Design of Intelligent Generation Agent for Power Supply Scheme based on Large Language Model

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Abstract: With the rapid development of artificial intelligence big model technology, intelligent generation of power supply solutions has become a focus of continuous optimization in the business environment. In response to the problems of manual based, time-consuming, and inaccurate power supply scheme preparation, this article proposes to use a large model to construct an intelligent agent called "Power Supply Scheme Intelligent Generation", which integrates multimodal perception, cognitive reasoning, and analytical decision-making capabilities, reconstructs the business process of power supply scheme preparation, and creates an intelligent new mode of automatic intelligent generation, real-time push, and real-time response to customers of power supply schemes. It promotes a more convenient experience, more efficient process, and more time-saving, and helps accelerate the upgrading of industry expansion and installation.

Keywords: Large Model; Agent; Power Supply Scheme; Automatically Generated

1. Introduction

Power expansion and installation is an important part of the marketing activities of electric power enterprises, which mainly includes business acceptance, on-site inspection, response to power supply schemes, engineering construction, intermediate inspections, and completion inspections. It is characterized by strong policy relevance, complex on-site environments, extensive inter-departmental coordination, tight schedules, and multiple procedures. Among these, the design of power supply schemes is influenced by on-site environments, electricity demand, and grid resources, needing to achieve a balance among various aspects such as economy, safety, and construction difficulty. This directly affects the investment construction costs of customer electricity projects and supporting grid projects, thus making the automation and intelligentization of power supply scheme preparation a focus for optimizing the business environment in the power industry.

Large models refer to machine learning models with a large number of parameters and complex computational structures, possessing core capabilities such as perception and understanding, autonomous learning, data processing, decision-making and planning, as well as interaction and communication [1]. As the complexity of human-computer interaction scenarios driven by application demands increases, and with continuous breakthroughs in data, computational power, and algorithm models, agents are gradually becoming an important direction for breakthroughs in artificial intelligence technology [2]. Smart agents based on large models leverage extensive and richly trained language or multimodal models as core components, enabling highly intelligent understanding and generation capabilities, which allows them to better perceive their environment, interact efficiently, and make intelligent decisions [3]. Compared to traditional large model IT architectures, the AI agent model has many advantages such as autonomy, intelligence, adaptability, evolvability, resource sharing, and collaboration.

With the rapid development of AI agents, their application in the field of electric power marketing has become increasingly widespread, involving various aspects such as human-computer interaction services, intelligent customer service, anomaly recognition, and monitoring and warning. Therefore, this article is based on improving

weak links in the current power supply scheme, utilizing the results of large model construction in the power industry, integrating multi-modal perception, cognitive reasoning, and analytical decision-making capabilities to build an 'Intelligent Generation of Power Supply Scheme' agent. This will reconstruct the business process of preparing power supply schemes and create a new intelligent model for automatic generation of power supply schemes, real-time pushing, and real-time responses to customers, helping to accelerate the upgrade of business expansion applications and promoting the comprehensive digital and intelligent transformation of power marketing.

2. Research Foundation

2.1 Research and Practice of AI Intelligent Agents at Home and Abroad

Currently, major domestic and foreign internet companies and technology firms are conducting a series of research based on AI agents, with the results applied in various fields.

On the international front, technology companies such as OpenAI, Amazon, Google, and Meta have conducted extensive exploration in the development and application of large models and intelligent agents. For example, Meta released the AI agent project MetaGPT, which uses a single-line input to generate APIs, data structures, competitive analysis, etc., providing rapid solutions for complex tasks [4,5]. In terms of vertical applications, the American company reAlpha launched the AiChat intelligent agent [6], while the American company Ushur introduced a member service intelligent agent [7], both of which have found widespread application in the social field. The American vaccine manufacturer Moderna launched an intelligent agent for analyzing and evolving large codebases [8].

Domestically, companies such as Huawei, Alibaba, Tencent, and Baidu have launched a series of large models and intelligent applications [9-11]. For example, Baidu recently released its intelligent agent ecosystem plan, introducing the Wenxin intelligent agent platform, where developers can create intelligent agents with a simple text instruction 'in one sentence'. So far, it has attracted over 100,000 enterprises and 600,000 developers to participate [12].

In the field of electric energy, the Southern Power Grid Company has independently developed the first controlled large model in the electric power industry–the Mega-Watt model [13]. Based on the electric power AI innovation platform, they have created real-time sectional control intelligent agents, metering intelligent agents, and intelligent customer service agents, which are widely used in scenarios such as system regulation, load forecasting, knowledge inquiry, intelligent query, and equipment fault diagnosis. The State Grid Corporation has launched the first trillion-level multimodal industry large model in the electric power sector, providing specialized intelligent services across the entire industrial chain of electric power production, construction, management, operation, research, manufacturing, and services [14].

2.2 Research Practice on Auxiliary Generation of Power Supply Plans

In recent years, power companies have also engaged in a lot of practical work regarding the auxiliary generation of power supply schemes. With the gradual integration of cross-disciplinary business systems such as marketing, development, and scheduling, and the deepening application of mobile operation terminals, Jiang et al. [15] proposed auxiliary generation of user access schemes based on the integration of operation data from equipment ledgers in the production management system, distribution automation, and electricity consumption collection systems, leveraging GIS's spatial analysis capabilities. Zhou et al. [16] considered the use of spatial and non-spatial information relevant to the electricity industry to achieve synchronous integration of marketing and distribution information, using decision tree methods and the IDA heuristic algorithm to automate the generation and optimize the evaluation of power supply schemes. Yao [17] and Xu et al. [18] researched the application of big data technology for calculating the available capacity of distribution networks and for planning power grid lines, addressing the challenge of calculating grid capacity in the automated generation process. Wan [19] and

Cai et al. [20] explored the application of different tools such as RPA in the preparation of power supply schemes. Yang et al. [21] considered emergency power supply scheme design in the context of coordinated power transportation. Beletsky et al. [22] proposed the efficiency of centralized power supply for subways by switching traction points during the design of power supply schemes. Additionally, Ayca and Dincer [23] considered a full lifecycle evaluation of the auxiliary generation of power supply schemes to enhance work efficiency.

However, in the actual response phase of the power supply scheme, the generation of the power supply scheme mainly involves two methods: one is for customer managers to manually maintain the power source data relationships to formulate the power supply scheme, and the other is to obtain the power grid topology through GIS and design the power supply scheme based on the power grid topology. The technical solutions proposed by the aforementioned scholars only achieve partial information sharing and have not truly realized the automation and precision generation of the power supply scheme.

The above research and practice fully demonstrate the development prospects of intelligent agents, and the characteristics of high repeatability, strong interactivity, and large data volume in the power supply scheme preparation process coincide with the features and advantages of intelligent agents. Therefore, this paper proposes the construction of an intelligent generation agent for power supply schemes based on a large model in the power industry, forming key intelligent applications such as proactive information pushing, intelligent generation of schemes, efficient customer interaction, and a knowledge base for power supply schemes. This supports the intelligent upgrading of the entire response process for power supply schemes, including business acceptance, intelligent generation of power supply schemes, auxiliary verification of power access plans, recommendations for power supply schemes, and auxiliary responses, fundamentally addressing issues such as ease of error, low efficiency, and lengthy time-consuming processes in drafting power supply schemes.

3. Design of Intelligent Agent for Power Supply Scheme Based on Large Models

3.1 Business Design

In the traditional model, after the on-site inspection, the customer manager of the power company manually prepares the power supply plan and submits it for review, and communicates with the customer to confirm the power supply plan through offline methods, which is time-consuming and inefficient. By using an intelligent agent to automatically generate power supply plans, we create an interactive and intelligent AI expert aimed at users, reshaping five key stages: intelligent push of acceptance information, intelligent generation of access plans, intelligent generation of power supply plans, interactive plan comparison, and generation and feedback of power supply responses (Figure 1 below), thereby creating a new model of interactive, generative, and accompanying expansion services.

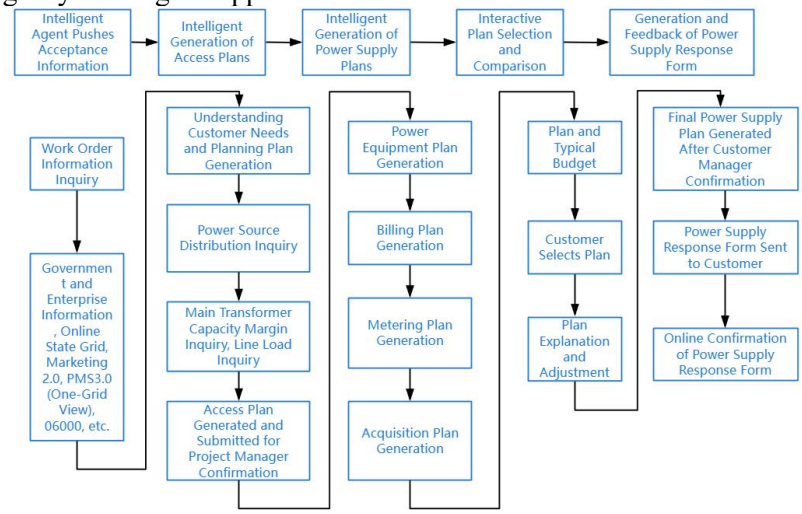

Figure 1. Work Ideas for Responding to Power Supply Solutions based on Intelligent Agents

3.2 Technical Path

The intelligent generation agent of power supply schemes is built on the foundation of large models in the power industry, incorporating technologies such as strategy optimization, content generation, RAG-enhanced retrieval, memory capabilities, and multi-turn interaction. It combines prompt engineering and knowledge bases, integrates multi-modal perception, and decision-making abilities to construct the intelligent generation agent for power supply schemes. The technical implementation path is shown in the Figure 2 below.

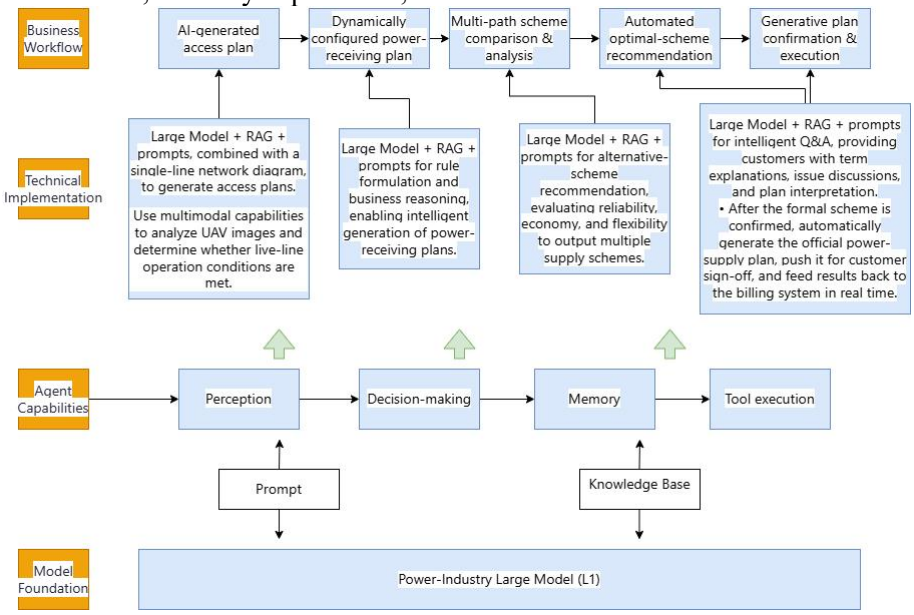

Figure 2. Implementation Path of Intelligent Agent Technology for Power Supply Scheme Generation

3.3 Intelligent Agent Construction

To solve the problem of multi-variable real-time processing that traditional systems cannot address, this power supply plan intelligently generates four intelligent agents, including three sub-agents (metering scheme sub-agent, billing scheme sub-agent, service receiving point sub-agent).

The power supply scheme generation intelligent agent is implemented using a nested approach of main and subordinate intelligent agents, avoiding the instability issues of the main intelligent agent caused by overly long prompts. Meanwhile, the subordinate intelligent agents can also complete independent tasks for generating different schemes, increasing flexibility in supporting the business system. The main intelligent agent uses the REACT framework to ensure that each scheme is prepared systematically, while the subordinate intelligent agents use the WORKFLOW framework to ensure operational efficiency.

1) Training power supply scheme model

Starting from the actual demand of business expansion installation services, based on general training corpora and professional knowledge data of business expansion installation, connect customers with the electricity industry knowledge base, power supply scheme compilation rule base, power supply scheme knowledge base, and business rule base. Collect relevant laws and regulations for power supply scheme compilation such as "Overhead Power Transmission Line Design Technical Regulations" and "Power Supply Business Rules," along with a large amount of historical data on business expansion installation. Conduct sample cleaning, annotation, and quality inspection, following the "data-sample-knowledge" evolution path to carry out large model training for power supply schemes. Based on model evaluation and testing results, continuously optimize the model to ensure that the large model has the capability to automatically compile typical power supply schemes for different scenarios of individual and corporate customers. The training approach is shown in Figure 3 below.

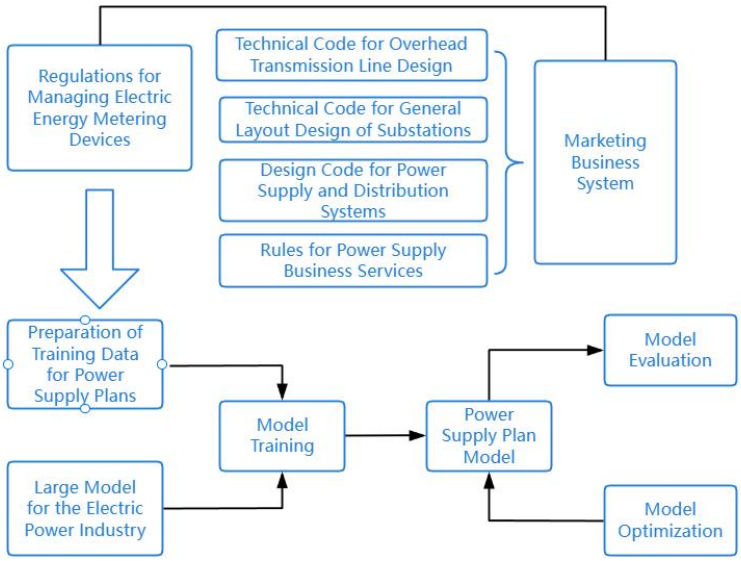

Figure 3. Training Power Supply Scheme Model

2) Developing an intelligent agent for power supply solutions

Based on the power consumption characteristics of individual and corporate users, and taking into account parameters such as the user's power consumption category, industry classification, power equipment, and importance level, a user's power demand is formed. Centered around the user's high voltage distribution and low voltage metering box location, the resource utilization of the power grid is fully leveraged, including load rate, road management networks, and occupancy of power grid resources. Based on the training results of large models, the design of intelligent agents, planning design, prompt design, and tool design are carried out, along with the development of intelligent agents for smart generation of power supply schemes, to ensure that the intelligent agents have the ability to conveniently and accurately generate power supply solutions. The construction process is illustrated in the following Figure 4.

3) Establish a power supply plan knowledge base

Based on the power supply scheme model, combined with power supply business rules, relevant laws and regulations of the electric power industry, and industry standards, a power supply scheme knowledge base is constructed to verify the information entered by business personnel and to validate the automatically generated power supply schemes, improving the accuracy of the power supply schemes and ensuring the legality and compliance of metering and billing plans. The construction idea is shown in the following figure 5

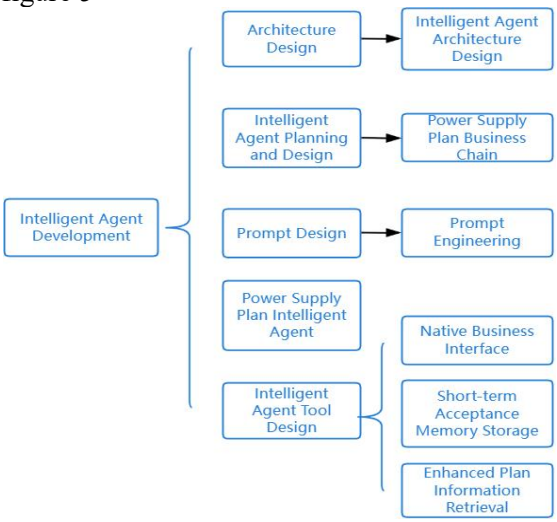

Figure 4. Building an Intelligent Agent for Power Supply Solutions.

4. Application Cases

Within the State Grid system, the intelligent generation agent for power supply schemes is built on the Guangming Electric Power large model. Below, we take a power customer in Jiangsu Province as an example to implement the intelligent generation application of power supply schemes.

4.1 Intelligent Agent Push Acceptance Information

After completing the customer's electricity installation application and generating the work order, the marketing business system automatically pushes the acceptance information, and calls the installation capacity,

address, industry category, load nature, demand type, voltage level, and other information from the electricity business application form generated during the business acceptance process. Based on a real-time comprehensive view of the surrounding power grid resources, including the status of electrical equipment and switches, line load rates, and the inventory materials of various units, it also obtains real-time municipal conduit information to ensure the reserved openings for cable channels. The main information of the customer is shown in Table 1 below.

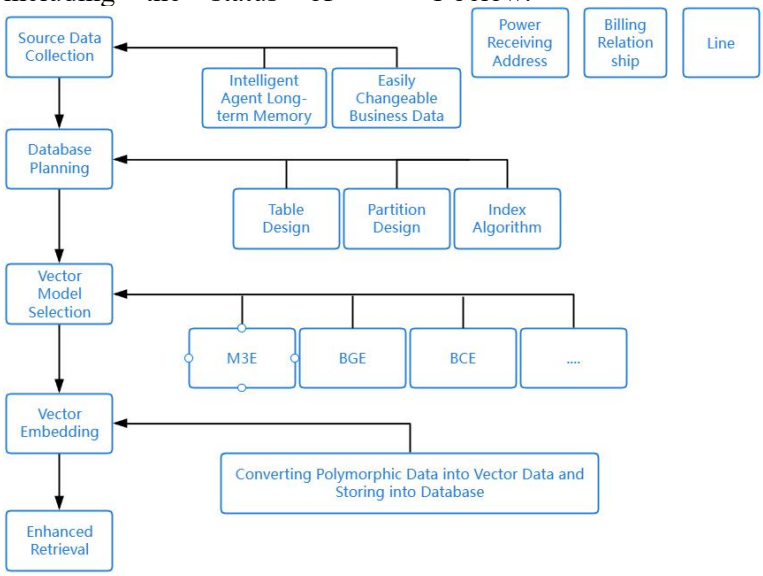

Figure 5. Building a Knowledge base for Power Supply Solutions

Table 1. Customer Business Expansion Report on Electricity Consumption Information

Electricity use address	No. 86 Chongwen Road, Lishui District, Nanjing City, Jiangsu Province.	Industry classification	Health
Urban and rural category	Urban	Business type	New high-voltage connection
Contract Capacity	600kVA	Load Characteristics	10kV AC
Importance Level	Tier-2 key customer	Customer Class	General commercial and other
Pricing Scheme	Two-part tariff	Power-Factor Evaluation	Standard assessment

4.2 Intelligent Generation of Access Schemes

The power supply plan generating intelligent agent calls and integrates data from multiple systems such as marketing business systems and the power grid map, taking into account the current operation status and planning of the power grid to achieve collaborative work across multiple disciplines on maps. First, it clarifies the substations near the customer's power supply point and the margin of the main transformer, distribution network lines and load rates, the remaining capacity of poles and ring network cabinets, and the occupation of municipal power corridors. Secondly, based on the future planning of the power grid and the customer's desired connection time, it confirms the expected new connection points near the power supply point. Finally, based on the above information, generate multiple highly reliable (load rate qualified), low-cost (short distance, few materials), and easy to implement (high feasibility of supporting engineering) optimal power access solutions, and push them to the customer manager.

4.3 Intelligent Generation of Power Receiving Schemes

The power supply scheme generation agent is based on the historical typical power supply schemes learned through independent learning, and combines incoming scheme information such as station line, power supply voltage, and application capacity. It extracts information from the power supply scheme formulation rules database and knowledge base, performs intelligent verification, and generates key information for the power supply scheme. Based on the application capacity and demand type (internal electricity usage type, such as production power for factories, daily electricity for office spaces, etc.), it generates a billing measurement plan. Then, based on the measurement and billing plan and voltage level, it generates a collection scheme. Finally,

multiple power supply schemes are generated and sent to the account manager.

Among them, the advantage of Power Supply Option 1 is its dual power source and high reliability; Option 2's advantage lies in easier adjustments during later operations; and Option 3's advantage is its lower construction cost.

4.4 Interactive Scheme Comparison

Based on the typical design schemes of user substations according to the corresponding voltage levels, a cost estimation of the user power supply schemes in various supply options is conducted. The online State Grid, intelligent outbound calls, and SMS services are utilized to integrate the specific needs of the customers, considering multiple factors such as economy, reliability, and flexibility, and then presented to the customers for selection. Due to the customer's high demand for power supply reliability, they ultimately chose Option 1.

4.5 Power Supply Response Generation and Feedback

Customers receive the power supply plan pushed through online channels such as the State Grid APP. After selecting the power supply plan, customers only need to manually sign and confirm the return. The intelligent system synchronously and in real-time sends back to the marketing business system for the "power supply plan response" stage, and automatically triggers the next step, ultimately generating an electronic version of the power supply plan response document and replying to the customer. The customer completes the confirmation using an electronic signature on their mobile device, finishing the entire power supply plan response process.

During the above process, customers can express personalized needs at any time through voice interactions, and the intelligent agent will convert the voice data into business information, automatically pushing relevant knowledge for customer reference. For example, the intelligent agent will conveniently push key field definitions such as business fee information, power quality requirements, and power factor assessment standards based on customer needs, making it easier for customers to understand the details of the power supply plan.

5. Summary and Outlook

This article focuses on the weak links in the development of electricity supply plans for business expansion. It introduces breakthrough large model technology to construct an intelligent agent for generating electricity supply plans, creating a new interactive, generative, and accompanying response model for electricity supply plans. This makes the experience of customers applying for power supply more convenient, saves more time, and improves service efficiency. Since the implementation of the intelligent agent for electricity supply plans within the State Grid Corporation's system, the efficiency of developing electricity supply plans has increased by 60%. Through large model technology, it flexibly presents electricity supply plans to customers from multiple angles, satisfying personalized needs based on multiple rounds of interaction results, reducing the official response time for electricity supply plans from 10-15 working days to 5 working days, thus promoting the optimization of the business environment in the electricity sector and enhancing customer satisfaction.

The next step will be to take the intelligent generation of typical templates for power supply solutions as an opportunity to deeply explore marketing application needs, creating more useful and easy-to-use marketing large models. This will continuously drive the continuity and process-oriented transformation of marketing business scenarios. We will actively serve the government and enterprises in the industrial chain, promoting the implementation of diverse high-frequency “AI+” scene applications, jointly advancing the power industry towards intelligence and efficiency.

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