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Smart Grid Automatic Dispatching System Based on Dynamic Characteristics of Adjustable Resources

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Abstract

In order to solve the problems of low precision and long time-consuming in traditional power grid dispatching system, this paper proposes to design an automatic dispatching system of smart grid based on dynamic characteristics of adjustable resources. The system consists of power data acquisition module, web module and smart grid automatic dispatching module. Among them, the function of power data acquisition module is to collect and preprocess power data, and the data similarity measurement method is used to preprocess the collected power data; the web module uses the web to process the collected power data The server is connected with the power management information system, according to the dynamic characteristics of power data, the dynamic threshold of load intensity in the dynamic evaluation index is obtained to realize the adaptive scheduling of power data; in the automatic dispatching module of smart grid, hierarchical task scheduling mode is selected to schedule the grid tasks, and the power data probability distribution model of task scheduling is constructed by curve fitting Taking the adjustable dynamic attribute of power data as its constraint condition, the maximum entropy method is used to obtain the objective function of power grid automatic dispatching, and the design of smart grid automatic dispatching system based on the dynamic characteristics of adjustable resources is completed. The experimental results show that the performance of the designed system is better in task scheduling.

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I. INTRODUCTION

In recent years, with the continuous development of power technology, smart grid technology has also been considerable development, smart grid technology is becoming more and more mature. The emergence of smart grid automatic dispatching system is the need of power enterprise development. The system can improve the working efficiency of power grid and enhance the economic benefits of enterprises. In this environment, the dispatching automation technology of power grid is constantly updated. However, due to the limitation of technology and equipment, the development of smart grid automatic dispatching system is hindered. Therefore, how to improve the efficiency of smart grid automatic dispatching has become a key topic in this field[1].

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In the smart grid automation scheduling, the dynamic characteristics of adjustable resources refer to the dynamic characteristics of the power data in the power grid. It has uncertainty and will change anytime and anywhere. In the design of smart grid automatic dispatching system, it needs to be constrained to improve the performance of smart grid automatic dispatching system [2]. Based on this, this paper proposes to design a smart grid automatic dispatching system based on the dynamic characteristics of adjustable resources.

II. OVERALL ARCHITECTURE OF SMART GRID AUTOMATIC DISPATCHING SYSTEM

The smart grid automatic dispatching system based on the dynamic characteristics of adjustable resources mainly includes power data acquisition module, web module and smart grid automatic dispatching module. Its overall architecture is shown in Figure 1.

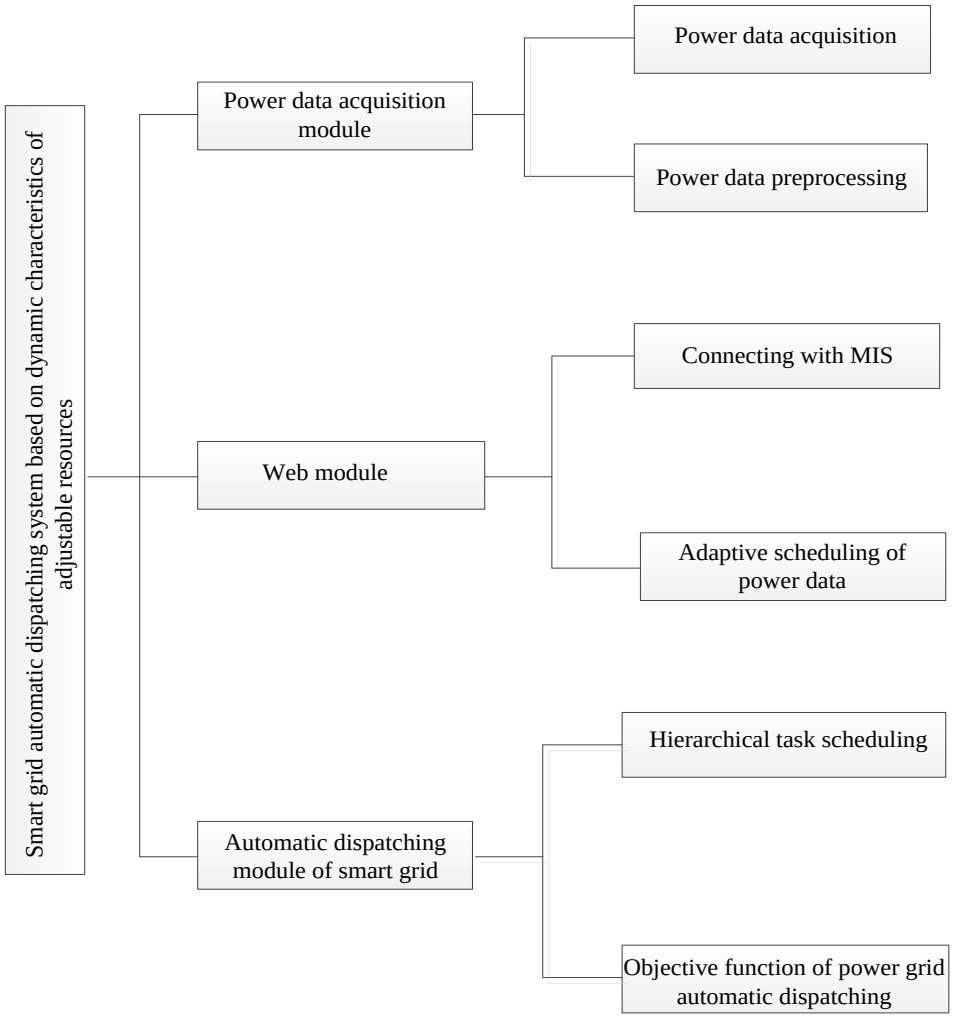

Fig 1: Overall system architecture

Power Data Acquisition Module

Power data acquisition module is the most basic module in power grid automatic dispatching system. The main functions of the module include power data acquisition and power data preprocessing.

- **Power data acquisition**

The acquisition of power data is the basic function of smart grid automatic dispatching system. Only after obtaining the power data can the intelligent dispatching be carried out. Electric power data is usually obtained in the form of files. It is mainly

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obtained from the power standard database, including SQL server, mysql, etc., and the power data is collected according to the relevant protocols of power data acquisition [3]. According to the dynamic characteristics of adjustable resources, the obtained power data are divided into dynamic data and static data. Static power data refers to the power business data of other related power systems; dynamic power data refers to the real-time power data that changes in the operation of power grid. The data collected by the power data acquisition module are mainly dynamic power data, and the acquisition process is shown in Figure 2.

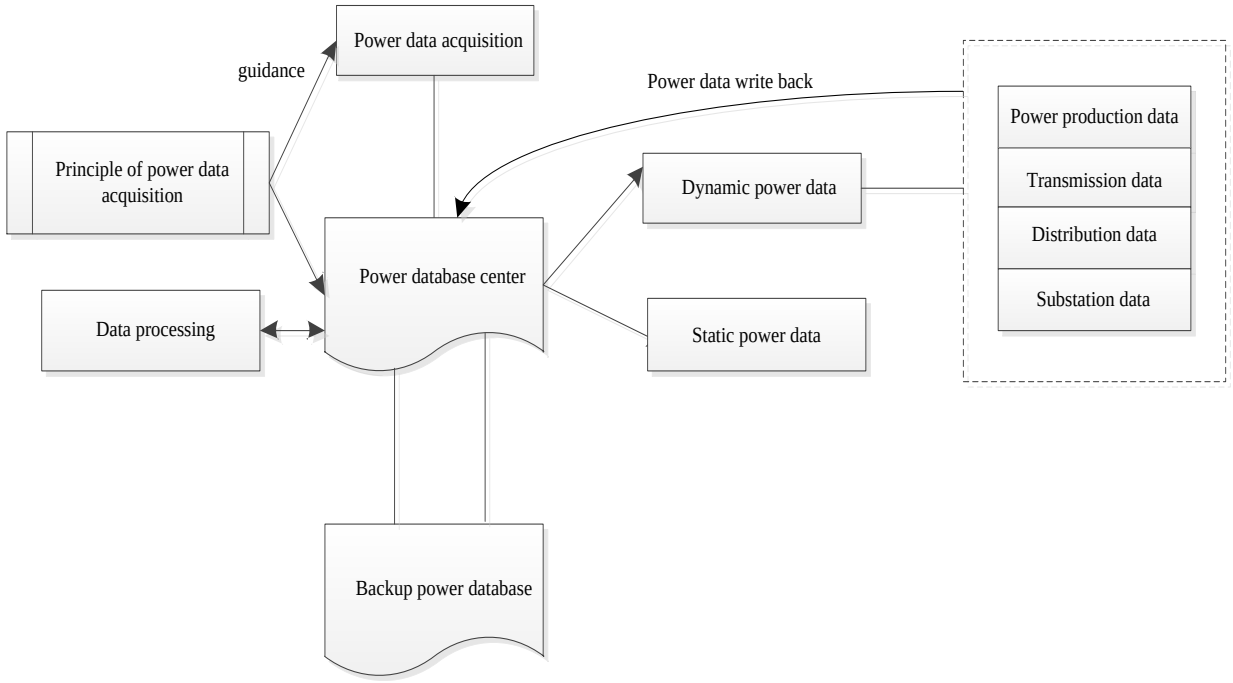

Fig 2: Power data acquisition

- **Power data preprocessing**

After power data acquisition, it is necessary to preprocess it to improve the efficiency of smart grid automatic dispatching. Due to the large amount of power data obtained above, the pressure of smart grid automatic dispatching system is greater. Therefore, in the power data preprocessing, this paper uses the data similarity measurement method [4] to merge the collected power data, reduce the probability of duplicate power data, and lay the foundation for high-speed dispatching of smart grid automatic dispatching system.

Firstly, it is necessary to determine the proportion of the obtained power data in all the data, and calculate the power data importance measurement value [5], which can be calculated by formula (1), that is.

$$F_i = \frac{\mu_i}{1-\mu_i} \tag{1}$$

In the formula, F_i represents the power data importance measure, represents the proportion of non-repeated power data.

After obtaining the importance measure value of power data, the richness measure of power data [6] can be calculated by formula (2), that is,

$$Y_i = \frac{y_i}{\max\{y_i\}} \tag{2}$$

In the formula, Y_i representing the power data richness measure, represents the richness of raw power data. According to the importance and

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richness of power data, the similarity of power data is obtained,

$$d\{x,y\}=\sum_{i=1}^{n}x[\omega_i]\otimes y[\omega_i] \tag{3}$$

In the formula, x and y represent any two data of the obtained power data respectively; d{x,y} represents the similarity measure value of two power data. In general, the similarity measure of power data ranges from [0,1]， When the similarity measure value of the collected power data is [0.85,1] , the two power data are combined.

Web Module Design

In the design of smart grid automatic dispatching system, in order to improve the performance of smart grid automatic dispatching system, this paper connects the web server with the power management information system, and the connection circuit is shown in Figure 3

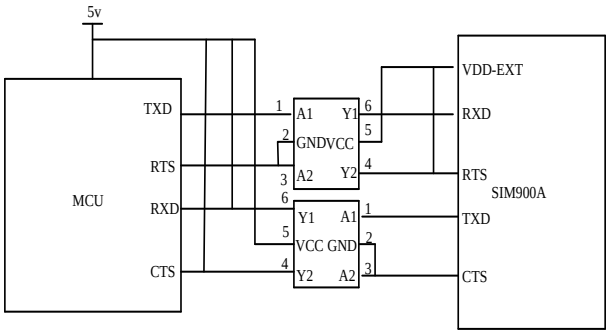

Fig 3: web server and electric power management information system circuit

The security isolation equipment is set in the web server to ensure that the power grid automatic dispatching system can transmit the power data to the web server. The power management information system can understand the power operation data and call the data of the master station through browsing on the web server, so as to realize the automatic dispatching of the smart grid [7]. This method can effectively reduce the cost of smart grid automatic dispatching, reduce security issues, and ensure the efficiency of smart grid automatic dispatching. Its functional structure is shown in Figure 4.

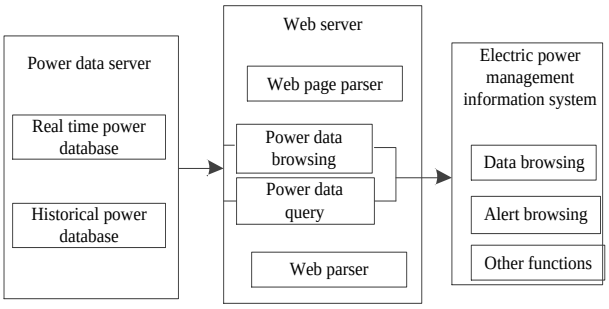

Fig 4: Functional architecture of web module

Due to the dynamic characteristics of power data, the web module also needs to control the browsing and querying power data to realize the automatic dispatching of smart grid.

In this paper, the dynamic impact threshold of load intensity in dynamic evaluation index is applied to adjust each power data through web browser adaptively.It is assumed that the dynamic influence threshold [8] of power data is ψ_1, ψ_2 , After passing through the web browser, the sum and difference of the standard deviation of power data load intensity are as follows.

$$\begin{aligned}\psi_1&=\vartheta-\upsilon\\ \psi_2&=\vartheta+\upsilon\end{aligned} \tag{4}$$

In the formula, ϑ represents the average load strength of all power data through Web browsers , υ represents the standard deviation of a grid dispatching system , it can be obtained by formula (5), namely,

$$\upsilon=\sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i-\bar{x})^2} \tag{5}$$

In the formula, n represents the amount of power data from all Web browsers, x_i represents the average load strength of power data i.

On the basis of obtaining the above load strength, the power data through web browser is adjusted adaptively.

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$$\vartheta_k = \frac{1}{m}\sum_{k=1}^{m}\varepsilon_k \tag{6}$$

In the formula, ε_k represents the ability of adaptive regulation of power data.

Automatic Dispatching Module of Smart Grid

The main function of smart grid automatic dispatching module is to realize the task scheduling of power data. The task scheduling of power data includes centralized scheduling, distributed scheduling and hierarchical scheduling. Among them, centralized scheduling is the central scheduler assigning all the power data and other task data to the task, using the same task scheduling method, which concentrates on the scheduling of the power data tasks, but the later maintenance costs are higher, and the system will be paralyzed by [9] due to the failure of the central scheduler. Therefore, the task scheduling mode of this module is hierarchical task scheduling mode. In this power task scheduling mode, the core central scheduler is set to control the management and cooperation of smart grid resource dispatching. Three local schedulers are set to assist the core dispatcher in dispatching grid resources. The dispatching mode is shown in Figure 5.

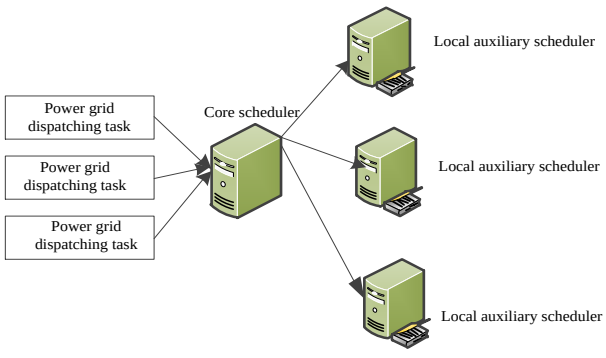

Fig 5: Design of hierarchical task scheduling structure

In order to ensure the realization of smart grid automatic dispatching function, it is necessary to consider the dynamic characteristics of adjustable resources. In smart grid automatic dispatching system, the dynamic characteristics of adjustable resources mainly refer to the dynamic characteristics of power data. When scheduling tasks, it is necessary to analyze the dynamic information. In this paper, the probability distribution model of power data for task scheduling is constructed by curve fitting. The dynamic change of power dispatching data is uncertain, so the maximum entropy method is used to obtain the objective function of power grid automatic dispatching [10], and the adjustable dynamic attribute of power data is taken as its constraint condition.。

It is assumed that the probability distribution of dynamic characteristics of power data adjustable resources is as follows.

$$G(x) = \frac{\beta^n}{e}\gamma^{-\beta}, e = 0.1,... \tag{7}$$

In the formula, β represents the Poisson's ratio coefficient, e represents the amount of requests for scheduling tasks, γ represents the amount of scheduling tasks for the actual input system.

According to the request probability function, the entropy can be obtained, that is,

$$S = \beta - \beta\log\beta + \sum_{k=1}^{n}\log\tau(k+1)l(k), k > 0 \tag{8}$$

On the basis of the above analysis, the entropy value obtained is optimized, and the dynamic characteristics of adjustable resources are taken as the optimization conditions. When the entropy value is the minimum, the effect of smart grid task scheduling is the best. Combined with the constraints of the dynamic characteristics of adjustable resources, the effect of the system is optimized. Namely,

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$$Max\ \ S_n = -\sum_{i=1}^{n} \phi_i \ln \phi_i$$

$$s.t. \sum_{i=1}^{n} \phi_i = 1$$

$$\phi_i > 0, i = 1,...n$$

$$\sum_{i=1}^{n} \phi_i(e_i) = E \tag{9}$$

In the formula, n represents the number of tasks to be scheduled, ϕ_i is state value representing the dynamic characteristics of the adjustable resource. According to the above analysis, the entropy value obtained can reach the minimum value, that is, combined with the constraints of dynamic characteristics of adjustable resources, the effect of the system can be optimized.

III. EXPERIMENTAL ANALYSIS

In order to verify the comprehensive effectiveness of the designed system, experimental analysis is carried out.

Experimental Environment

The system is developed on the platform of MATLAB. Microsoft Virtual Studio 2010 is used to develop the system software, and power designer 10.0 is used to develop the power database. The experimental operating system is windows 10 system, and its running memory is 8 GB. The extension structure of the system structure is shown in Figure 6.

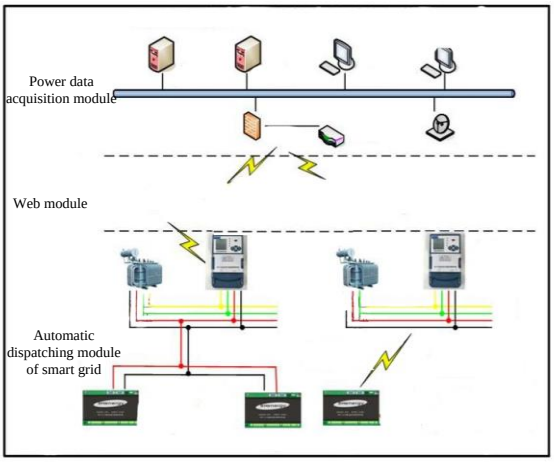

Fig 6: The system extension structure constructed

Experimental Parameters

The experimental parameters are shown in Table 1

Table 1 Experimental parameters

Parameter	Value
Power data information/GB	2
Scheduling task / piece	10
Dynamic change of power data / Hz	1.0~3.0

Experimental Scheme

In order to verify the feasibility of the designed system, this paper compares the system, the grid resource scheduling system of cloud computing and the grid connected microgrid double-layer scheduling system to analyze the accuracy of resource scheduling and the scheduling time-consuming of the system.

Analysis of Experimental Results

- **Accuracy analysis of power grid resource dispatching**

This system is used to schedule the task data of the power grid for 10 times, and the resource scheduling accuracy of this system and the traditional dispatching system is compared. The experimental results are shown in Figure 7.

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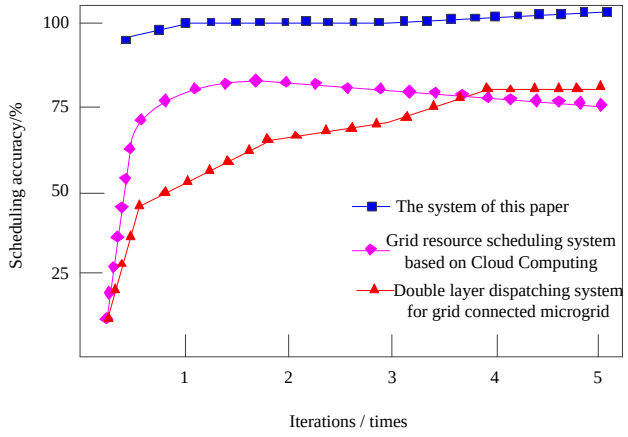

Figure 7: Precision results of resource scheduling

By comparing the resource scheduling accuracy of this system and the traditional scheduling system, we can see that the power grid task scheduling accuracy of this system is higher, up to 98%, while the accuracy of resource grid resource scheduling of other two traditional systems is far lower than that of this system. This is due to the proposed system in the design of the power data preprocessing, remove duplicate data, improve the purity of grid resource scheduling data, and then improve the scheduling accuracy of this system, which verifies the scientific effectiveness of the system.

- **Time consuming analysis of power grid resource dispatching**

In order to further verify the comprehensive effectiveness of the proposed system, the grid resource scheduling system based on cloud computing and the grid connected microgrid double-layer scheduling system are experimentally analyzed. The experimental results are shown in Figure 8.

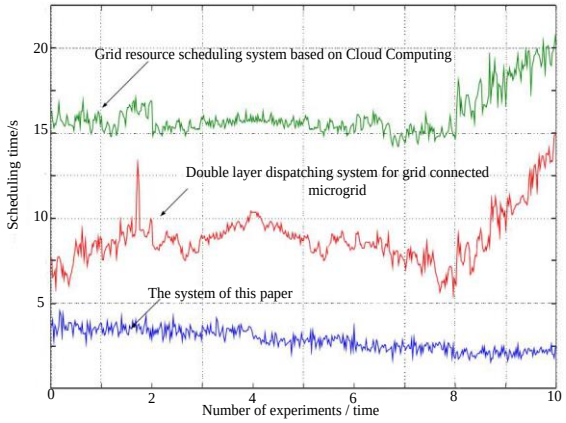

Fig 8: Time consumption analysis of power grid resource dispatching

It can be seen from figure 8 that there are some differences in the time consumption of the three systems for grid resource scheduling. The scheduling time of the proposed system is the shortest and always lower than the other two systems. This is because the proposed system takes into account the dynamic characteristics of power grid resources and constrains them, thus speeding up the dispatching of power grid data.

IV. CONCLUSION

This paper designs a smart grid automatic dispatching system based on the dynamic characteristics of adjustable resources. Through the detailed analysis and processing of power data acquisition module, web module and smart grid automatic dispatching module, the design of smart grid automatic dispatching system based on dynamic characteristics of adjustable resources is completed. Compared with the traditional system, this system has the following advantages.

(1) The accuracy of resource scheduling in this system can reach 98%, which has certain credibility.

(2) In this paper, the system resource scheduling time is short, always less than 5 seconds, improve the efficiency of the system.

Although some achievements have been made in this paper at this stage, there are still many deficiencies,

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which will continue to be improved in the future in order to contribute to the development of power grid.

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