Research on the Design and Execution of Distributed Electric Vehicle Charging Pile Operation Management System Based on WebGIS

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Abstract. The integration of communication tech, data acquisition tech, Web and GIS tech is helpful to improve the automatic operation and management of electric vehicle charging pile, so it has momentous research value. Based on this, this paper first analyses the concept and connotation of WebGIS, then studies the architecture of distributed Electric Vehicle (EV) charging pile operation management system based on WebGIS, and finally gives the function design of distributed EV charging pile operation management system based on WebGIS.

Keywords: Distributed Charging Pile, Electric Vehicle, WebGIS

1. Introduction

With the iterative progress and growth of social economy, the number of cars in the society is increasing year by year. While cars bring incalculable convenience to people's travel, they also bring a series of problems and deficiencies, such as energy consumption, environmental pollution, especially environmental pollution. In this context, Electric Vehicles (short for EVs) have achieved significant growth and development, and gradually become an momentous means to solve the problem of traffic environmental pollution and energy conservation and emission reduction [1]. On the other hand, with the continuous breakthrough of key technologies of EVs, the performance and economy of EVs have been incalculably improved. At present, the key element restricting the development of EVs lies in the follow-up of relevant supporting facilities, especially the perfection of charging facilities represented by charging piles, which will have a significant effect on the further popularization of EVs.

As a key link in the EV industry chain, the charging facilities of EVs mainly include several parts as shown in Figure 1 below. At present, in order to promote the rapid growth of the EV industry, the relevant energy supply enterprises and institutions have made a lot of achievements in the energy supply facilities and tech of EVs, including the verification of key technologies, the formulation of standard system, demonstration projects and the construction and research of operation service mode, and have made some achievements [2]. The energy service facilities of EVs, represented by charging piles, are characterized by a large number of devices and scattered locations. In order to effectively collect the geographic location information of charging facilities such as charging piles, it is necessary...
to build a multi-source database to obtain valuable information and enable users to master and manage the information at the same time.

Figure 1. Subsystem of EV charging facilities

In addition, with the continuous maturity of computer tech, the combination of GIS tech and computer network tech continues to expand, and thus the birth of WebGIS, the charging point and other spatial information and services integrated into the distributed network environment [3]. The integration of communication tech, data acquisition tech, web and GIS tech to realize the automatic operation and management of EV charging pile not only helps to reduce the work intensity of relevant personnel, but also helps to further improve the efficiency and operation level of EV charging pile.

In a word, the distributed charging pile has strong space and cost advantages, so it is very suitable for promotion as a supporting and auxiliary setting of EVs. However, the charging network composed of distributed charging facilities has the typical characteristics of large number, scattered location and complex environment. In order to guarantee the safe and reliability operation of the distributed charging network, higher requirements are put forward for the monitoring and maintenance management level of the charging network [4]. The distributed charging pile network system should have the functions of remote monitoring, user management, distributed management, billing management and asset management. The location information of distributed charging pile needs the assistance of geographic information system. Therefore, it is of incalculable practical value to study the design and execution of operation management system of distributed EV charging pile based on WebGIS.

2. The concept and connotation of WebGIS

2.1. The concept of WebGIS
As a product of Internet tech applied to GIS growth, WebGIS uses Internet tech to publish geographic info on the web, so that any node on the network can browse the geographic info in WebGIS site, and carry out various info retrieval and processing, so as to open and share the geographic info. From any node of the network, users can browse the spatial data in the WebGIS site, make thematic maps, and conduct various spatial info retrieval and spatial analysis [5]. WebGIS can take advantage of the unique functions of internet, including accessing remote GIS data and applications on the Internet, conducting GIS analysis, and providing interactive maps and data on the Internet.

In addition, the key features of WebGIS are object-oriented, distributed and interoperable. Any GIS data and function is an object. These pairs are deployed on different servers on the Internet and are assembled and integrated when needed. Any other system on the Internet can exchange and interact with these objects.

2.2. Function and architecture of WebGIS
WebGIS is an integrated client / server network system. WebGIS applies the concept of client / server to perform the analysis task of GIS. It divides the task into two parts: server and client. The client can request data, analysis tools and modules from the server. The server either executes the client's request
and sends the result back to the client through the network, or sends the data and analysis tools to the client for use [6]. WebGIS uses Internet as a distributed system to deploy GIS data and analysis tools on different computers in the network. WebGIS and data source are dynamically linked. As long as the data source changes, WebGIS will be updated. In addition, WebGIS can access different platforms, and there are no restrictions on any computer and operating system. WebGIS can link different map pages through hypermedia hot links. The typical architecture of WebGIS is as shown in figure 2 below.

![Figure 2. The principle of building natural ventilation](image)

2.3. Application advantages of WebGIS
The application of WebGIS has the advantages of lower growth and application management cost, wider access scope, real info sharing, real info sharing and cross platform characteristics. Among them, in terms of growth and application costs, WebGIS uses a common browser to publish geographic info, and uses free plug-ins to reduce the training cost and technical burden of end customers [7]. In a wide range of access level, customers can access the latest data of multiple servers located in different places at the same time, which makes the data management and composition of distributed multiple data sources easier to achieve. In addition, at the level of info sharing, WebGIS can release info through a common browser, which makes it convenient for not only professionals but also ordinary users to obtain the info they need. At the level of extended space, WebGIS is easy to integrate seamlessly with other info services in the web to build specific GIS applications with rich functions.

3. WebGIS based distributed charging pile operation management system architecture

3.1. Communication architecture of charging pile operation management system
In order to facilitate the use of end users, charging piles are often widely distributed and lack of effective communication channels, which makes it difficult to achieve real-time and transparent management of equipment info [8]. The establishment of the communication channel of the charging pile can grasp the status of the charging pile in real time. For the centralized charging pile facilities, the data collector should be used to collect and upload the charging pile info. For the scattered charging pile facilities, the mobile communication private network should be used for communication. The monitoring system of charging pile operation process realizes the info interaction with each charging facility through the private network.

3.2. Software architecture of charging pile operation management system
The software level of the distributed EV charging pile operation management system based on WebGIS adopts the three-tier architecture as shown in Figure 3 below. In the system platform layer, cross platform and mixed platform operation are supported. In the supporting service layer of the system, with the help of unified data transmission, database access and control command interface, the separation of service layer and application layer is realized. In the business application layer, different
application system foundations are built through service function modules to guarantee the security and functionality of system data.

![Diagram of software architecture of charging pile operation management system]

**Figure 3.** Software architecture of charging pile operation management system

### 4. WebGIS based function design of distributed charging pile operation management system

#### 4.1. Module composition of charging pile operation management system

The functional modules of the distributed EV charging pile operation management system based on WebGIS mainly include charging pile monitoring module, dynamic environment management module, power supply monitoring module, operation and maintenance management module, card issuing module, marketing management module, sales analysis module, cashier module, purchase, sales and inventory module and billing management module [9]. Through the establishment of cloud service platform in the monitoring background, the integration of big data, the query and management of EV charging station, and the operation management of electricity recharge, the integration of charging service providers and demanders under WebGIS. In addition, with the help of WebGIS based distributed EV charging pile operation management system function, the location of charging pile can be located, which is convenient for end users to query nearby charging points and make remote reservation.

#### 4.2. Function realization of charging pile operation management system

WebGIS based distributed EV charger operation management software platform adopts mainstream operating system to realize cross platform and mixed platform operation. WebGIS is used to establish operation service background, integrate big data in the industry, and organically integrate charging service providers and demanders [10]. As a smart terminal, the charging pile transmits data to the remote cloud server in real time with the help of GIS module and web data info chip, so as to realize the user's query, remote reservation and payment of the available state of the charging pile. In addition, with the help of the background database of the monitoring and operation management system, the effective integration of various real-time data, state data, state data, electric energy measurement and statistical data is realized, so as to guarantee that the charging pile automatically sends out the historical data sorting reminder according to the storage space.

In addition, in the execution level of WebGIS system, GIS services provide data services and functional services, and release WebGIS extension interface through web tech, so that the web system can integrate GIS functions. With the help of GIS, the site selection of charging pile and charging station is analyzed, and the best countermeasures and asset allocation scheme are worked out. The charging facilities resources are controlled and utilized scientifically to guarantee the reliability and expansibility of the system.

### 5. Conclusion

In summary, the distributed charging pile network system should have the functions of remote monitoring, user management, distributed management, billing management and asset management. The location info of distributed charging pile needs the assistance of geographic info system. This
paper analyzes the function and architecture of WebGIS by studying the concept and connotation of WebGIS. Through the analysis of WebGIS based distributed EV charging pile operation management system architecture, the communication and software architecture of charging pile operation management system are studied. Through the research on the function of distributed EV charging pile operation management system based on WebGIS, the module composition and function realization of charging pile operation management system are analyzed.

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