Active optimization method of wind farm operation parameters remote test equipment based on Data Mining

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Abstract. The function of remote test equipment for wind farm operation parameters is complex, which requires timely and accurate equipment tuning in complex environment. In order to achieve the above requirements, an active optimization method of wind farm operation parameters remote test equipment based on data mining is proposed. Combined with the data mining technology, the remote test characteristic data of wind farm operation parameters are collected. In order to grasp the operation status of the equipment timely and accurately, the remote test equipment is used for dynamic adjustment, and the real-time data update model of remote test is established and installed. Finally, the experimental results show that the active tuning method based on data mining for wind farm operation parameters remote test equipment is significantly higher in the actual application process, and fully meets the research requirements.

1. Introduction

To mine the operating parameters of remote test equipment of wind farm operation parameters. Monitor the operation data of remote test equipment and the operation of other equipment. In order to save time and manpower and overcome the disadvantage that the instrument can not be carried, the data mining algorithm is used to track and monitor the remote test equipment of wind farm operation parameters in real time and test the performance[1]. In case of equipment failure, the technical personnel or relevant experts of the equipment manufacturing enterprise must personally go to the site to carry out the test[2]. Equipment remote detection and diagnosis system is an effective means to provide technical support and support for equipment by using existing network, computer and related software and other hardware equipment, so as to improve the practicability and flexibility of equipment.

2. Active optimization method for remote test equipment of wind farm operation parameters

2.1. operation information collection of remote test equipment for wind farm operation parameters

In terms of power supply, the power supply of all devices is dual power supply. Using MySQL database software has been deployed on server part 1 and 2. Based on this, feature mining of equipment operation parameters is carried out, and the specific principle is shown in the figure below.
The field testing equipment can carry out on-the-spot detection and diagnosis under the control of the computer. The LXI bus control mode allows remote support experts to directly control the instrument for testing and diagnosis, without the need for a field computer [7]. Through the construction of IPSec VPN encryption tunnel, an embedded encryption authentication gateway is established between the security encryption authentication gateway and the field test terminal, so as to ensure the data security of the interaction between the test remote main site and the field test terminal.

2.2. Dynamic update of wind farm operation parameters remote test

By adding front-end data collector, excitation signal source, communication equipment and video collector, PCI bus data acquisition card and automatic sensor data locator, the parameters of real-time monitoring equipment such as voltage, waveform and frequency are updated and adjusted. Wind farm operating parameters remote test equipment signal generator and program control function of AC and DC power supply, to provide a working environment for the object to be tested [8]. In order to ensure the operation effect of equipment, the dynamic change trend of remote test equipment for wind farm operation parameters is calculated by combining mining algorithm

$$B + T = S - \lim_{M+O}$$

In the above algorithm, B is the solution range of equipment data real-time update, T is the range of real-time data feature classification, and the equipment operation efficiency can be recorded as (max (B + T)). The characteristic variable of information collection is S, the update variable is M, and O is a fixed value. Furthermore, the operation status of remote test equipment for wind farm operation parameters is optimized

$$\Delta w = \sum B + T - \sigma / \Delta S + \Delta M - \Delta O$$

Among them $\sigma$ A is the static remote update data, and the real-time update difference value is obtained $\Delta(B + T) = \Delta S + \Delta M - \Delta O$ In the same form of subtraction, $\Delta(B + T)$ can be obtained by operation tuning. When C remains unchanged in the optimized operation, $\Delta O$ = $\Delta O_e$ can be obtained. The further defined objective function of process system operation optimization is as follows:

$$\max n^{\Delta w - \lambda} = \Delta w \prod \Delta O_e (\Delta S + \Delta M)$$

Further deconstructs the two equipment operation stages a and b, and reconstructs the operation process of the stage according to the micro operation $z$ defined in the stage.
\[ Bu(n) = \max_n n^{\Delta^F}\Delta_A \left( \sum_{i=1}^{n} \left( 1 - a_i \right) \left( 1 - b_i \right) \frac{z}{z - a_i} \right) \]

The model is transformed into the state space equation of equipment test:

\[ x(n+1) = \max_n n^{\Delta^F}\Delta_A \prod Ax(n) + Bu(n) \quad (5) \]

\[ y(n) = Ax(n) + Bu(n)Cx(n) \quad (6) \]

Among them:

\[ x(n) = \left[ x_1^T(n), x_2^T(n), \ldots, x_m^T(n) \right]^T \quad (7) \]

\[ A = \text{diag}(A_1, A_2, \ldots, A_m) \quad (8) \]

\[ B = \left[ B_1^T, B_2^T, \ldots, B_m^T \right]^T \quad (9) \]

\[ C = \text{diag}(C_1, C_2, \ldots, C_m) \quad (10) \]

Based on the above algorithm, the equipment detection and operation progress are checked regularly, and the real-time dynamic adjustment is carried out\(^{[9-11]}\).

### 2.3. Implementation of active optimization of remote test equipment for wind farm operation parameters

The data mining algorithm is further applied to search and optimize the parameter configuration, so as to directly operate and adjust the structural object without the limitation of derivative and function continuity. The probability optimization method without definite rules can automatically obtain and guide the optimization search space and adjust adaptively. Search direction\(^{[12]}\). In order to ensure the effect of equipment optimization, the logical relationship of remote test equipment optimization information of wind farm operation parameters collected is analyzed, as shown in the following table:

| Logical level | Function | Remarks |
|---------------|----------|---------|
| Equipment master station | Data management, data acquisition, user monitoring, power data statistics, operation management | Safety dispatching and assistant decision |
| Equipment testing | - | Orderly detection |
| Data update | Acquisition terminal and metering equipment management | Measurement point |

In order to reveal the quantitative relationship between the feasible gain matrix and the control parameters, it is necessary to analyze the multivariable fractional order closed-loop data \( P(z) \). The complex correlation \( K \) between the multivariable \( D(z) \) input and output of the equipment detection and the equipment operation is analyzed logically. The closed-loop system \( w(n) \) is decoupled, and then the closed-loop operation value of the equipment operation is removed. The specific algorithm is as follows.

\[ P(z) D(z) K u(n) = x(n+1)P(z) D(z) K I w(n) \]

\[ -P(z)D(z)+KD(z)^{-1} y_r(n) \]

\[ -P(z)D(z)+x(n+1)u(n) \quad (11) \]

In the above algorithm, \( I \) is taken as the initial population, and the initial population is randomly generated. The iteration counter \( z = 0 \), where \( y_r(n) \) represents the nth generation population, and each individual is composed of seven parameter values in Table 1. Equipment operation health index is an
important index to measure the health adaptability of equipment. Individuals with strong adaptability perform better, while those with weak adaptability perform poorly\cite{13}. The number of reads and writes per second using the CEPH file system is a GA adaptive value and the sum of fitness of all individuals should be calculated

\[
F = \sum_{i=1}^{M} f(i) + P(z) D(z) K u(n)
\]

(12)

Furthermore, binary coding is used for the equipment configuration parameters, and single point random cross setting is used for alternating parameter information. It encodes single base mutation and operates random mutation of one or more genes according to mutation probability. Finally, the parameter words are decoded to generate a new group\cite{14-15}.

In this paper, the performance parameters of the wind turbine telemetry device are evaluated with the sensitivity parameters of the performance indicators as the standard. A new parameter tuning set is obtained by cross modifying the default parameters, and the new parameter tuning is obtained by inputting new parameters into the performance model, to repeat the above steps until you find the best parameter tuning.

3. Analysis of experimental results

In order to verify the effectiveness of the active optimization method for remote test equipment of wind farm operation parameters, the experiment was conducted. LXI instrument system is adopted. The sensor resolution of the device is 0.01 mm. Because the beam width emitted by the beam emitter of the sensor is generally larger than 1 mm, the maximum error is 3 mm, and the maximum error produced by the sensor is 0.03 mm. Therefore, the standard operational numerical algorithm of the sensor is as follows:

\[
u_{11} = \frac{0.03}{\sqrt{3}} = 0.0173 \text{mm}
\]

(13)

Further, the calibration range of the platform six axis portable measuring instrument is developed by Faro company of the United States, and the accuracy can reach 0.036 mm

\[
u_{12} = \frac{0.036}{\sqrt{3}} = 0.0208 \text{mm}
\]

(14)

The Leica theodolite is used to calibrate the error to 20.000 mm. In the calibration process, the measurement uncertainty value caused by the calculation is as follows:

\[
u_{13} = \frac{0.0208-0.0173}{\sqrt{3}(u_{12}-u_{11})} \leq 0.0058 \text{mm}
\]

(15)

In the test process, the remote test host sends test hit rate every 0.5 s. After the flow control, the test hit rate is 0.1 times higher than before, and it can send 5 LXI packets continuously. Table 1 shows that each service flow starts to generate in 110 s. The simulation results of end-to-end delay, delay jitter, node throughput and data loss rate of test commands are obtained. Based on this comparison, the accuracy of the traditional method and the method in this paper is recorded, and the specific test result person is shown in the figure2 below:
Based on the above detection results, compared with the traditional methods, the active tuning method of wind farm operation parameters remote test equipment based on data mining proposed in this paper has significantly lower tuning error value and higher maximum tunable value than the traditional method under the same environment compared with the traditional method, which confirms that the wind power based on data mining has better performance. The results show that in a certain adjustment time, the reference target can be quickly updated and optimized, and good results are achieved.

4. Conclusion

With the high technology of modern equipment, its structure is becoming more and more complex and its functions are becoming more and more powerful. Equipment is large in scale and complex in function, which is difficult to replace. It needs high reliability operation support, various maintenance skills and scientific maintenance decision. Therefore, an active optimization method for remote test equipment of wind farm operation parameters based on data mining is proposed. While strengthening the application of maintenance and trial operation technology, we should develop and apply remote maintenance and trial operation technology, timely detect equipment, accurately grasp the operation status of equipment, analyze and diagnose faults, judge fault location and cause, and improve support speed and support effect.

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