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Research Article

Application of Big Data Clustering Algorithm in Electrical Engineering Automation

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The existing control methods have the problem of imperfect automatic distribution linkage model, which leads to excessive noise in the process of practical application. This paper designs an electrical engineering automation control method based on big data clustering algorithm, obtains the load parameters of power cable laying mode, arranges the cable channels hierarchically, extracts the technical characteristics of electrical engineering automation control, integrates the equipment operation information, builds the automatic distribution linkage model, mines the data rules of power index, sets the distribution structure of electrical equipment by big data clustering algorithm, and centrally configures the functional units.*Experimental Results*. Compared with the other two control methods, the average noise of this control method is 19.774 dB, 35.462 dB, and 36.323 dB, which proves that the control method combined with big data clustering algorithm has better practical application effect.

1. Introduction

Electrical engineering is the main functional support of building construction. Under the requirements of intelligent building construction, we should introduce communication information technology and apply it in electrical engineering, so as to achieve the automation and intelligent application of electrical. But in the specific design, if it is improper, it will bring all kinds of thorny problems, such as unstable operation and even failure. This requires us to design and apply in practice according to the requirements of electrical indicators, intelligent requirements, economic requirements, performance characteristics of equipment, and the specific situation of buildings. Electrical technology in electrical engineering automation refers to the integration of electrical technology by electrical energy and electrical equipment, which creates a certain power environment for buildings and building groups [1, 2]. Construction engineering is accompanied by human civilization, and electrical technology is only a hundred years of history, but because of the irreplaceable application of electrical energy in the home and office, building electrical technology is quickly recognized as a professional discipline and deeply studied by industry scholars. At first, the application of electrical technology in the construction industry is the primary voltage transformation, wiring, etc. later, through leakage protection and other measures to repair the power failure and then through the absorption of control technology, communication technology, and microelectronics technology to realize the monitoring of residual current and realize the cut-off and unified management of super large current. To sum up, the development of building electrical technology is from a single strong current mode to a comprehensive application mode of combining strong and weak current.

Data clustering is to analyze and divide the data without class reference into different groups, that is, to derive class labels from these data. Clustering itself is to discover data objects and their relationship information according to data. The objects in each group are similar, but the objects in each group are irrelevant. The higher the similarity in each group and the higher the dissimilarity between groups, the better the clustering. Data clustering can effectively deal with large data sets, and the algorithm keeps scalability and efficiency, so it can be used when the data volume is large. Data

clustering has the advantages of saving memory, high speed, and identifying noise points. In the context of sustainable social and economic development, people's living and office requirements for building functions are also increasing, and the challenge of building electrical technology will be greater and greater [3]. On the one hand, the types of modern buildings are also increasing, and the functionality and pertinence are also becoming stronger, and the pattern, construction area, shape, and so on are changing. On the other hand, as a place where people gather, buildings will face all kinds of unpredictable disasters, including fire and terrorist attacks, so they need to have the function of fire control and early warning. At the same time, with the society's attention to environmental protection and resource conservation, green and energy-saving buildings began to be mentioned more. In this way, there is still a lot of room for the development of building electrical technology. Its development trend includes intelligence and informatization. The rapid development of information technology and big data technology is its technical support, and the implementation in buildings requires the cooperation of electrical technology [4–6]. At this stage, access control platform, elevator platform, central air conditioning, etc. have begun to introduce intelligent information technology, so that it can automatically and optimally realize various functions of the building [7, 8]. But this kind of application still has a big demand and development space in the future. Green and energy saving, usually buildings, can produce indoor insulation effect based on the glass film, the setting of external walls, but the energy saving of buildings is far more than that. First of all, electricity saving is directly related to people's electricity habits. Energy saving not only needs to reduce people's demand for electricity but also needs to carry out intelligent deployment according to their usage habits, and electrical technology should also adjust and adapt to this demand. The electrical technology in the field of construction is from the integration of architecture and electrical, and with the increasing complexity of construction engineering, its requirements for electrical technology are also higher and higher, which will promote the further subdivision of building electrical technology, such as energy saving and intelligent. At present, the research on big data clustering algorithm and electrical engineering automation is not comprehensive enough and needs to be further discussed.

2. Design Electrical Engineering Automation Control Method Based on Big Data Clustering Algorithm

2.1. Obtaining Load Parameters of Power Cable Laying Mode. In practical application, there are different emphases for line selection under different conditions. In principle, the selection of bus needs to check the heating principle, thermal stability, and dynamic stability, but generally, the bus at the end of the electric well and later distribution platform cannot check the thermal stability and dynamic stability, while the bus in the substation must check the thermal stability and dynamic stability [9–11]. In principle, the selection of cables needs to check the heating principle, voltage loss, and thermal stability, while the high-voltage cables need to check the thermal stability. The cables of low-voltage lines need not be checked for thermal stability, and the cables arranged in non-high-rise buildings and indoor need not be checked for voltage loss. The selection principles of low-voltage insulated conductor are heating principle, voltage loss principle, and mechanical strength principle. The mechanical strength principle can only be checked when the X-type low-voltage insulated wire is laid overhead. Generally, BV- or BVV-type wires are used indoors, and the mechanical strength and voltage loss are not checked [12]. Due to the simple construction, material saving, and heat dissipation of power cable, this method is generally selected when conditions permit. Direct burying means that the cable line is directly buried underground, which does not need early civil engineering. It is a more economical way of laying. It is not easy to suffer from lightning or other mechanical damage, has less faults, and is safe and reliable. The number of cables buried in the same path should be less than 8, so as to avoid excessive earthwork of digging and filling cable trench. When more than 8 cables are laid, the cable trench laying method should be adopted. First, the pipeline is buried underground in advance, and then, the cable is laid in the pipeline. It is usually used in places with large number of cables and heavy traffic. There are many kinds of pipes used in pipe laying, such as resin glass fiber-reinforced plastic cable conduit, glass fiber quartz pipe, hard plastic pipe, asbestos cement pipe, steel pipe, and concrete pipe. It is to lay the cable directly in the excavated cable trench. This laying method is relatively simple and easy. A cable trench can lay a large number of cables, which is conducive to the later cable expansion and planning and easy to check and lay. When the laying distance is short and the number of cables is more than 8, we generally use the method of laying in the cable trench. This method is often used in conjunction with the direct burial of cables and the laying of cable ducts. Because the cable trench laying method does not have strong protective effect on the cables, and the cables are easily damaged by external forces, it is generally used in places with little ground pressure, and there are no corrosive substances.

The N-1 standard is a single fault safety inspection rule. In the normal operation mode, any component of the power system (such as lines, generators, transformers, and DC monopoles) has no fault or is disconnected due to fault. The power system should be able to maintain stable operation and normal power supply, other components are not overloaded, and the voltage and frequency are within the allowable range. When the power cable laying structure meets the N-1 criteria, the load parameters of the number of distribution terminals are estimated, and the estimation formula is as follows:

$$I_0 \geq \frac{t}{\beta \times (s-1)} - 1. \tag{1}$$

In formula (1), t is the number of feeders, β is the reliability index of fault factors, and s is the availability of power supply. The advantages of cable tray laying method are very

prominent, compared with other methods, it has a strong applicability and perfection, and whether it is the trunk line with a large number of cables or the distribution line with a small number of cables, this method can generally be used. The cable tray does not occupy the cable channel alone, saving space, and because the cable is laid in the air, the heat dissipation effect is good, the maintenance is convenient, and it is easy to add new cables. Different cables need to be arranged in layers when they are laid on the bridge. The order from top to bottom is weak current cable, control cable, low-voltage power cable, and high-voltage power cable. This arrangement is to block the mutual influence between the cables and exclude the interference signal, which is not only conducive to the heat dissipation of the cable but also conducive to the later repair and maintenance. When the power cable and control cable are installed on the same bridge floor, we should adopt effective methods to separate the strong current from the weak current to prevent mutual interference. Generally, metal partition is used to separate them. Based on this, the step of obtaining the load parameters of power cable laying structure is completed.

2.2. Extracting the Technical Characteristics of Electrical Engineering Automation Control. Electrical automation control technology refers to the automation control technology through a variety of tools and platforms, while obtaining information, processing, and decision-making of various kinds of information. It is applied to the daily production activities of the factory, through the application of electrical automation control technology, improves the production efficiency, production level, labor productivity, and operation reliability of the factory, liberates people from the programmable and heavy labor, and engages in more meaningful creative activities [13]. The data acquisition mechanism of electrical automatic control technology is composed of various types of sensors, such as flow sensor, liquid level sensor, temperature sensor, and pressure sensor. The analog signals in various productions are converted into electrical signals and input into the automatic control platform. The data processing and program execution mechanism are logic circuit or programmable logic controller, which control the processes of the collected information. The main actuator of electrical automation control technology is motor, solenoid valve, travel switch, etc. Through different functions of the actuator, complete a variety of different functions of electrical control, in order to achieve factory production automation. No matter electrical platform or motor power transmission and electronic engineering automation technology, they are important conditions to promote the sustainable development of modern, technical, and automatic chemical plants. Electrical automation control technology marks the modernization level of industrial development. Its main characteristics are as follows: the application of electrical automation control technology tends to be simplified. The electrical automation technology of the factory is controlled by different interfaces. At present, it has realized the transformation from manual operation to man-machine cooperative operation, which can greatly simplify the cumbersome procedures of the electrical automation control platform, reduce the maintenance process of the platform in the future, and reduce the amount of manpower required for the platform control. The application of electrical automation control technology is developing towards distributed direction. The application equipment of electrical automation control technology mainly includes frequency converter, motor starter, serial cable, PLC, remote I/O station, and computer platform. The operation information of the above technology application equipment is integrated and uniformly stored in the central control center of the factory. The equipment is controlled in a radial distribution mode. The specific structure is shown in Figure 1.

It can be seen from Figure 1 that the application of electrical automation control technology is developing in the direction of informatization. The application of electrical automation control technology in the factory is divided into horizontal and vertical aspects. The horizontal aspect covers the automation control platform of the whole factory, which fundamentally improves the configuration quality of the automation platform. The vertical aspect deeply excavates the data of various departments in the factory, which makes preparation for effectively saving the data information of all parties. The continuity characteristics of electrical automation control technology. Because the enterprise production is a continuous process of assembly line, so its automatic control part has the characteristics of continuity. Enterprise production process is continuous, and its control steps are continuous, to ensure that the production is carried out according to the production process step by step. In order to achieve the effective use of automatic control equipment, different programming methods can be used to achieve its control function. The operating interface of staff can be through touch screen, industrial computer, or button switch, which has very high flexibility. In addition, automatic control technology also has real-time characteristics. Most of the controllers in modern enterprises are programmable logic controllers, which scan the program circularly. The running cycle time of the program is about tens of milliseconds to hundreds of milliseconds. The acquisition of input variables is real-time acquisition, and the execution time of input to output program is millisecond level, which is real-time output. Therefore, the electrical automation control has the characteristics of real time. Due to the continuous refinement of the production process of modern enterprises, the control requirements are increasing, and the control variables are increasing. In order to achieve the control requirements, the automatic control technology is also iterating, which is becoming more and more complex. On the basis of the above description, the feature extraction steps of electrical engineering automation control technology are realized.

2.3. Construction of Automatic Distribution Linkage Model. The size of the correlation coefficient of the statistical data of electrical engineering automation can only show the strength of the correlation between the statistical data but cannot determine the causal, accompanying, and other linkage between the electrical engineering automation power indicators. The long-term synchronous movement trend of the two indexes is not determined, and the linkage of electrical engineering automation power indexes is not

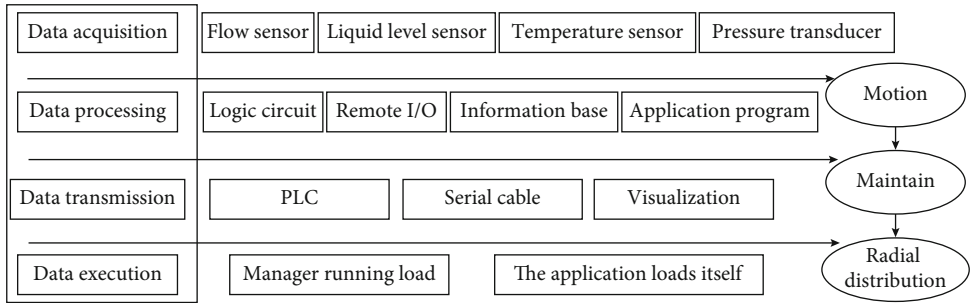

Figure 1: Structure of automation control technology for electrical engineering.

determined. In order to determine the linkage of electrical engineering automation power indicators and eliminate the "pseudo correlation" problem existing in the correlation analysis method, the linkage analysis theory in metrology is applied to the linkage analysis of electrical engineering automation power indicators, and the automatic distribution linkage model is constructed. In order to control the running state of each power equipment in real time, the platform needs to have the function of monitoring its working state. The specific implementation is to capture the device information to be monitored through each port of the main controller and store it in the server through a certain format [14]. Therefore, the monitoring data cannot only be collected but also be stored for a long time, which is conducive to the transfer of power maintenance personnel. Fault isolation and power supply recovery need the distribution automation platform to discover, alarm, cut off, and restore the power supply in time, as well as the intelligent realization of reactive power compensation. It is necessary for distribution automation platform to use intelligent controller to detect the reactive current and control the switching of current transformer. The performance requirements of the automatic distribution platform include stability requirements, good stability of the automation platform, full-time detection, and control ability for power equipment. The stationary sequence of electrical engineering data is obtained, and the expression formula is as follows:

$$h = \sum_{q=1}^{c} \frac{e}{q} + 1. \tag{2}$$

In formula (2), c represents the correlation interval of power index, e represents the estimator of power index, and q represents the adjacent coefficient. The security of the platform means that the control of the power cannot be blindly controlled, so as to cause damage to the distribution equipment or power loss without reason. At the same time, it also requires that the data obtained by the platform should be secure and not be stolen or tampered with. Scalability requirement means that when the distribution equipment is expanded, the platform can bring the expanded equipment into the regulatory system. Ease of use of this requirement means that the platform is easy to operate, for power workers, and their computer level is often limited, so ease of use is one of the performance requirements of the platform [15, 16]. At present, most of the factory electrical monitoring platform is still unable to cover all the production and operation equipment, cannot meet the needs of automatic monitoring of factory electrical automatic devices, and cannot provide the basis for all-round monitoring of factory electrical equipment in the form of fault report. The factory staff cannot get the fault report of electrical equipment, and they are not clear about the problems existing in the operation of electrical equipment, which lays a hidden danger for the operation of electrical automatic devices in the factory. If they do not deal with the fault in time, it will inevitably lead to different degrees of production accidents, which will lead to heavy losses of personal safety and property safety of the factory. Moreover, the quality of the electrical automatic control devices currently used in the factory is generally low, the response of the device is not flexible enough, the response is delayed, and there are errors, resulting in short-circuit burning and component damage of the plant equipment protection device. In the absence of a clear automatic monitoring technology, the electrical device technicians cannot timely and accurately judge the problems of the protection device and the electrical automatic device in the electrical automatic monitoring platform. The electric power index data correlation analysis of electrical engineering automation is to mine the inherent laws hidden in the electric power index data through data mining technology. Electric power index is an important index to reflect the operation of electric power. Through data clustering, we can get the value of electric power change, electric energy data, and measurement data, which are mainly power changes. When the power index is higher, the effect of full perception of power grid state is better, and the effect of full control of operation data is better. Under the condition of known numerical variables, the correlation coefficient of power index is calculated, and the calculation formula is as follows:

$$\lambda = \frac{V(a,b)}{\sqrt{G(a)} \times \sqrt{G(b)}}. \tag{3}$$

In formula (3), V is the power load variable, G is the average generation load, and a, b is any two power indexes in the same space. According to the calculation results of formula (3), the expression formula of automatic

distribution linkage model is obtained as follows:

$$R = \Delta p_{d-1} + p_d \varepsilon + \cdots + w_d. \quad (4)$$

In formula (4), p represents the number of constant terms, d represents the time trend term, ε represents the critical value of smooth operation, and w represents the stationary value of time series. Electrical automation control platform also needs to be further standardized, convenient and healthy, which requires the construction of automatic distribution linkage model to assist the safe and healthy operation of electrical equipment and make up for the application defects of current electrical automation control technology. It is necessary to strengthen the management of the computer network platform of the factory, realize the interaction and integration of the factory management system and the computer monitoring system, and apply the most advanced electrical automation control technology, sensor technology and advanced inverter electric valve, and other actuators in the world, so as to make the factory intelligent, environmentally friendly, highly reliable, and economical in maintenance, providing conditions for accurate transmission of plant equipment operation information and production operation data and making full use of computer technology and automation system to achieve docking with ERP, MES, and other terminals, as well as information transmission between the systems. It can effectively solve the problems such as the difficulty of equipment information transmission and the inconsistency of program structure faced by the factory with a lower cost and a more convenient way. It also needs the network architecture constructed by the main line of the main communication network to build a strong information transmission function with its network system, to implement on-site monitoring of all electrical equipment in the operation of the factory, to help the on-site equipment monitoring personnel reduce the work pressure, and to improve the supervision and management efficiency of the operation of electrical equipment. Based on the above calculation, the goal of automatic distribution linkage model is achieved.

2.4. Big Data Clustering Algorithm to Set the Distribution Structure of Electrical Equipment. The idea of big data clustering algorithm comes from the spectral graph partition theory. Its essence is to transform the clustering problem into the optimal graph partition problem, which is a point-to-point clustering algorithm. The algorithm can cluster in arbitrary shape sample space, easy to understand and implement, and not easy to fall into local optimum [17, 18]. Generally speaking, centralized structure is a structure that can collect and process substation data and complete protection and monitoring tasks. In recent years, with the development and progress of science and technology, microprocessor control technology has begun to bloom gradually. Now, centralized devices with multiple sets of microcomputer devices have been developed. For example, the protection function of a substation can be realized through an indefinite number of microcomputer protection devices, and the function of data acquisition and control of substation is to use another set of microcomputer device. The microcomputer, which completes data acquisition and control, can also keep communication with the superior control center. At the same time, it can connect with the microcomputer protection device through the serial communication port, so it can send the protection action information to the control center or receive the protection setting value. Big data clustering algorithm assumes that the cluster center is surrounded by neighbors with lower density, and the distance between the cluster center and any other point with higher density is relatively large [19]. The local density of multiple sample points is calculated by the following formula:

$$k = \sum_{m}^{c} n(f_s - f_m). \quad (5)$$

In formula (5), m represents the clustering space, n represents the density distance, f represents the local distance of data samples, and 4 represents the number of sample points. According to the calculation results of formula (5), the unit layer structure of electrical engineering is set, including hierarchical structure, hierarchical distributed structure, and decentralized structure. Layering means that the secondary equipment of substation can be divided into substation layer and unit layer according to different functions. The function of the substation layer is to manage the local monitoring and communication processing upper computer, and the unit layer contains a variety of protection and monitoring devices. The two layers generally coordinate information through fieldbus and LAN. The distribution in hierarchical distributed structure means the different distribution of functions in different units. Generally, the configuration of protection units is designed according to the primary equipment, and the centralized configuration of function units mainly includes expansion, measurement, and fault recording. In order to shorten the length of the control cable, we usually configure the equipment in the substation layer in the control room and install the unit layer device in the area close to the primary equipment. The unit level device of distributed structure is mainly aimed at the primary equipment and electrical isolation equipment and usually has a fixed installation location. It is generally installed near the high-voltage switchgear or on the indoor switchgear. This device can combine the functions of protection and measurement and control into one and can also be directly designed as a device with independent protection and measurement and control functions [20–22]. At present, if the voltage level is low, the integrated design of protection and control functions is more commonly used, but if the voltage level is high, the independent design of protection and measurement and control functions is usually adopted. The field protection measurement and control layer mainly includes microcomputer integrated protection device and measurement and control device. Through these devices, we can achieve a device integrating protection, control, measurement, and communication. Therefore, the device can be connected with the control center in the communication management layer through the field bus or LAN. All kinds of high-

Table 1: Noise test results.

Electric load (kW)	Noise (dB)		
	Electrical engineering automation control method based on fast heuristic	Electrical engineering automation control method based on density peak	Electrical engineering automation control method based on big data clustering algorithm
50	9.241	11.203	5.331
100	21.146	24.316	12.309
200	29.794	30.848	14.338
300	37.362	36.117	18.224
400	48.525	47.065	28.339
500	66.705	68.392	40.103

voltage or low-voltage intelligent devices inside the substation, such as small current grounding line selection device, DC power supply device, and intelligent switching device, can be connected with the main control computer in the communication management layer through the corresponding communication interface. The substation can be connected with all kinds of equipment layer through communication network, which makes many independent and scattered equipment evolve into an organic whole that can work together. At the same time, the organic whole can also maintain the state of tight connection with external devices. The layer with such special functions is called communication management layer. The performance of communication management largely determines the performance of substation integrated automation device. The main controller is the main configuration of communication management layer, which has the function of communication management. At present, in the application scheme of electrical engineering automation, we usually use unit combination design to design the main control computer. In this design, any main control unit can provide multiple serial interfaces, which can access various electronic devices. After a series of complex conversion, these devices can access the communication system or Ethernet. Based on the above description, complete the setting of electrical equipment distribution structure.

3. Experimental Analysis

3.1. Setting up Experimental Environment. In order to verify the application effect of big data clustering algorithm in electrical engineering automation, the experimental test is carried out, and the experimental environment is built according to the needs of the experimental test. Electrical engineering automation experiment adopts HMI + ATV312 + M218 architecture, which can realize the teaching of configuration software, computer control technology, programmable controller, and so on. HMI is a man-machine interface, which usually appears in the form of a screen. After it is connected to PLC, it can also display data on the screen to carry out automatic control of electrical engineering. ATV312 frequency converter has the characteristics of powerful function, compact structure and easy installation, convenient parameter configuration, and strong communication compatibility, which can improve the human-computer interaction effect. M218 programming cable is a T-shaped port of USB data cable with shielding magnetic ring, which can reduce signal interference and make signal transmission more stable. Programmable logic controller is used as the experimental PLC, 14 groups of digital quantity are used as internal settings, 4 groups of fast output and 10 groups of relay output, and the counting function of fast input of 4 points is adopted, which can realize the control of multiaxis positioning. The communication interface is used for rts-485 standard interface and Mini USB interface. It supports ASCII protocol communication and can realize communication with frequency converter and touch screen. The standard Ethernet interface is used to realize the data communication with the host computer. It can support up to 152 extended I/O points. As an extension module and compatible module of PLC, tm2dockn is dedicated to realize the compatibility of extension module. The extended function of the experimental platform is mainly realized by tm218. Tm2alm3lt is an analog input-output mixed expansion module, which can output 0-10 V voltage and input 0-20 mA current. The output frequency range of the inverter is 0-500 Hz. The built-in CANopen communication protocol can realize the communication with other control equipment, realize the start-up and speed regulation, and realize the motor control, and the AC motor can be well controlled through the external voltage or current signal. Motor protection and motor starting can be realized in one. The modular and highly integrated starting motor equipment can be realized through the starter controlled by the industrial computer, which takes up less space and can protect the motor from long running time, short circuit, under load, and unbalanced phase current. At the same time, the Modbus and DeviceNet extensible communication module can be realized. The control of traffic motor can also be controlled by frequency converter. In the above experimental environment, the experimental test is carried out, and the experimental results are obtained.

3.2. Experimental Result. After a substantial increase in power demand, the newly installed capacity needs to meet the current power demand, so it is necessary to increase the power load to ensure the national power supply. When the power load is 50 kW-500 kW, it can meet the power demand in a small range and the power demand of daily life. Therefore, in order to meet the applicability of noise

research, 50 kW-500 kW is selected for testing and research. The electrical engineering automation control method based on fast heuristic is compared with the electrical engineering automation control method based on density peak and the control method designed in this paper. The noise of the three methods is tested under different load conditions. The smaller the noise is, the better the performance of the method is. The experimental results are shown in Table 1.

It can be seen from Table 1 that in the range of 50-500 (kW) power load, the average noise of the electrical engineering automation control method based on big data clustering algorithm and the other two control methods is 19.774 dB, 35.462 dB, and 36.323 dB, respectively, which proves that the noise of this control method is lower than that of the other two control methods. This is because the proposed method uses data mining to build an automatic distribution linkage model, which can effectively control the power index, thus improving the operation effect of the power system and reducing the noise during operation and maintenance.

4. Conclusion

Electrical automation is the use of information technology, microcomputer control technology, and electronic technology to realize automatic control of electrical operation. It is the key link and core content of power system operation and maintenance and reflects the working objectives and basic functions of power system management. In order to solve the problem of excessive noise in the practical application of power system, an automatic control method of electrical engineering based on big data clustering algorithm is proposed. The load parameters of power cable laying mode are obtained by constraint calculation. Through data mining technology, the law of power index data is collected, and the automatic distribution linkage model is constructed, and the stationary sequence of electrical engineering data is obtained. The big data clustering algorithm is used to set the distribution structure of electrical equipment, obtain the local density of multiple sampling points, and realize the noise reduction in the process of electrical engineering automation. The test results show that the average noise of the proposed method is low. However, due to the limited research time and research conditions, the test experiment environment can only complete the test in one mode, which cannot restore the type of automatic control operation and maintenance of power engineering. Therefore, it will be further improved in the future research. The comprehensiveness of the proposed method is verified on the basis of various environments, which lays the foundation for the safe and stable operation of power system.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

It is declared by the authors that this article is free of conflict of interest.

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