Retraction

Retracted: Real-Time Monitoring of High Voltage Switch Based on CAD

Advances in Multimedia

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] L. Di, Y. Xiao, F. Hu, Y. Liang, J. Tan, and Y. You, "Real-Time Monitoring of High Voltage Switch Based on CAD," *Advances in Multimedia*, vol. 2022, Article ID 9136046, 9 pages, 2022.

Research Article

Real-Time Monitoring of High Voltage Switch Based on CAD

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In the process of online real-time monitoring of intelligent digital filter high-voltage switchgear, the mechanical state diagnosis of high-voltage circuit breaker is based on fully understanding the mechanical characteristics of each component of circuit breaker. In this paper, K-means clustering algorithm is applied to the mechanical state detection of digital filter high-voltage switchgear. The mechanical state of the digital filter high-voltage switchgear is monitored in real time by using 126 kV GIS. Through fault simulation experiment and mechanical stability experiment, the corresponding changes of characteristics of each mechanical component of circuit breaker in signal waveform and corresponding data changes are found. The experimental results show that this method has good running speed and stability and is more suitable for the real-time monitoring of intelligent digital filter high-voltage switchgear.

1. Introduction

With the continuous development of science and technology and the continuous improvement of economic level, the requirements for the safety and stable operation of the system have been gradually improved [1–3]. At present, the industrial field is also gradually realizing automation, high-speed, and continuous development. However, what is urgently solved in various industries and fields is to use computers to monitor the digital-filtered high-voltage switch mechanical status of system faults in real time. Since the reform and opening up, the industrial sector has achieved rapid development. At the same time, the system instability has caused safety events of different severity, which has a greater impact on product production and product quality. The fault of the digital filter high-voltage switch machinery usually occurs through abnormal vibration and automatically detects and recognizes the system according to the vibration signal. The continuous development of the technology improves the equipment maintenance mode. However, there are many outfield disturbances (nonlinearity, modeling errors, parameter perturbations, and many other uncertainties) in practice,

while the fault detection filter does not consider robustness. It is not conducive to solving practical problems [4–6].

The powerful tracking filter leads to the model mismatch fault due to the wrong system hardware and software element parameters, with good robustness. The soft and hard faults of the system circuit parameters can quickly and accurately conduct the automatic diagnosis and identification ability and then effectively solve the fault of the nonlinear analog circuit system. In this paper, the K-means clustering algorithm is applied to the effective monitoring of the digital filtering high-pressure open mechanical state and constructs the data model. Finally, this paper takes 126 kV intelligent GIS as the experimental research goal to verify the effectiveness and practicability of the proposed method.

2. Introduction of Principle

2.1. The K-Means Clustering Algorithm. Cluster analysis algorithm is not only a monitoring learning algorithm but also an important direction of machine learning algorithm research. It is an effective analysis tool that can effectively process the data in the process of data mining. MacQueen first proposed the K-average clustering algorithm (K-means

algorithm), which is a practical algorithm in the scientific and industrial applications at that time and is also the most basic division method of clustering method, usually will take the error square value and benchmark function as the clustering benchmark function.

K-means algorithm can also be called the K-average algorithm [7–9]. The average of all data samples in each subset of the cluster can be used for the mainstream idea typical of the cluster. The algorithm mainly divides the acquired data according to different data types in the iterative process, so as to facilitate performance evaluation for different cluster reference functions to ensure that the generated cluster data is compact, and the same type of data is independent of each other. However, the algorithm is not suitable to handle discrete data and is better for clustering with good continuity. When computing the sample data connections, appropriate similar measures need to be determined according to the actual situation.

If the acquired data set is set to $X = \{x_m \mid m = 1, 2, 3, \ldots, n\}$, the variables in X can use d characteristics to describe the data set, the attributes of the data are represented by $A_1, A_2, \ldots, A_d$, and all the d description attributes have continuous attributes. The data samples of the study are set as $x_i = (x_{i1}, x_{i2}, \ldots, x_{id})$ and $x_j = (x_{j1}, x_{j2}, \ldots, x_{jd})$, where $x_{i1}, x_{i2}, \ldots, x_{id}$ and $x_{j1}, x_{j2}, \ldots, x_{jd}$ are described by d attributes $A_1, A_2, \ldots, A_d$ corresponding to samples x_i and x_j in turn. The similarity between the data samples x_i and x_j can measure the distance $\mathrm{dis}(x_j, x_j)$ between them [10, 11]. If the distance is smaller, then the data samples x_i and x_j will be more similar; if the difference is smaller, the distance will be larger, The difference between sample data x_i and x_j determines the size of the difference, resulting in greater differences. The corresponding calculation formula is

$$\mathrm{dis}(x_i, x_j) = \sqrt{\sum_{k=1}^{d} (x_{ik} - x_{jk})^2}. \tag{1}$$

The L-means clustering algorithm uses the error sum of square criterion function to evaluate its clustering performance. It is assumed that the given sample data set X contains the attribute description of the data, but does not contain the description of the attributes of other categories. Suppose that the sample data X contains k cluster subsets $x_1, x_2, \ldots, x_k$; the number of cluster subsets of each sample data is represented by $n_1, n_2, \ldots, n_k$ in turn, and the mean of each cluster subset is represented by $m_1, m_2, \ldots, m_k$ in turn.

The sum of error square criterion function formula for the sample data is expressed as

$$E = \sum_{i=1}^{k} \sum_{p \in x_i} \| p - m_i \|^2. \tag{2}$$

The K-means algorithm mainly uses the error square and the reference function for the cluster reference function of the sample data. The main idea of the algorithm is that the closer the Euclidean distance between the sample data, the greater the similarity between the sample data will be. The main goal is to obtain compact and independent clusters, and the clusters obtained using the K-means algorithm are all composed of close-European distance objects.

The proposed algorithm is performed as follows:

(1) Randomly selects any k objects from the T objects of the dataset as the initial cluster center and initializes as a cluster.

(2) Measures the remaining Euclidean distance of the other objects of the dataset to the center of each initial cluster and classifies it into the class cluster of the nearest cluster center.

(3) Recalculates the average of the objects assigned to each class cluster and updates the center of that class cluster.

(4) Repeats (2~3) until the algorithm converges or reaches a certain number of iterations. The results of the cluster partition are also returned.

So far, many clustering tasks select the K-means clustering algorithms. The K-means clustering algorithm has the advantages of effectively gathering large datasets, but the K-means algorithm also has the following two disadvantages: before using the algorithm, the number of clusters must be predetermined, k, but in practice, the k value is difficult to determine. Second, the algorithm has some limitations in practice because the accuracy of the cluster results and ends when the number of iterations increases, and the local optimal value of the algorithm is obtained.

2.2. Establishment of the Standard Data Model. In the mechanical state real-time monitoring system of the intelligent digital filter high-voltage switching device, the state monitoring is the premise of realizing the real-time state monitoring, and the basic state monitoring means to collect the working state of the high-voltage switch of the digital filter accurately and in real time, including parameters of mechanical, gas, and insulation [12–14]. Through state monitoring, the action state of the digital filter high-voltage switching device can be monitored in real time. In the actual operation of the system, the main state amount of measurement and monitoring of the system is the travel of the contact, the switch time, the position of the breakpoint, the switch coil current, the energy motor current, and the SF6 gas state. According to these state quantities, generating parameters characterized by the characteristics of the high-pressure switching device of multiple intelligent digital filters, such as the switching speed, charge time, and synchronicity.

Based on the indepth study of the K-means cluster algorithm, this manual uses 126 kV intelligent GIS as the test platform to collect a certain amount of raw data, with basic data preprocessing and standardization. Figure 1 shows the mechanical state real-time monitoring model of 126 kV intelligent GIS.

This paper uses 126 kV intelligent GIS to build a state monitoring and real-time monitoring system and a real-time state monitoring database. Using background software
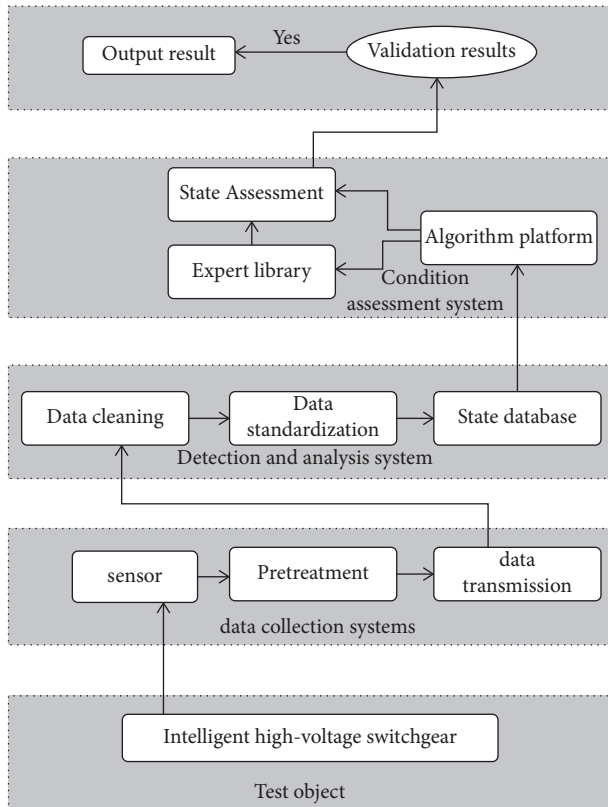
Figure 1: Real-time monitoring model of 126 kV intelligent GIS machinery state.

Figure 2: Typical state monitoring data curves.

system to extract feature parameters based on the real-time monitoring algorithm to realize real-time monitoring of switch health status.

Based on the above real-time monitoring model, the obtained raw data is first transmitted to the monitoring and analysis system by mechanical life testing (1000 switch disconnection actions of the intelligent GIS of 126 kV).

Data analysis, data cleaning, preprocessed the obtained raw data, identify data that did not meet the technical conditions, and these identified data were excluded from the calculation process during the subsequent calculation process.

Finally, the data were standardized by data cleaning and converted to a unified form and stored in a state database. The typical data curves stored in the database are shown in Figure 2.

The K-mean clustering algorithm obtains the data sequence of m data curves of the same type from the database to form a specific data set $X = \{x_m | m = 1, 2, 3, \ldots, n\}$, describing d attributes for selecting samples of the data set X, where each data x_i includes its travel value, operating time, and switching speed and can be represented by data attributes such as switching current, charging time, and switching type [15].

To calculate K-means clustering algorithms, K-mean clustering algorithms must face two flawed problems of how to solve inherently existing. In the design of the real-time monitoring system of intelligent digital filter, this paper is solved in the following way.
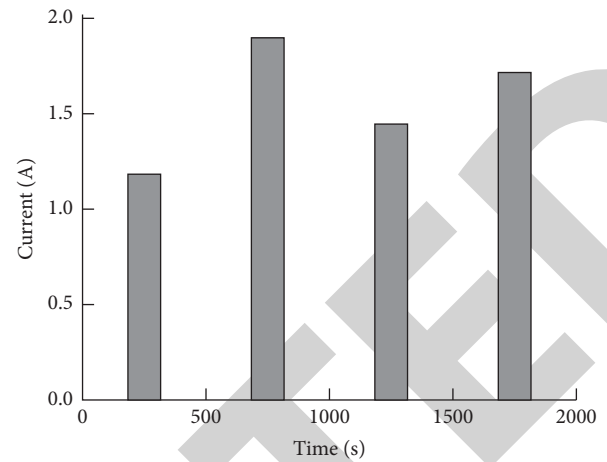
(1) Before quoting the K-means cluster algorithm for sample data processing, the number of clusters needs to be confirmed. In addition, monitoring the operation status under the intelligent digital filter high-voltage switch requires the data in the monitoring system, mainly the test samples of 126 kV intelligent GIS. Before the test, it needs to verify whether the equipment is factory qualified and technical standard. The mechanical properties of any high-voltage switch of intelligent digital filter need to be generally consistent. Only when the device exception, the data collected varies substantially from the usual data. Therefore, in the mechanical state real-time monitoring system of the intelligent digital filtering high-voltage switching device, the number of clusters is by default to 2 when the K-means cluster algorithm is used for clustering normally. The equipment has only two normal and abnormal states. Only in the case of large changes in the arm bending and measurement mode of the mechanism inspected or adjusted for one device, the data analyzed data may have a greater error than the data at the previous shipment. So, the number of clusters increases by default each change, but if you change multiple times in the same location, the default value of the number of clusters does not change.

(2) The cluster center of the sample data needs to be determined before applying the K-means clustering algorithm. Otherwise, it will cause an increase in the operation number of the algorithm, which will end when the dataset obtains the optimal value, but the reasonable clustering results cannot be calculated. For the 126 kV intelligent GIS, there are corresponding requirements for each mechanical part in the early design stage, and the real-time data of the corresponding intelligent digital filter high-voltage switch mechanical operation state needs to be met within the ideal travel value of 120 mm, and the switch time of the machine is 29 ms and 90 ms. The ideal value of the intelligent digital filter high-voltage

switch speed, respectively, is 5.2 m/s and 2.6 m/s. Therefore, in the mechanical operation state monitoring process of intelligent digital filter high-voltage switch; therefore, in the real-time monitoring system of intelligent digital filter high-voltage switch, the K-means clustering algorithm can set the initial clustering center as the optimal value of the product's mechanical characteristics in the clustering process. However, the optimal values cannot be used directly for the standard data values within the system. Mainly due to the components of the machinery in the process of manufacturing and installation, the actual manufacturing products have ideal characteristics, but there are also certain deviations. At the same time, with the growth of the service life of the intelligent digital filter high-voltage switch, its own wear degree will also increase, making the characteristics of the product will gradually decline.

Considering the above analysis, who mainly performs the real-time number monitoring and analysis of it according to the mechanical operation state of the intelligent digital filter high-voltage switch and chooses the appropriate method to solve the problem of the K-means cluster algorithm. Mechanical characteristic curve of intelligent digital filter high-voltage switch is collected by the data acquisition system. Analysis is mainly based on the historical run data. So, the amount of data stored in the data state is large. The calculated standard curve will also be closer to the reality. Get the mechanical characteristic curve of intelligent digital filter high-voltage switch for subsequent different stages. It can be monitored in real time according to its operating status. Then, the system will update the obtained standard data model in the intelligent digital filter high-voltage switch state monitoring database using the K-means cluster algorithm. To greatly simplify the system operation quantity, the proposed method has good real-time performance and reliability.

2.3. Basic Composition of the Online Monitoring System.
The overall system is composed of superior machines and multiple online monitoring devices. Each online monitoring device collects action information from the vacuum digital filter high-voltage switch through a sensor or transmitter or other interfaces. After meeting the startup conditions (such as, e.g., the digital filter high-voltage switch division, and switch signal), the data collection can be started by the online monitoring device, and the specific functions can also be set by the user. The upper computer and the online monitoring device are connected through the RS485 interface, as shown in Figure 3. Retrieve the online monitor devices in the order of the upper computer. When the response is asked, it is indicated that the action data of monitoring the digital filter high-voltage switch is recorded, and the data will be immediately saved with the date and device number. During the visit, the upper computer can collate and analyze the data, calculate the mechanical parameters of the high-voltage switch of each digital filter, retrieve printable data,
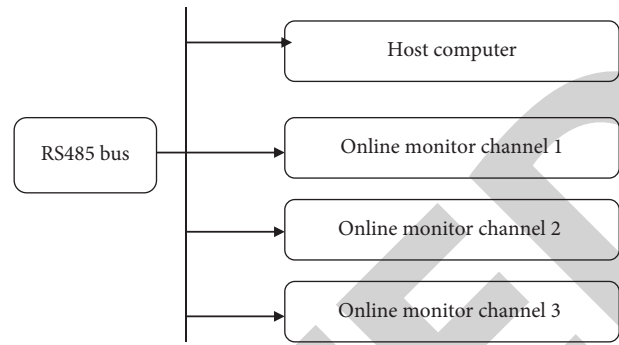

Figure 3: System composition.

print action curves, etc. As data accumulate, the system can predict and diagnose faults and development trends, issuing alarms based on the pattern and grade of the failure. If the expert system is borrowed, appropriate suggestions can be made for the inspection of the equipment. On the other hand, the data will be provided to manufacturers to provide reference for the design optimization of future products.

2.4. Implementation of the Online Monitoring Device.
One channel of the online monitoring device is divided into the main panel and the interface board. In order to be as flexible as possible for the system, just change the interface board and change the main board program, and each channel can be applicable to different determination requirements. Cost performance of the system has been improved. Maximum one channel can be connected to the connection main panel, and the data collection channel and wiring main panel are set on a single enclosure to form a complete online monitoring device. The number of channels per superior currently designed is 16, and better driving RS485 communication chips can be replaced if more channels are required. As shown in Figure 4, each online monitoring device may be a channel in the virtual box, and each online monitoring device may have up to four such channels.

2.5. Implementation of the Hardware Section.
The digital filter high-voltage switch has many mechanical parameters, such as brake, close; brake speed, split, close; and brake time, three-phase separation, switch synchronization, contact distance, just equivalent to separation. By observing the rebound amplitude of the contact gate, the mechanical state of the digital filter high-voltage switch can be judged and failures such as misoperation. Here, usually when the machine often breaks down, the operating mechanism and the transmission system specifically show the astringency of the mechanism, the deformation, displacement, or damage of the parts. In order to obtain the mechanical parameters of the digital filter high-voltage switch, brake core relaxation, loose shaft pin, button shedding, etc. (poor secondary wiring contact on electric control and auxiliary circuit, loose terminal, slow switching of auxiliary switch, operating power failure, etc.), only for the spring operating mechanism, the signal needs to judge the mechanical status and fault of the digital filter high-voltage switch. Voltage and current of
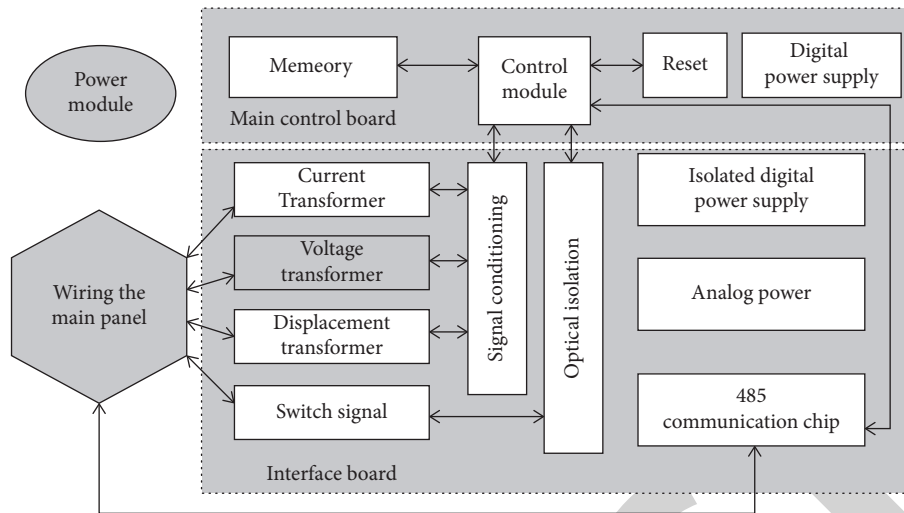
Figure 4: Composition of the online monitoring device.

capacitor, gate coil voltage, three-phase break switch amount, travel signal, and gate coil current.

In full consideration of the functions needed by the system, the hybrid digital signal SOC processor used by the main control module, which has the advantages of fast, flexible, and low energy consumption, is the use of 8051 internal memory and streamlined command structure, and multiple communication interface with the watchdog, as long as by the ISP flash memory and data memory card. The eight channel reset consisted primarily using a 12 bit ADC, 212 bit DAC and two comparators using a supply voltage of 3.5V. The chip uses the JTAG interface, which can complete the download and debugging of the control program, system design, and interface adjustment, can store data at the speed of 5s, coupled with the configuration itself has the serial communication function of the C8051F000 chip, combined with the RS485 communication chip, and the communication problem with the upper computer can be quickly solved.

2.6. Implementation of the Software Section. During the data collection process of the system, the communication process is controlled through the software control of the superior machine, and the software of the online monitoring device only controls the passive response to the data collection and the query of the superior machine. If the necessary data is obtained in the online monitoring device, it can be received on the upper position computer. The host saves the obtained data as a standard data form and asks for subsequent data processing software or staff. When the data are accumulated, the mechanical parameters of the digital filter high-voltage switch are obtained, and the mechanical state information of the digital filter high-voltage switch can be analyzed. The state change of the digital filter high-voltage switch varies suddenly and changes slowly, and the tendency is that the gradient state can be analyzed. The information of each

action of the digital filter high-voltage switch is recorded, making it easy to determine whether the digital filter high-voltage switch reaches the designed mechanical life.

2.7. Software Design for CAD. In the regularly output continuous sample pulse of the output comparison module, it controls the synchronous sampling and transformation of the modulus 7606. After the transformation, the modulus 7606 notifies the CPU conversion end interrupt read result into the sampling value buffer, it returns to the main program for data analysis and processing and judges whether the switch action or operation is normal according to the change trend of each parameter. In the case that the nearest sampling value is recorded using a ring buffer and a switch operation is determined, the buffer content is stored together with the operating time provided by the main CPU to the GPS (Figure 5).

The calculation of the displacement amount is also conducted through the interrupt service program, the angular displacement encoder outputs the pulse signal of the two-phase phase 90° phase shift, photoelectric separation, and level transformation A phase decreases, and the mechanical displacement of the contacts can be updated by triggering the interrupt service program determining the rotation direction from the state of the B phase (Figure 6).

2.8. Analysis of Experimental Results. The basic data for the study in this paper were collected onsite at an intelligent GIS test sampler at 126 kV. The mechanical characteristic data of digital filter high-voltage switch collected in the test are mainly as follows: current data, displacement data, energy storage data, SF6 gas state data, and sensor monitoring. The collected raw data are standardized to data cleaning and stored in the real-time monitoring database of state monitoring.
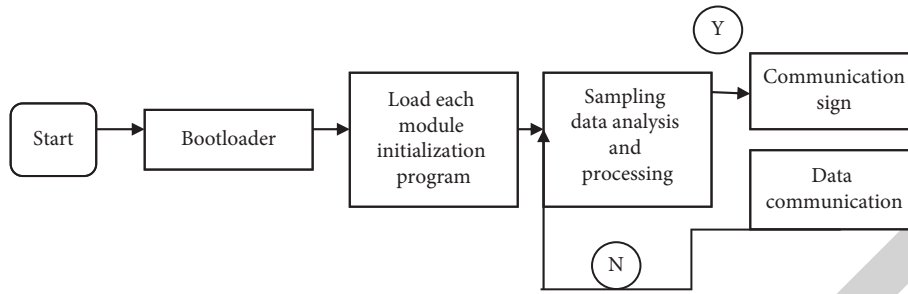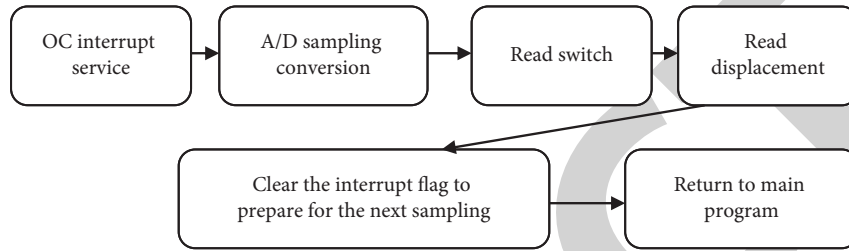
FIGURE 5: The CAD software process.

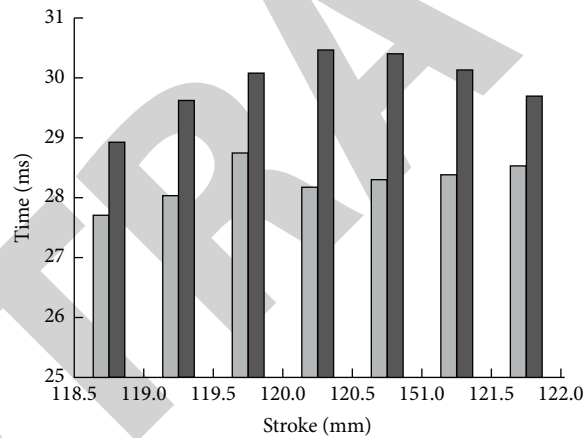FIGURE 6: Displacement measurement software flow.

FIGURE 7: Travel and time relationship clustering result plot.

To date, a total of 1227 raw data of the intelligent GIS state monitoring database of 126 kV have been calculated by the K-means cluster algorithm, and the main execution results in the test are shown in Figure 7 and 8.

Figure 7 is the assumption of A. For each of the two clusters (120.17.18727.656) and (120.53459.847), respectively, calculated from the two classifications of the K-means clustering algorithm (121.199.27.873) in two types of B (120.54229.843). The number of data points contained in the B class is significantly lower than the number of data points included in the A class. Most of these data are concentrated in the following A classes. The guidance for reality is that, in the field experimental data of the 126 kV intelligent GIS model, the central point of the circuit breaker trip is centered around 120.178, while the central point of the circuit breaker time is centered around 27.636. The cluster data points obtained from the B class in the Figure 7 are essentially considered anomalous data, but all data points in the A class

employ normal data points for the center point. In the actual operation of the trial machine, 2 ms errors in the time of classes B and A may occur due to the unstable operating voltage or the poor separation of the mechanism and mechanism. Therefore, the sample can calculate the true value of the important feature points in the actual run, and the value of the center point of the cluster can be the standard value of the data model.

As in Figure 7, the two clustering centers calculated based on the two distinctions of K-means are (119.785.2.787) and (120.6988.2.578). Assume A, respectively: (119.765.2.655) B (120.6988.2.786) of the two categories; from Figure 8, we can see that there is little difference in the amount of data between type A and type B. In addition, the data used this time are all normally collected data. All the data conform to the normal discrete distribution. The clustering results can still be classified into (119.885.2.607) and (120.6988.2.577) to process the
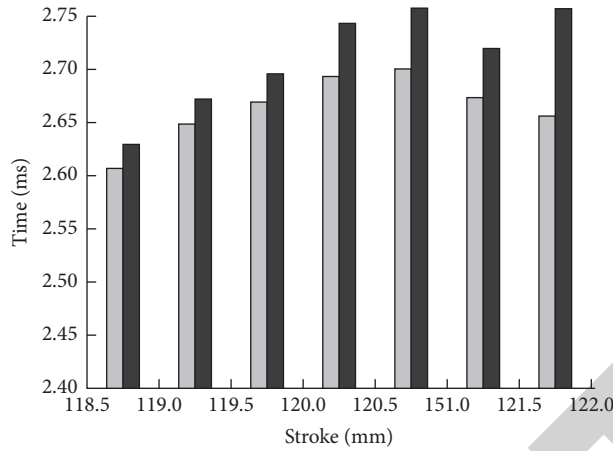
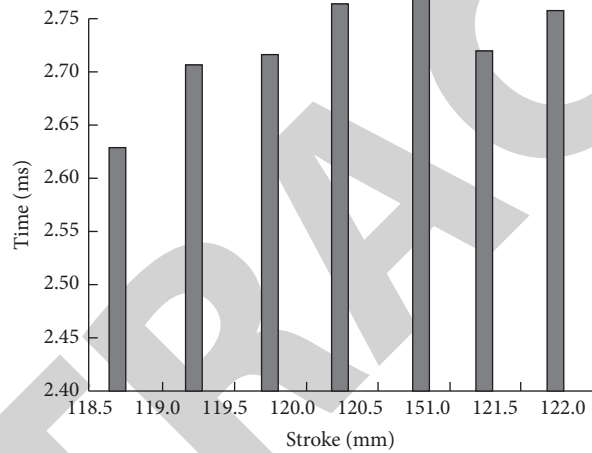FIGURE 8: Cluster results diagram of travel speed class 2.

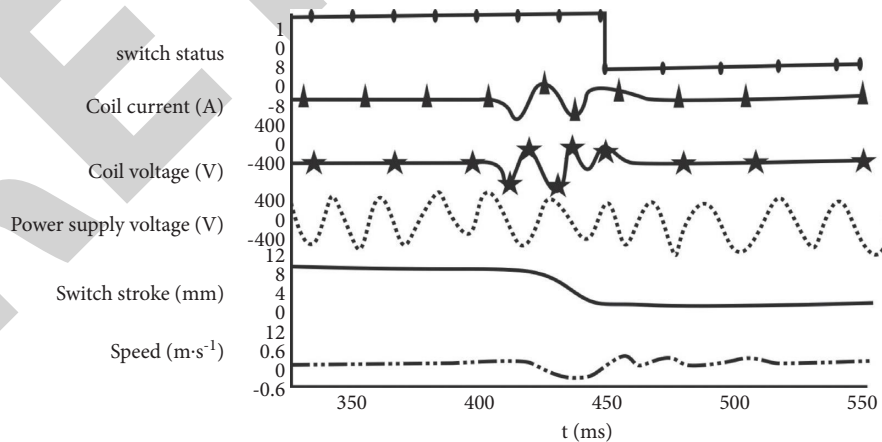FIGURE 9: Cluster results diagram of stroke speed type 1.

FIGURE 10: Test curve of the closing process.

data. However, from the distribution characteristics of the data, such processing is obviously very inappropriate; so, the test data fit the usual discrete distribution, and the clustering status of the two results is not appropriate. The K-means clustering algorithm is shown in Figure 9, allowing for a class of cluster calculations. The center of the cluster calculated thus is (120.205.2.612), and there is still a large gap in the standard values (123.267) calculated between the results of the two clusters and the mean of the center points (2.612). The cluster centers calculated from a
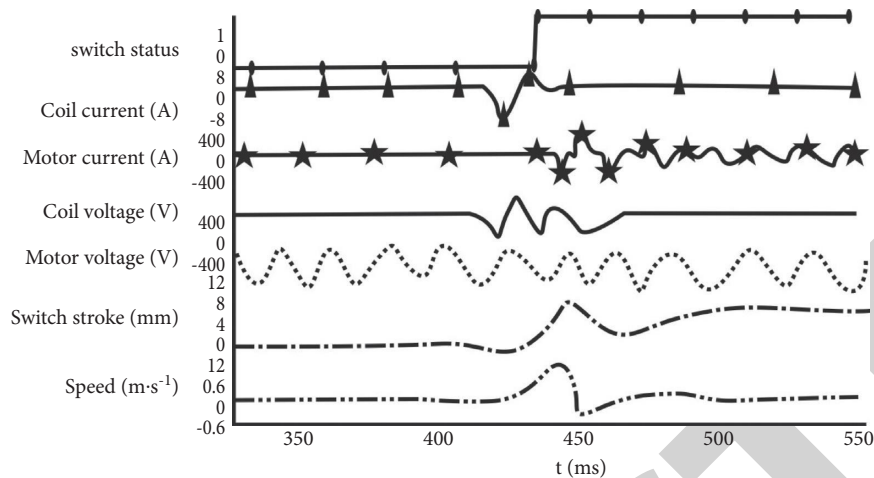
FIGURE 11: Gate split process test curve.

class of clusters of the K-means cluster algorithm better represent the central position of the entire dataset and approach the real reference value of the 126 kV smart GIS operation.

The data sampling frequency is set to 10 kHz. The digital mode output port of the device separates the gate tube driven by optical coupling to controls the action of the digital filter high-voltage switch. Figure 10 shows a curve of a switch state, switch stroke, coil current and voltage, and power supply voltage. When the switch is locked, the contact lenses bounce.

Figure 11 is a current and voltage diagram of switch status, switch stroke, coil current, coil voltage, and energy storage motor in a brake test (for explicit representation, only a time period was cut).

The analysis shows that the device meeting the design requirements has good interference resistance and can meet the needs of practical application. Digital filter control power supply for the high-voltage switch, the amount of three-phase break switch, switch trip-time characteristics, coil circuit current and voltage for jumping electromagnets, and current for the energy savings of the motor carry out the voltage and reliable monitoring. In the case of measuring the simulation amount of path 8 and the exchange amount of path 7, the data collection speed of each channel reaches the resolution of the 12.5 kHz, and simulation data of 12 bits and 1M bytes of data capacity can be recorded at a time, with the recording time corresponding to the collection speed.

3. Conclusions

In order to protect the normal operation of the circuit breaker and ensure the normal operation of the power system, the mechanical condition monitoring of the circuit breaker is essential. The 126 kV intelligent digital filter high-voltage switch is adopted, and the K-means clustering algorithm is used to monitor the mechanical state in real time, complete the real-time monitoring of the intelligent digital filter high-voltage state, and construct the monitoring system. The monitoring system correctly monitors the

mechanical characteristic state information of the circuit breaker, which can ensure that, on the basis of the monitoring information, through the analysis and judgment of the background diagnosis system, it can prevent the mechanical fault of the circuit breaker and play a positive role in the normal operation of the power system. Finally, the experimental results show that the digital filter proposed in this paper has high precision and fast processing speed.

Data Availability

The labeled dataset used to support the findings of this study is available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

Acknowledgments

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