Research and Application of Artificial Intelligence Based on Smart Grid

Gengyi Xiao*
Department of Mathematics and Computer Technology, Guilin Normal College, Guilin, China

*Corresponding author e-mail: xiao6169@126.com

Abstract. In order to achieve the goal of intelligent dispatching, the article analyses the requirements of the smart grid, and then applies the artificial intelligence multi-agent technology to the smart grid dispatching system to study the formal structure and communication cooperation of the multi-agent. Using SQL Server 2000 to build a power grid dispatching data model, set up different Agent function modules, do some research on the living environment and decision behaviour of functional Agents, improve the structure of Agent-based dispatching decision-making systems, and build an Agent-based The intelligent dispatching decision system based on technology provides a feasible solution for the dispatching decision system of the smart grid.

1. Introduction
The smart grid has the core value of strong, reliable, economic, and environmental protection functions. It has a new generation of grid model that is interactive, self-healing, and meets multiple requirements. This article first analyses what a smart grid is, the differences, characteristics, and advantages of smart grids compared to traditional grids, and the key technologies and implementation methods of smart grids [1]. The difference between intelligent scheduling and traditional scheduling lies in intelligence, and this intelligence is built on computers and corresponding artificial intelligence technologies. The content of this article starts with Agent technology and the multi-Agent system developed from it. The structure of the Agent and the interaction and cooperation between the Agents introduce the response, autonomy, and social characteristics of the Agent into the intelligent dispatching model of the power system, and establish the functional Agent model and the coordination mechanism of the Agent under the intelligent dispatching system. The database in the intelligent dispatching system based on Agent technology is an important part of the intelligent dispatching system. It is necessary to establish an intelligent dispatching database model. Starting from the analysis of the state of the power grid, through the corresponding formalization of knowledge representation, the trigger mechanism of the state and events of the power grid is established to realize the corresponding decision-making measures for the state and events in intelligent dispatch. Existing dispatching systems are not yet capable of intelligent diagnosis and decision processing of power grid accidents. Establishing an agent-based intelligent scheduling system requires improving the structure of the existing intelligent decision-making system on the existing scheduling system, reducing its coupling and increasing changeability, and establishing a functional Agent model. Based on this, a multi-agent-based model is established. The agent's intelligent dispatching decision system analyses...
the working method of intelligent dispatching decision, and provides a solution for dispatching decision under the smart grid based on the actual situation [2].

2. Research on smart grid and smart dispatch

2.1. Smart grid
The concept of smart grid was first proposed by the United States, and later China and Europe also proposed corresponding concepts. Smart grid is a cutting-edge subject. Smart grid is a new generation power network based on an integrated, high-speed two-way communication network that uses digital technology to implement the transmission, distribution, management, and control of electrical energy from power sources to users, to save energy and costs, reduce risks, and improve survivability. Smart grids have a strong ability to withstand external interference and self-recovery, meet the power needs of different users in different situations, allow effective access to power and loads in various forms of power generation, and ensure the efficient operation of the power market and assets in the long term. Figure 1 is a diagram of power consumption patterns in a smart grid [3].

![Figure 1. Consumer power consumption mode under smart grid.](image)

2.2. Intelligent Dispatching in Smart Grid
The intelligent dispatching system is composed of intelligent dispatching centre, integrated communication network, plant and distributed energy, third-party products and network clients, as shown in Figure 2. It can realize the functions of data acquisition, adjustment and control of power grid state, analysis application of advanced software and intelligent dispatch operation management. The equipment status information collected through the plant station is transmitted to the intelligent dispatch centre through the fibre channel, and is uniformly stored, managed and used on the database server. Advanced analysis software can be used to automatically adjust the system status, proactively diagnose faults and provide recovery strategies. Dispatchers can intuitively understand the status of plant-related equipment and load on the dispatch centre screen or Web client, and issue the corresponding control command.
A very important part of the smart grid is the effective acceptance of renewable energy. The research on distributed energy by intelligent dispatching is mainly in the establishment and planning of distributed energy models. The impact of distributed power on the grid after it is connected to the network is mainly manifested in voltage, power angle and frequency, which is likely to cause the short-circuit capacity increase and power overrun of the transmission network. This is mainly because the accurate prediction of distributed energy output cannot be made well at present.

3. Agent Intelligent Technology Research

3.1. Artificial Intelligence Technology Analysis
Artificial intelligence, referred to as AI, is a branch of the computer field. Artificial intelligence is an algorithm that enables machines to simulate certain tasks that humans can accomplish. However, the implementation of this implementation is different in form and complexity. The complexity is only related to the algorithm, it is like the behaviour of a child picking up an object and launching a rocket. Through the implementation of reasonable algorithms, complex scientific calculations can be easily implemented in calculations [4]. Computers can take advantage of the speed of calculations to complete these tasks faster and more accurately than the human brain. The calculation itself cannot be regarded as intelligent, only viewed as a repetitive task. It can be seen that people's understanding of complexity has changed, but the specific goal of artificial intelligence has never changed. Research and simulation of human behaviour and consciousness (including thinking). Artificial intelligence is the study of the laws of human intelligent activity, constructing a certain intelligent system, and making the system complete certain tasks through computational thinking, studying how to use the software and hardware of the computer to simulate some basic theories of human intelligent behaviour, Techniques and methods.

3.2. Agent technology
Agent first appeared in the field of distributed artificial intelligence. There are different definitions and representations of the concept of Agent. More commonly, it is called intelligent agent; no matter what people call it, researchers have the same understanding of Agent function That is, the Agent is an active entity with autonomous knowledge, goals, and behavioural capabilities, and can make inference decisions alone or under a small amount of human guidance. It is a computer system packaged in a certain environment and has autonomous behavioural capabilities. When it comes to the tasks that people set for them, the Agent can move flexibly and autonomously in the corresponding environment. The research on the Agent model is mainly aimed at its attributes and structure. Agents generally have
the following characteristics: autonomy, social ability, reaction ability, mobility, and reasoning learning ability.

Multi-Agent system is an intelligent open distributed system. Agents in the system cooperate to complete tasks. Collaboration can enhance the ability to solve problems and improve the performance and flexibility of the system. The Agent system itself is dynamic and inconsistent. How to cooperate and effectively complete the common tasks of the Agent is the main goal of our research and application of the Agent. Collaboration refers to the process in which multiple Agents surround a goal, reach a consensus, and reduce inconsistencies and uncertainties through a structured exchange of related information and improvement of common views and plans. The two most basic components of collaboration are "allocation of limited resources" and "communication of intermediate results". As shown in Figure 3, it is a collaboration model of a multi-agent system [5].

Figure 3. Multi-Agent System Cooperation Model.

4. Intelligent scheduling database model

4.1. Definition of grid status

In the current dispatching system, the detection of the power grid includes three parts: monitoring, analysis, and control. The three are connected and integrated through EMS. However, the system's perception of the external environment is not enough, and the system cannot start the corresponding analysis program by changing the environment. Mastering the state is an important means for multi-agent systems to obtain environmental information. The effective reasoning process and decision-making results can be started only after the status of the multi-Agent system is identified. Therefore, the division and definition of the operating status of the power grid is the basis for the automatic identification system of the Agent, and it is also the first step in establishing a grid environment model. Status. The power system is a dynamic system that generates electrical energy to be consumed. In this dynamic process, in order to ensure the stability of the power system, the power grid must meet two sets of equations [6].

The first is the equation that guarantees the power balance between power generation and power consumption. Suppose there are \( n \) power plant stations in the system, the active power from the first generator is \( G_1 \), the reactive power is \( O_1 \), and there are \( m \) loads. The active power taken by the \( j \) loads is \( P_j \), and the reactive power is \( Q_j \). Power transmission and distribution equipment has active power loss, the active loss is \( L_1 \), and the reactive loss \( L_1 \). Here \( O_j \) is the net reactive load after considering the reactive power generated by the capacitor. In addition, in order to generate reactive...
power, synchronous compensators and electrostatic capacitor banks are also used as reactive power sources, so the equation constraint equations for power generation are obtained, as shown in formulas (1)-(2).

\[
\sum_{i=1}^{n} P_{gi} = \sum_{i=1}^{n} P_{li} + P_{ri}
\]

\[
\sum_{i=1}^{n} Q_{gi} = \sum_{i=1}^{n} Q_{li} + Q_{ri}
\]

The second is an inequality that guarantees the safety of the operation of the primary equipment. In order to limit the voltage value of each bus and the current value of each branch in the system to a range, as shown in equations (3)-(4).

\[
U_{K_{\text{max}}} > U_K > U_{K_{\text{min}}} \quad \forall K = 1, 2, \ldots, K_n
\]

\[
I_{L_{\text{max}}} > I_L > I_{L_{\text{min}}} \quad \forall L = 1, 2, \ldots, L_m
\]

Where: \(t_n\) is the total number of nodes; \(l_m\) is the total number of branches. Generally, the generated power is less than the used power, which destroys the constraint conditions of the equation, resulting in an imbalance between the power generation and the power supply. At this time, an abnormal situation occurs, and the power generation equipment must be started or disconnected in time or cut off some to the load to ensure power generation and electricity balance. When the inequality constraint encounters damage, overvoltage or undervoltage or overcurrent may occur. These conditions can cause damage to the equipment and, in severe cases, even damage. After the power system meets the above two sets of constraint equations, in order to determine the implementation of measures such as prevention and control, we now divide the operating state of the power system to clarify the control measures to be taken in different states [7].

4.2. Formalization of Grid State Agent Decision
The formal processing of the operating status of the power grid aims to enable the computer to identify the status of the power grid through formalized language. To this end, we describe it by defining different attributes for the power grid status. To this end, we represent the state of the power system as a judgment statement in the form of IF R THEN S, R represents the condition of the grid status, and S represents the conclusion or operation of the system under the current conditions. In this way, according to different state attributes, the computer can uniquely determine the current state of the system and corresponding measures. The various operating states of the power grid are defined as follows: normal state: degree0; alert state: degree1; emergency state: degree2; crash state: degree3; recovery state: degree4.

5. Agent-based intelligent scheduling decision system
Agent-based intelligent scheduling and decision-making system is a process in which the functioning agents cooperate with each other to cope with, analyse, and process problems. First, the management decision-making agent receives decision tasks from the system resource layer through the communication service layer and the decision resource layer. Basic information and status description; according to the information and difficulty of the problem, each functional agent and expert decision agent coordinate and make decisions to eliminate conflicts. Then, each functional agent feedbacks the management decision agent according to the judgment and negotiation information of the problem; the
management decision agent communicates the decision result to the execution agent, transmits the instruction through the integrated communication network, and finally responds to the system through the corresponding switching action [8]. Agent-based intelligent scheduling decision-making system, which consists of four layers: human-computer interaction layer, decision resource layer, communication service layer and functional subject layer. The specific framework is shown in Figure 4.

![Agent-based power grid dispatching decision system diagram](image)

**Figure 4.** Agent-based power grid dispatching decision system.

For example, if a short-to-ground fault occurs in the power grid, the system first sends out an alarm signal to inform the system that it is in an abnormal state. The fault diagnosis agent quickly finds the place where the short-circuit fault occurred through impedance ranging, and issues a fault repair operation ticket and line maintenance. The personnel can quickly reach the designated place to repair the line, so that the system can return to the normal state again in the shortest time and avoid the accident from expanding. The biggest advantage of using Agent to implement intelligent dispatch is to quickly and accurately judge accidents, give correct recovery decisions, and guide and assist maintenance personnel to quickly recover from power grid failures.

6. Summary
Intelligent dispatching decision-making is the direction of research and development of dispatching automation. Agent-based intelligent dispatching decision-making system can realize the management and decision-making functions of the grid operation through the perception of the power system environment by the Agent. The adjustment and control of the mode can reduce dependence on dispatchers. And it can make faster and more accurate decision-making measures than dispatchers to ensure that the power grid is safer, more economical, and more stable.

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