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Energy Data Storage Based on Improved Particle Swarm Algorithm

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Abstract: As a large improving country, my country has serious problems in energy utilization. Vigorously promoting energy conservation and emission reduction is an undisputed choice for my country and even the world. Energy data storage based on data warehouse can effectively assist energy consumption supervision departments to monitor changes in local energy consumption and predict energy consumption trends. The purpose of this paper is to store energy data based on improved particle swarm algorithm. This paper studies the concept and origin of particle swarm optimization, analyzes the cloud storage system and its characteristics, and the relationship between energy big data and cloud storage. In the experiment, the basic particle swarm algorithm is used to investigate and analyze the three modules of energy cost management, index analysis and energy prediction and performance realization.

1. Introduction

With the improvement of energy systems and data storage systems, monitoring the real-time operating status of energy systems becomes more and more important. As one of the important data processing methods for monitoring the operating state of the energy system, state estimation can not only grasp the actual situation of the energy system, identify bad data, but also provide reliable data support for subsequent dispatching departments [1].

Building an energy system can not only increase the flexibility of the social energy supply system, but also reduce the environmental pollution caused by energy consumption, which is of great significance for improving energy utilization. Particle swarm optimization also plays a huge role in energy data storage.Wani EN Software Costing is a forecast of the improvement effort

required to improve projects. Software costing has always proved to be a challenging issues, thus attracting the attention of many researchers. Metaheuristic techniques have been increasingly used for software costing. A framework consisting of a functionally connected artificial model and a swarm optimization algorithm is proposed as a training algorithm. Particle swarm optimization is performed by iterative optimization of filter solutions. The proposed model is evaluated datasets, using the error size and its mean as a performance metric to measure the quality of the obtained estimates [2]. Tu S believes that QPSO is a method inspired by particle swarm optimization and quantum mechanics. However, it shows the best situation for many electrical issues. However, when dealing with difficult optimization problems, we sometimes get stuck in local expectations. Therefore, in order to maintain a balance of search and search in particle swarm optimization, three improvements are proposed to the QPSO method, called the advanced MQPSO algorithm. First, we improve a new selection procedure that will select the best particles in the community within space for high-performance detection. Second, a new conversion method is adopted to maintain the ease of use of the existing QPSO system [3].Particle swarm optimization algorithm is an effective and intelligent algorithm for dealing with function optimization problems.

This paper studies the improved algorithm in intelligent optimization algorithm, the concept and origin of particle swarm algorithm, analyzes the cloud storage system and its characteristics, and the relationship between energy big data and cloud storage. Using the basic particle swarm algorithm and taking the energy data of large enterprises in M city as the research object, three modules of energy cost management, index analysis and energy prediction and performance realization are mainly analyzed.

2. Research on Energy Data Storage Based on Improved Particle Swarm Algorithm

2.1. Intelligent Optimization Algorithm

(1) Intelligent algorithm

With the rapid improvement of intelligent algorithms, various optimization algorithms continue to emerge, and the improvement of intelligent algorithms provides convenience for the optimization of water supply systems. The intelligent algorithm is a search algorithm based on the behavioral rule of biological group foraging. It regards every possible solution in the space as a biological group individual in nature, and the process of seeking the optimal solution is the group individual evolution or Foraging process [4]. Swarm intelligence algorithm is an intelligent behavior that finds low-intelligence individuals to achieve final coordination and obtain optimal results through the coordination and cooperation among individuals in the group. In other words, this process is an iterative process in which the poor probability solution is replaced by the dominant possibility solution many times in the simulation optimization. The typical ones are genetic optimization algorithm, hybrid frog leaping optimization algorithm, neural network optimization algorithm, particle swarm optimization algorithm, etc.

(2) Improved algorithm

As a swarm intelligence optimization technology, the algorithm has a strong ability of global optimization, and it is more effective for solving the global optimal problem of the objective function with nonlinear and multimodal characteristics [5]. However, the basic algorithm has problems such as poor local search ability and low precision, and the global optimal solution may not be able to be searched. In the process of searching, it is easy to fall into the solution and has certain dependence on parameters . Therefore, based on the basic algorithm, many researchers have proposed many improvements to the basic algorithm, group topology structure and mixing with

others.

2.2. Particle Swarm Optimization

(1) Concept

The formation of particle swarm optimization is based on the thinking of the feeding behavior of birds in nature. If the birds randomly search for food within a certain range, and the amount of food is certain, let these birds that can communicate information find the largest food in the food, provided that all birds in the space do not know the specific spatial location of the largest food , but can perceive the distance between its current position and the largest food in the space, then the simplest and fastest search strategy is to search the area near the flock of birds that is closest to the largest food in the space until the largest food is found [6-8]. Particle swarm optimization has the simple and easy-to-understand concept, easy-to-implement operation, and fast convergence speed. After years of improvement, particle swarm optimization has been used, but in solving combinatorial problems, the application is still less. On the advantages of it and the research purpose of this subject, this subject will apply it to the practical problems of multi-water supply system optimization research. 9].

(2) The origin of particle swarm optimization

It was originally derived from the bird flock simulation model of Craing Reynolds. This model is a complex adaptive system. The main body of the complex adaptive system continuously adapts and adjusts its own behavior under the action of the system and the environment, so that the system organization structure occurs change [10]. The subjects in the system can exchange information and learn from each other, and change their own behavior and organizational structure through continuous learning. The system has the following properties: ① The subjects in the system are alive and have the ability to learn ; ② The subjects in the system can exchange information and learn from each other; ③ The macro (environmental influence) and micro (subject influence) in the system are in a state of organic combination and cannot be completely separated. By observing the behavior of birds flying in flocks in the air, when they encounter obstacles, they go around and then reunite. It is believed that there are some reasonable rules in the behavior of these birds synchronously separating and synchronously reuniting. In the particle swarm algorithm, all particles simulate the process of bird flocks flying and searching for food. These spatial particles are initially randomly distributed in the multi-dimensional solution space. The quality of the current spatial position of the particles is evaluated by the fitness function value. The particle fitness value The size reflects the value to a certain extent. At a certain moment in the optimization calculation, the particles judge the action direction and walking length of the next moment by evaluating the current position, the best historical position and the random factors existing in the system. The particles distributed in the space The group performs a position update according to the position formula, and the entire optimization process completes an iterative process [11]. The particle group in the space is to constantly hunt down these two historical best extremums, and constantly adjust the forward direction until the global optimal extremum of the space is searched, and finally the optimization process is completed.

2.3. Cloud Storage System and its Characteristics

Cloud computing is to use the excellent computing and storage capabilities of clusters to store and process massive data quickly, efficiently, and reliably, while ensuring the reliability and

scalability of the system [12]. Cloud storage is based on data storage and management, providing a scalable, secure and reliable infrastructure for enterprises and organizations. In general, energy data cloud storage features reliability, scalability, ease of use, and data management [13].

2.4. The Relationship between Energy Big Data and Cloud Storage

The popular understanding refers to the data set with huge data scale and beyond the scope of ordinary computing and storage in the emergence stage. At present, it is proposed by IBM that big data has the following 5V characteristics:

(1) Volume: The amount of data is huge [14]. The amount of data collected, stored and calculated in intermittent energy is very large, and it cannot be effectively processed using conventional processing methods and methods. In the intermittent energy management system, a large amount of data is generated in the links of equipment monitoring and collection, power transmission and power consumption.

(2) Velocity: The data production rate is faster than the current technical processing speed [15]. In the intermittent energy data, the data collection period of the wind turbine is 1-2s.

(3) Variety: There are many types of intermittent energy monitoring data, including structured, semi-structured and unstructured data. There are many sources of system operation data; structured monitoring data, operation log data, video data, etc.

(4) Value: In intermittent energy big data, the data value density is relatively low. In the continuous monitoring data, the value of the overall data is not very high [16].

(5) Veracity: Massive wind power monitoring data can feed back the operating status of the wind power monitoring system. Big data is to the cloud platform like a car is to its wheels.

Data processing must depend on computing power and storage capacity, and big data is more dependent on distributed computing architecture, the powerful computing and storage technology of cloud platform and its fit to the needs of big data [17]. In the research of intermittent energy big data storage, the traditional data processing center uses the single-machine active-standby mode and multi-thread mode, which can no longer meet the requirements of mass data storage and data management. In the face of rapidly growing data, the scalability, service availability, and data reliability of traditional processing systems cannot be guaranteed, and new technologies and methods are needed to deal with them. With the improvement of intermittent energy, the amount of data generated will gradually increase, the data pressure brought by the operation will also increase, and the data needs more and more computing and storage resources. Relying on the big data processing of intermittent energy on the cloud platform, and storing a large amount of data generated in the cloud storage platform, this is an inevitable trend of technological improvement [18]. Through the combination of cloud storage and other technologies, and making full use of the cloud storage platform's high-efficiency advantages of storing massive data and distributed, it should be able to better meet the requirements of infrastructure such as storage and computing of big data in intermittent energy big data.

3. Investigation and Research on Energy Data Storage Based on Improved Particle Swarm Optimization

3.1. Implementation and Testing

Taking the energy data of large enterprises in M city as the research object, three modules of energy cost management, index analysis and energy prediction and performance realization are

mainly analyzed according to demand analysis and function design.

3.2. Basic Particle Swarm Optimization

In the basic particle swarm algorithm, two important indicators of speed and position are used to describe the particles in the space. In a D-dimensional space, each particle is regarded as a point in the D-dimensional space, represents the coordinates of particle x_i, p_i represents the current speed of particle i, and represents the historical optimal position of particle i. The algorithm is to seek a better position in the space through continuous iterative replacement, so as to update the optimal position p_i in the history of the particle. In the formula, $i=1,2,\Lambda\ N$ (N represents the size of the population), j is the number of iterations of the population update, and $d=1,2,\Lambda\ D$ (D represents the spatial dimension). v_{id}^{j+1} is the component of the velocity of particle i in the d-dimensional direction after j+1 iterations, x_i^{j+1} is the component of the position of particle i in the d-dimensional direction after j+1 iterations, ξ、η is the random number introduced by the system, and obeys U(0, 1) distribution to ensure that the system has stronger expressive power and population diversity. The specific formula is as follows:

$$v_{id}^{j+1}=v_{id}^{j}+c_1\xi\left(p_{id}^{j}-x_{id}^{j}\right)+c_2\eta\left(p_{gd}^{j}-x_{id}^{j}\right) \quad (1)$$

$$x_{id}^{j+1}=x_{id}^{j}+v_{id}^{j+1} \quad (2)$$

4. Analysis and Research of Energy Data Storage Based on Improved Particle Swarm Optimization

4.1. Realization of Energy Cost Management

Energy cost management has functions such as cost report, comparative analysis, and input of industrial output value. The cost report function mainly includes querying the energy cost per unit of its consumption, querying the consumption structure of the unit; querying the energy cost of energy-consuming equipment, querying the energy consumption structure of energy-consuming equipment; querying the energy cost of the process, querying the energy consumption structure of the process; querying the energy cost of products, Query the major functions of the energy consumption structure of the product. Comparative analysis of the main energy consumption unit energy purchase cost, the specific data are shown in Table 1 and Figure 1:

Table 1. Data sheet of energy cost

Unit	Natural gas	Electric energy	Air
	Net expensive use (yuan)		
A company	958470	2842213	695421
B company	1098547	1548774	154125
C company	595471	1854669	584741
D company	896241	3514521	658412

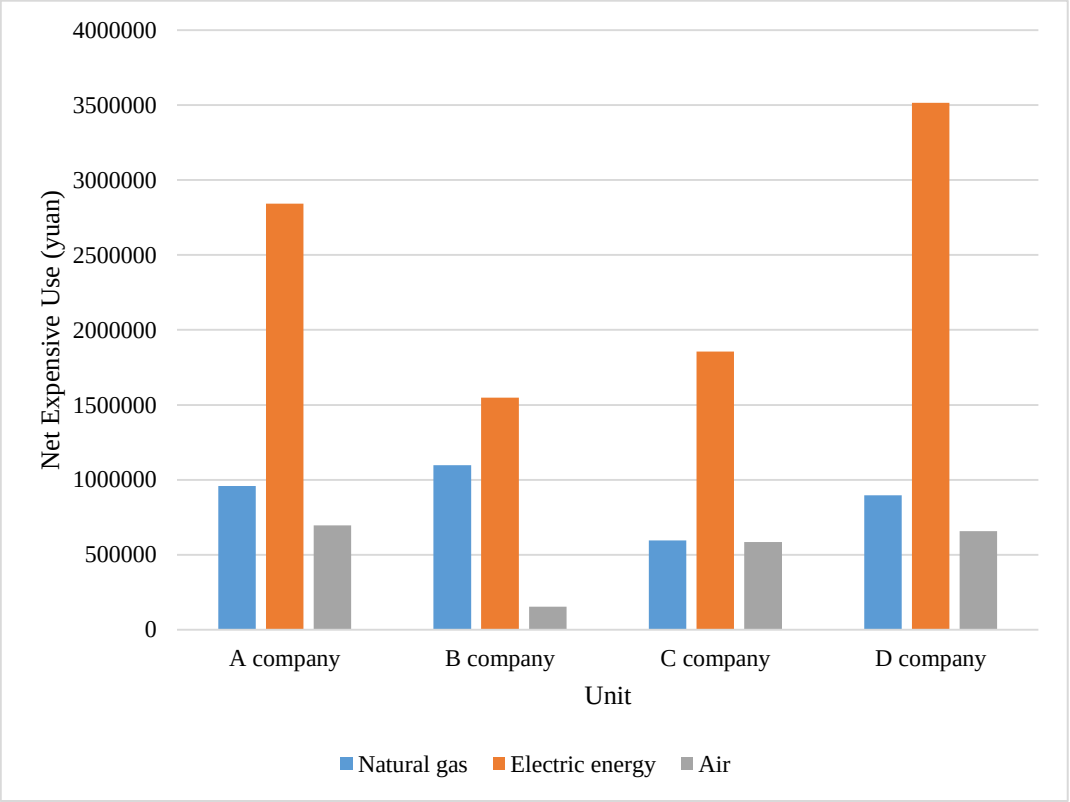

Figure 1. Collation map of unit energy cost chart

4.2. Implementation of Indicator Analysis

The realization of index analysis includes the realization of monthly index analysis, quarterly index analysis, and annual index analysis. For each index analysis, it includes the analysis of energy consumption, it is the analysis of energy-consuming equipment, process energy consumption analysis, process The realization of several sub-functions is analyzed by single consumption. Taking the key energy-consuming equipment in the monthly index analysis as an example, by comparing the physical quantity and the equivalent energy consumption data as shown in Table 2 and Figure 2:

Table 2. Energy consumption analysis interface of carbon dioxide compressor equipment

Energy types	Physical measurement value	When measuring the value
Electric energy (kw-hr)	854125	387459
Natural gas (stere)	45147	44755
Air (stere)	41365	95417
Comprehensive energy consumption	0	569874

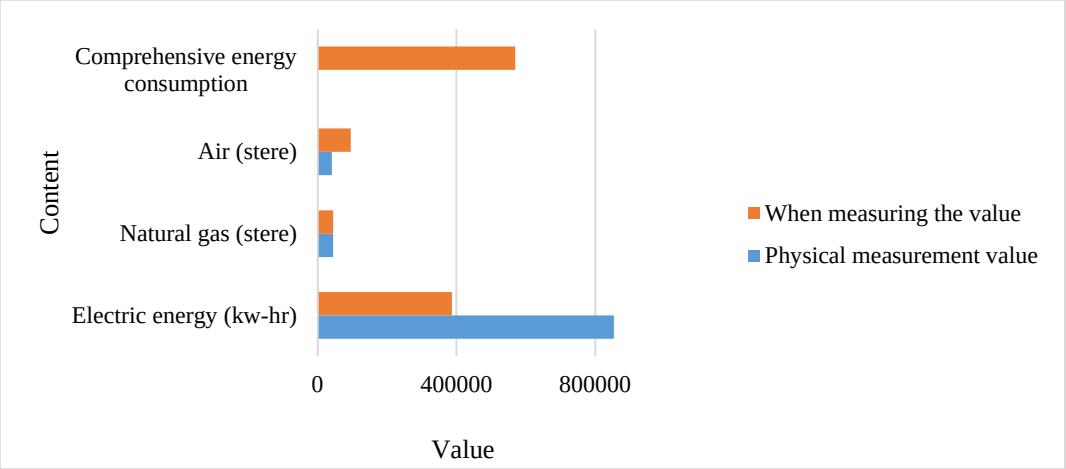

Figure 2. Comparison diagram of electricity and natural gas and equivalent value

4.3. Energy Forecast and Performance Realization

The realization of energy forecasting and performance includes elastic coefficient method forecasting, trend forecasting method forecasting and the realization of performance appraisal. The realization of the elastic coefficient method prediction can be divided into the function of the unit energy consumption prediction module. The predicted data of energy consumption per unit of energy consumption are shown in Figure 3 and Table 3:

Table 3. Energy consumption forecast data Table

Energy types	In February	In March	In April	May forecast for energy data
Electric energy	86931	635141	658964	1024547
Natural gas	648745	669854	705412	958741
Air	851876	836547	854896	968745
Comprehensive energy consumption	7854854	7835412	8544121	10254870

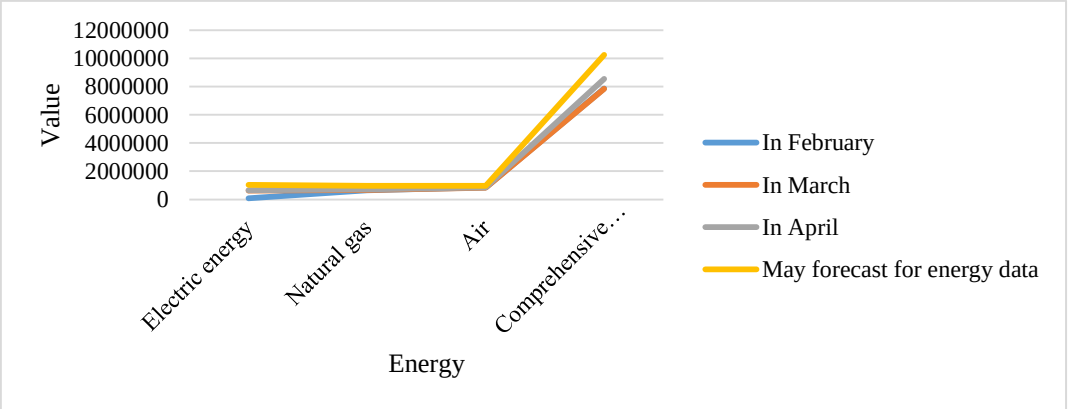

Figure 3. Comparison chart of the energy data predicted by energy-using units

5. Conclusion

Although the particle swarm optimization algorithm has made great progress since it was proposed by scholars, it also has some shortcomings. It is necessary to further improve and perfect the optimization performance of the particle swarm optimization algorithm, and most of them are carried out on the basis of the standard particle swarm optimization algorithm. Convergence time and jumping out of local optima are related to improvement work. Due to the increasing scale and type of energy contained in the energy system and the increase of measurement data, the traditional method will no longer be suitable for the condition monitoring of energy data storage. Therefore, in order to improve the energy utilization rate and save energy reasonably, it is of great significance to study a method suitable for energy data storage.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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