the user experience and promote the development of electric vehicles. At present, most of the built charging piles only support users' on-site charging, and users can't conduct quick information query, feedback experience and other operations. Therefore, the whole charging process should be effectively integrated, and the big data technology should be fully used to further tap the actual needs of users, so as to promote the development of electric vehicles.

5.1. Application of big data technology

Big data technology has been widely used in the commercial field and has created great commercial value, but its application in the power system has just started. Therefore, combined with the technical advantages of big data and the application requirements of power system, big data technology can further tap the actual needs of users and provide more targeted and high-quality services for users; And it can more effectively analyze the user's charging habits, charging area, etc., provide effective data support for the reasonable construction of charging pile, make the distribution of power resources more reasonable, and maximize to meet the actual needs of users. At the same time, it can also help power enterprises to clarify the future development direction, and assist enterprise leaders to make reasonable and feasible decisions

[18][19]. Giving full play to the value of big data of intelligent charging pile network will bring new development opportunities for the construction of intelligent charging pile network.

5.2. Implementation of client

The first mock exam mobile phone has been changing from the beginning of IC card to 2D code to mobile phone APP, WeChat official account and WeChat applet. It has developed from functional single mode to multi-functional assembly mode.

The traditional IC card and scan two-dimensional code mode only meet the user's charging needs, the user can not understand the corresponding information of charging pile, and the security is low; the client based on mobile app can effectively solve the problem There are also many problems exposed, such as inaccurate display of charging pile information, no unified security protocol, etc., which affect the user experience. Based on this, a new charging pile app is proposed in [20], in which the intelligent unlocking and deposit mode has good guiding significance: 1. Intelligent unlocking: users can quickly unlock by scanning and password input, It avoids the disadvantages of traditional unlocking, simplifies the user operation process, and improves the user experience; 2. Deposit mode: charging pile app software cooperates with ant financial services, and only users with sesame score above 650 can be free of deposit; on the contrary, they need to pay 100 yuan deposit. This mode can fully protect the interests of operators and complete the investment promotion work, which can further promote the development of electric vehicle industry. However, the client based on app mode can not support charging piles of various operators.

After a lot of research, the researchers proposed that WeChat should be built as a client carrier by using the public platform. The document [21] built a system by combining Internet of things technology and WeChat official account platform, and developed a charging management system based on WeChat public platform. Users can query the charging pile information, booking charging piles, order orders and recharge through the legal verification of official account. And use navigation map API as the geographic information system of the platform to realize navigation map planning. The system can also be combined with the optimization theory to create the optimal route planning, and provide user feedback communication mechanism to effectively improve the user experience. The operation of the system is relatively simple, and the page is intuitive and concise, which is a big prototype of charging client in the future. But the security performance of the system is low and needs to be improved. Literature[22] proposes to use wechat applet as the user interface to improve the convenience of charging stations. On the basis of literature [21], it further simplifies the charging process of different charging stations in different regions, and simplifies the payment process.

6. Research and Prospect

At present, the construction form of charging station is very good, but there are more and more challenges. We should combine the construction of charging facilities with the development of management platform

(1) Improve user experience: make full use of data mining technology, for example, further extract useful information to make theoretical preparation for the improvement of the system, improve the practical charging experience of users, such as the analysis of charging period and failure rate information of individual users, plan the charging station information for users in advance and send it to the user end; build the charging station beside the commercial area, such as shopping mall and coffee shop, to make charging more convenient, More charging stations can be put into highway entrance and rest area, so that the use frequency of electric vehicles is higher.

(2) Power guarantee: in areas where the grid voltage cannot be normally guaranteed, renewable resources such as wind energy and solar energy can be used for power storage, and the technical barriers of wireless charging should be overcome.

(3) Promoting development: putting relevant advertising information on the charging pile can further promote the development of the electric vehicle industry. It can cooperate with navigation software and automobile manufacturers, and the charging point operators should realize data and information interconnection, so as to jointly promote the development of the electric vehicle industry.

I believe that with the support of national policies and the development of related technologies, the electric vehicle industry will have a bright future.

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