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Inventeur(s):

GUO Hongri – China, SU Xiaoming – China, LIU Bo – China, FENG Zeyuan – China, WANG Ke – China, WANG Lei – China, LIU Yawen – China

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Mandataire(s):

IP SHIELD – 1616 Luxembourg (Luxembourg)

73

Titulaire(s):

NORTH UNITED ELECTRIC POWER CO., LTD. BAOTOU
NO.2 THERMAL POWER PLANT – 014030 Baotou
City (China)

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INTELLIGENT MONITORING SYSTEM FOR A SUBSTATION BATTERY PACK.

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The present invention provides an intelligent monitoring system for a substation battery pack, belonging to the technical field of intelligent monitoring. The system comprises: a data acquisition module, which collects the basic operating parameters of the battery pack and performs preprocessing on these parameters to obtain first operating parameters; a data analysis module, which normalizes the first operating parameters to obtain second operating parameters and utilizes the second operating parameters to conduct trend analysis on the operating state of the battery pack; a value determination module, which identifies trigger abnormal points of the battery pack, determines the trigger time of each abnormal point, and acquires abnormal continuous information within a preset time period following the trigger time to generate several abnormal alarm values corresponding to the battery pack, recording them within a monitoring platform corresponding to the battery pack; an information processing module, which processes the recorded information under different abnormal alarms for the same battery pack in the monitoring platform to identify frequently occurring abnormal areas, thereby ensuring the operational stability of the battery pack.

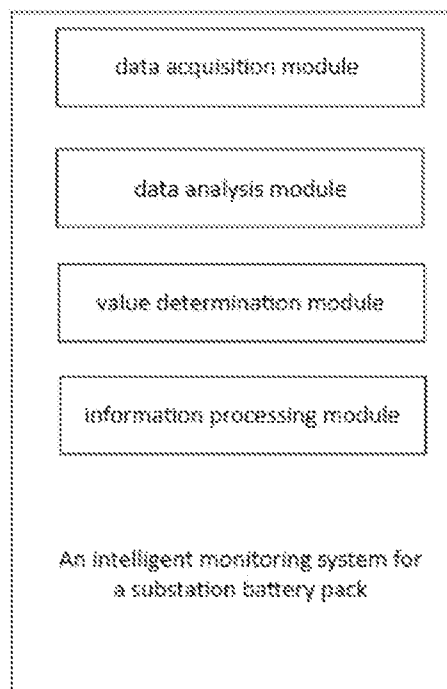


FIG.1

INTELLIGENT MONITORING SYSTEM FOR A SUBSTATION BATTERY PACK

Technical Field

The present invention relates to the technical field of intelligent monitoring,
5 particularly to an intelligent monitoring system for a substation battery pack.

Background Technology

Currently, due to the rapid development of big data, a solid technical foundation
has been laid for the real-time detection and warning of substation battery packs.
10 However, the complex environment of substations and the widespread distribution of
battery packs make the current solutions rely on simply monitoring and collecting data
from the battery packs, followed by professionals manually checking and analyzing for
abnormalities. In the process of monitoring the operating parameters of the battery
pack, errors may arise either due to the anomalies in the monitoring equipment itself
15 or during data analysis, thus failing to promptly detect abnormalities in the battery
pack and consequently reducing the operational stability of the battery pack.

Therefore, the present invention proposes an intelligent monitoring system for a
substation battery pack.

Summary of the Invention

The present invention provides an intelligent monitoring system for a substation
battery pack, aimed at achieving real-time monitoring and abnormal warning of the
battery pack through data collection, analysis, and early warning. It enables the timely
identification of abnormal changes and potential issues within the battery pack,
25 reduces the possibility of errors in analysis results, and is beneficial for the stability and
continuity of equipment operation.

The present invention provides an intelligent monitoring system for a substation
battery pack, comprising:

A data acquisition module: utilizing a measurement device to collect basic

operating parameters of the battery pack and performing preprocessing on these basic operating parameters to obtain first operating parameters;

A data analysis module: performing matching and standardization on the first operating parameters to obtain second operating parameters, and using the second
5 operating parameters to perform trend analysis on the operating state and abnormalities of the battery pack;

A value determination module: based on the trend analysis results, determining several trigger abnormal points of the battery pack, the trigger time of each abnormal point, and obtaining abnormal continuous information within a preset time period
10 following the trigger time for each trigger abnormal point; based on preset alarm rules, obtaining several abnormal alarm values corresponding to the battery pack, and recording them within a monitoring platform corresponding to the battery pack;

An information processing module: processing the recorded information under different abnormal alarms for the same battery pack in the monitoring platform to
15 identify frequently occurring abnormal areas and establish a detection scheme for the battery pack.

In one possible realization, the data acquisition module includes:

An access numbering unit: setting a first access number for the access port of the battery pack according to different types, and setting a second access number for the
20 different types of measurement devices to be connected;

A device matching unit: prior to connecting the measurement device, performing a one-to-one match between the first access number and the second access number for subsequent parameter acquisition of the battery pack.

In one possible realization, the data acquisition module further includes:

25 A parameter classification unit: classifying the basic operating parameters collected by the measurement device into different parameter types based on the physical meaning of the basic operating parameters;

A parameter processing unit: preprocessing the basic operating parameters under different parameter types to obtain the corresponding first operating parameters.

30 In one possible realization, the data analysis module includes:

A matching unit: performing time matching on the first operating parameters corresponding to the same parameter type at different time intervals to obtain a mapped matching parameter set $[(x_1, t_1), (x_2, t_2) \cdots (x_n, t_n)]$, where t_n represents the time interval mapped by the n -th parameter x_n , t_1 represents the time interval mapped by the first parameter x_1 , and t_2 represents the time interval mapped by the second parameter x_2 ;

A standardization unit: standardizing the current parameter set to obtain the corresponding second operating parameter mapping set $[(x'_1, t_0), (x'_2, t_0) \cdots (x'_n, t_0)]$;

Where the time interval of each parameter is standardized as follows:

$$t_0 = \begin{cases} \frac{1}{n} \times \sum_{i=1}^n t_i \times (1 + \delta 1^2), \frac{\left(\frac{t_i - t_{min}}{t_{max} - t_{min}}\right)_{max}}{\frac{1}{n} \sum_{i=1}^n \frac{t_i - t_{min}}{t_{max} - t_{min}}} \geq 1.3 \\ \frac{1}{n} \times \sum_{i=1}^n t_i \times (1 - \delta 1^2), \frac{\left(\frac{t_i - t_{min}}{t_{max} - t_{min}}\right)_{max}}{\frac{1}{n} \sum_{i=1}^n \frac{t_i - t_{min}}{t_{max} - t_{min}}} < 1.3 \end{cases}$$

Where t_i represents the time interval mapped by the i -th parameter x_i ; t_0 represents the standardized time interval; $\delta 1^2$ represents the variance based on all $\frac{t_i - t_{min}}{t_{max} - t_{min}}$; and $\left(\frac{t_i - t_{min}}{t_{max} - t_{min}}\right)_{max}$ represents the maximum value among all $\frac{t_i - t_{min}}{t_{max} - t_{min}}$;

Based on the standardized time interval, the corresponding standardized mapped parameter is obtained as:

$$x'_i = \left(x_i + \frac{\sqrt{\sum (x_i - x_{avg})^2}}{n} \right) \times t_0$$

Where x'_i represents the standardized mapped parameter of the i -th parameter x_i .

In one possible realization, the data analysis module further includes:

A characteristic parameter unit: obtaining the variance and mean of the second operating parameter mapping set under the corresponding parameter type and calculating the characteristic parameter of the second operating parameter mapping set:

$$x_0 = \frac{|(x_{max} - \sigma) + (x_{min} - \sigma)|}{n \times \varepsilon + 0.5} + \ln\left(\frac{x_{max}}{x_{min} + \varepsilon} + 1\right)$$

Where x_0 represents the characteristic parameter under the corresponding parameter type, x_{max} represents the maximum parameter value in the second operating parameter mapping set, x_{min} represents the minimum parameter value, σ represents the mean, and ε represents the variance of the second operating parameter mapping set;

A trend construction unit: drawing parameters of the second operating parameter mapping set based on time intervals to obtain a point-like discrete image and obtaining the slope and curve shape of the trend line of the point-like discrete image.

In one possible realization, the trend construction unit includes:

10 An equation construction subunit: selecting observations from the point-like discrete image that meet the observation standard and constructing an initial trend equation of the trend line of the point-like discrete image:

$$a_1 \times r^{t_1} + a_2 \times r^{t_2} + \dots + a_m \times r^{t_m} + e = y(r)$$

Where a_1 represents the first observation value of the trend line; a_2 represents the second observation value; a_m represents the m-th observation value; r^{t_1} represents the observation time of the first observation value; r^{t_2} represents the observation time of the second observation value; r^{t_m} represents the observation time of the m-th observation value; $y(r)$ represents the initial trend equation; e represents the constant of the trend equation;

20 Iterative analysis is performed on the observations and trend equation constant using the following formula to calculate the iteration values of the corresponding observations and the iterative constant of the trend equation constant:

$$S(e, a_j) = \sum (y_j - e - a_j \times r^{t_j})$$

Where, taking partial derivatives of e and a_j , setting the partial derivatives to zero, and solving for the iterative constant e' of e and the iterative value a'_j of a_j ; $S(e, a_j)$ is the iterative analysis function; y_j represents the initial trend equation of the j-th observation value a_j ; r^{t_j} represents the observation time of the j-th observation value a_j , with j taking values of 1,2,3,...,m.

Based on the iterative results, the final trend equation $y'(r)$ is obtained as:

$$a'_1 \times r^{t_1} + a'_2 \times r^{t_2} + \dots + a'_m \times r^{t_m} + e' = y'(r)$$

From the final trend equation, the slope and curve shape of the trend line at each time point corresponding to the second operating parameters are obtained.

5 In one possible realization, the value determination module includes:

An analysis determination unit: based on the slope and curve shape at each time point corresponding to the second operating parameters under the same parameter type, determining the analysis value at the corresponding time point;

10 A time marking unit: determining whether the detection location point corresponding to the second operating parameter in the battery pack is a trigger abnormal point by combining the analysis value; if it is, marking the detection location point in time;

A determination unit: determining the first marking point from the marking results as the trigger time of the corresponding trigger abnormal point.

15 In one possible realization, the information processing module includes:

A feature extraction unit: integrating information of the same battery pack under alarm conditions of different parameter types to extract the feature type and feature time of each parameter abnormal part, classifying according to the standard table of preset monitoring data for the battery pack;

20 An abnormal extraction unit: constructing an abnormal feature information table corresponding to different parameter types of the battery pack and, based on the frequently occurring abnormal parts and times, determining the parts of the battery pack requiring inspection and maintenance and identifying the abnormal states.

25 Compared with the existing technology, the advantageous effects of the present application are as follows:

By realizing real-time monitoring and abnormal warning of the battery pack through data collection, analysis, and early warning, it enables the timely identification of abnormal changes and potential issues within the battery pack, reducing the likelihood of errors in analysis results, which is beneficial for the stability and continuity
30 of equipment operation.

Other features and advantages of the present invention will be described in the following specification, partially becoming apparent from the specification, or learned through the implementation of the invention. The objectives and other advantages of the present invention can be achieved and obtained by the structure particularly pointed out in the written description and the accompanying drawings.

The technical solutions of the present invention are further described in detail below with reference to the accompanying drawings and embodiments.

Description of the Drawings

The drawings provide further understanding of the present invention, constituting part of the specification, and are used together with the embodiments of the present invention to explain the present invention, without constituting any limitation. In the drawings:

FIG.1 is a structural diagram of an intelligent monitoring system for a substation battery pack according to an embodiment of the present invention.

Detailed Embodiments

The preferred embodiments of the present invention are described below in conjunction with the drawings. It should be understood that the described preferred embodiments are merely to illustrate and explain the present invention and are not intended to limit the present invention.

Embodiment 1:

An embodiment of the present invention provides an intelligent monitoring system for a substation battery pack, as shown in FIG.1, comprising:

A data acquisition module: utilizing a measurement device to collect basic operating parameters of the battery pack and performing preprocessing on these basic operating parameters to obtain first operating parameters;

A data analysis module: performing matching and standardization on the first operating parameters to obtain second operating parameters, and using the second

operating parameters to perform trend analysis on the operating state and abnormalities of the battery pack;

A value determination module: based on the trend analysis results, determining several trigger abnormal points of the battery pack, the trigger time of each abnormal
5 point, and obtaining abnormal continuous information within a preset time period following the trigger time for each trigger abnormal point; based on preset alarm rules, obtaining several abnormal alarm values corresponding to the battery pack, and recording them within a monitoring platform corresponding to the battery pack;

An information processing module: processing the recorded information under
10 different abnormal alarms for the same battery pack in the monitoring platform to identify frequently occurring abnormal areas and establish a detection scheme for the battery pack.

In this embodiment, the measurement devices are various sensors or data collectors. These devices can be used to collect various operating parameters of the
15 battery pack, such as voltage, current, temperature, internal resistance, etc.

In this embodiment, the battery pack is a device for storing electrical energy, usually composed of multiple single batteries connected in series or parallel.

In this embodiment, the basic operating parameters typically include basic parameters such as voltage, current, and temperature, reflecting the performance and
20 status of the battery pack.

In this embodiment, preprocessing is a method of initially processing and analyzing the collected basic operating parameters to remove noise, outliers, and invalid data.

In this embodiment, the first operating parameters are those obtained from the
25 basic operating parameters after preprocessing.

In this embodiment, standardization processing refers to converting the first operating parameters into a standardized form.

In this embodiment, the second operating parameters are those obtained from the first operating parameters after matching and standardization processing.

30 In this embodiment, the operating state refers to the current working state of the

battery pack, including charging, discharging, and fault states.

In this embodiment, the abnormal situation refers to abnormal conditions or behaviors occurring during the operation of the battery pack, including abnormal voltage, temperature, capacity, internal resistance at different points in the battery
5 pack.

In this embodiment, trend analysis refers to analyzing the changes in the operating state and abnormal situations of the battery pack over time.

In this embodiment, a trigger abnormal point refers to a detection location point that is identified as corresponding to abnormal information based on trend analysis
10 results during the operation of the battery pack.

In this embodiment, the trigger time refers to the initial time point at which the battery pack is identified as abnormal after performing trend analysis on the second operating parameters in the data analysis module.

In this embodiment, the preset time period is the period set for analyzing the
15 abnormal situation following the trigger time of the trigger abnormal point.

In this embodiment, abnormal continuous information refers to the continuous data information of the second operating parameters that exhibit abnormalities within the preset time period following the trigger time of the trigger abnormal point.

In this embodiment, preset alarm rules are a series of standards set for the
20 abnormal situations in the operating state of the battery pack, such as threshold settings, trend analysis, and time period monitoring. If the set standards are not met, it is determined that an abnormality exists.

In this embodiment, an abnormal alarm value is an index for evaluating the abnormal situation in the operating state of the battery pack.

25 In this embodiment, the monitoring platform is a monitoring system used to monitor the operating state and abnormal situations of the battery pack.

The working principle and advantageous effect of the above technical solution are as follows: By achieving real-time monitoring and abnormal warning of the battery pack through data collection, analysis, and early warning, it enables the timely
30 identification of abnormal changes and potential issues within the battery pack,

reducing the likelihood of errors in analysis results and benefiting the stability and continuity of equipment operation.

Embodiment 2:

5 Based on the above Embodiment 1, the data acquisition module includes:

 An access numbering unit: setting a first access number for the access port of the battery pack according to different types, and setting a second access number for the different types of measurement devices to be connected;

 A device matching unit: prior to connecting the measurement device, performing
10 a one-to-one match between the first access number and the second access number for subsequent parameter acquisition of the battery pack.

 In this embodiment, the access port is an interface connected to the battery pack for connecting different types of measurement devices for parameter collection and monitoring.

15 In this embodiment, the first access number is a number assigned to the access port of the battery pack to identify and distinguish different types of access ports.

 In this embodiment, the second access number refers to the number assigned to different types of measurement devices to be connected to the battery pack, and it is used for matching in the device matching unit.

20 In this embodiment, parameter acquisition refers to the process of real-time monitoring and data collection of various parameters of the battery pack through the measurement devices connected to it.

 The working principle and advantageous effect of the above technical solution are as follows: By setting different access numbers for different types of access ports of
25 the battery pack and the connected measurement devices, matching and correct connections are achieved, improving the accuracy of data collection, facilitating device management and maintenance, and reducing the possibility of errors in analysis results.

30 Embodiment 3:

Based on the above Embodiment 1, the data acquisition module further includes:

A parameter classification unit: classifying the basic operating parameters collected by the measurement device into different parameter types based on the physical meaning of the basic operating parameters;

5 A parameter processing unit: preprocessing the basic operating parameters under different parameter types to obtain the corresponding first operating parameters.

In this embodiment, the physical meaning refers to the physical quantity of the basic operating parameters or the role of the physical quantity in physical terms.

10 In this embodiment, parameter types include voltage, current, temperature, and other basic parameter types.

The working principle and advantageous effect of the above technical solution are as follows: By preprocessing and classifying different types of basic operating parameters, the quality of data is improved, and the likelihood of errors in subsequent analysis results is reduced.

15

Embodiment 4:

Based on the above Embodiment 1, the data analysis module includes:

20 A matching unit: performing time matching on the first operating parameters corresponding to the same parameter type at different time intervals to obtain a mapped matching parameter set $[(x_1, t_1), (x_2, t_2) \cdots (x_n, t_n)]$, where t_n represents the time interval mapped by the n-th parameter x_n , t_1 represents the time interval mapped by the first parameter x_1 , and t_2 represents the time interval mapped by the second parameter x_2 ;

25 A standardization unit: standardizing the current parameter set to obtain the corresponding second operating parameter mapping set $[(x'_1, t_0), (x'_2, t_0) \cdots (x'_n, t_0)]$;

Where the time interval of each parameter is standardized as follows:

$$t_0 = \begin{cases} \frac{1}{n} \times \sum_{i=1}^n t_i \times (1 + \delta 1^2), \frac{\left(\frac{t_i - t_{min}}{t_{max} - t_{min}}\right)_{max}}{\frac{1}{n} \sum_{i=1}^n \frac{t_i - t_{min}}{t_{max} - t_{min}}} \geq 1.3 \\ \frac{1}{n} \times \sum_{i=1}^n t_i \times (1 - \delta 1^2), \frac{\left(\frac{t_i - t_{min}}{t_{max} - t_{min}}\right)_{max}}{\frac{1}{n} \sum_{i=1}^n \frac{t_i - t_{min}}{t_{max} - t_{min}}} < 1.3 \end{cases}$$

Where t_i represents the time interval mapped by the i -th parameter x_i ; t_0 represents the standardized time interval; $\delta 1^2$ represents the variance based on all $\frac{t_i - t_{min}}{t_{max} - t_{min}}$; and $\left(\frac{t_i - t_{min}}{t_{max} - t_{min}}\right)_{max}$ represents the maximum value among all $\frac{t_i - t_{min}}{t_{max} - t_{min}}$;

5 Based on the standardized time interval, the corresponding standardized mapped parameter is obtained as:

$$x'_i = \left(x_i + \frac{\sqrt{\sum (x_i - x_{avg})^2}}{n} \right) \times t_0$$

Where x'_i represents the standardized mapped parameter of the i -th parameter x_i .

10 In this embodiment, the mapping matching parameters refer to a set of parameters obtained by matching the first operating parameters of the same parameter type over different time intervals.

The time interval in this embodiment is the interval used when matching the first operating parameters of the same parameter type across different time intervals.

15 The standardized mapping parameters in this embodiment are the set of second operating parameters obtained by standardizing the current parameter set under the corresponding parameter type.

20 The working principle and advantageous effect of the above technical solution are as follows: Through the matching unit and standardization unit, time matching and standardization processing of parameters are achieved, resulting in standardized mapping parameters. This improves the accuracy of parameter analysis and application, providing a better data foundation for data analysis and modeling, enhancing data quality, and reducing the possibility of errors in subsequent analysis results.

Embodiment 5:

Based on the above Embodiment 1, the data analysis module further includes:

5 A characteristic parameter unit: obtaining the variance and mean of the second operating parameter mapping set under the corresponding parameter type and calculating the characteristic parameter of the second operating parameter mapping set:

$$x_0 = \frac{|(x_{max} - \sigma) + (x_{min} - \sigma)|}{n \times \varepsilon + 0.5} + \ln\left(\frac{x_{max}}{x_{min} + \varepsilon} + 1\right)$$

10 Where x_0 represents the characteristic parameter under the corresponding parameter type, x_{max} represents the maximum parameter value in the second operating parameter mapping set, x_{min} represents the minimum parameter value, σ represents the mean, and ε represents the variance of the second operating parameter mapping set;

15 A trend construction unit: drawing parameters of the second operating parameter mapping set based on time intervals to obtain a point-like discrete image and obtaining the slope and curve shape of the trend line of the point-like discrete image.

In this embodiment, the characteristic parameters are indicators that describe the statistical characteristics of the second operating parameter mapping set.

20 In this embodiment, parameter plotting refers to the process of drawing the data in the second operating parameter mapping set according to the time intervals to form a point-like discrete image.

25 In this embodiment, a point-like discrete image is a scatter plot formed by plotting the data of the second operating parameter mapping set according to the time intervals, where the time intervals map to the horizontal axis, and the corresponding values of the second operating parameters map to the vertical axis. Each point in the image represents the parameter value at a specific time interval, with all time intervals calculated from the origin, e.g., origin, point 1, point 2, where the time interval between point 1 and the origin is the time interval, and the interval between point 2 and the origin is the time interval, with point 2 following point 1.

In this embodiment, a trend line is a continuous curve obtained by fitting the data points in a point-like discrete image.

In this embodiment, curve shape refers to the overall shape and trend characteristics of the point-like discrete image, including linear growth, exponential growth, cyclical fluctuations, and other features.

The working principle and advantageous effect of the above technical solution are as follows: The characteristic parameter unit provides a comprehensive description of the parameter distribution and variation degree by calculating features such as the mean and variance of the second operating parameter set. The trend construction unit visualizes the parameter's temporal changes by plotting the parameter image and analyzing the slope and shape of the trend line, improving the quality of parameter data utilization, and reducing the possibility of large errors during construction, thus minimizing analysis errors.

Embodiment 6:

Based on the above Embodiment 1, the trend construction unit includes:

An equation construction subunit: selecting observations from the point-like discrete image that meet the observation standard and constructing an initial trend equation of the trend line of the point-like discrete image:

$$a_1 \times r^{t_1} + a_2 \times r^{t_2} + \dots + a_m \times r^{t_m} + e = y(r)$$

Where a_1 represents the first observation value of the trend line; a_2 represents the second observation value; a_m represents the m-th observation value; r^{t_1} represents the observation time of the first observation value; r^{t_2} represents the observation time of the second observation value; r^{t_m} represents the observation time of the m-th observation value; $y(r)$ represents the initial trend equation; e represents the constant of the trend equation;

Iterative analysis is performed on the observations and trend equation constant using the following formula to calculate the iteration values of the corresponding observations and the iterative constant of the trend equation constant:

$$S(e, a_j) = \sum (y_j - e - a_j \times r^{t_j})$$

Where, taking partial derivatives of e and a_j , setting the partial derivatives to zero, and solving for the iterative constant e' of e and the iterative value a'_j of a_j ; $S(e, a_j)$ is the iterative analysis function; y_j represents the initial trend equation of the j -th observation value a_j ; r^{t_j} represents the observation time of the j -th observation value a_j , with j taking values of 1,2,3,...,m.

Based on the iterative results, the final trend equation $y'(r)$ is obtained as:

$$a'_1 \times r^{t_1} + a'_2 \times r^{t_2} + \dots + a'_m \times r^{t_m} + e' = y'(r)$$

From the final trend equation, the slope and curve shape of the trend line at each time point corresponding to the second operating parameters are obtained.

In this embodiment, observation standards refer to the criteria for selecting and adopting observation values, including range limitations of observation values, exclusion of outliers, and data quality requirements.

In this embodiment, observation values are the data points in the point-like discrete image, i.e., actual data values.

In this embodiment, the initial trend equation is the trend equation used at the start of iterative analysis to estimate the initial shape of the trend line and serve as the starting point for the iterative process.

In this embodiment, observation time refers to the time point corresponding to each observation value in the trend line.

In this embodiment, iterative analysis refers to the iterative calculation process of observation values and trend equation constants.

In this embodiment, the iterative constant is the final value of the constant e in the trend equation obtained through iterative analysis.

In this embodiment, the final trend equation is the ultimate trend equation obtained by fitting the initial trend equation through iteration using the second operating parameters.

The working principle and advantageous effect of the above technical solution are

as follows: By selecting observation values and performing iterative analysis, the trend line of discrete observation data is constructed. During the iteration process, partial derivatives are calculated, and equations are solved to obtain the iterative constants and corresponding iterative results of the observation values. This improves the accuracy and flexibility of trend prediction, aiding data analysis and decision-making.

Embodiment 7:

Based on the above Embodiment 1, the value determination module includes:

An analysis determination unit: based on the slope and curve shape at each time point corresponding to the second operating parameters under the same parameter type, determining the analysis value at the corresponding time point;

A time marking unit: determining whether the detection location point corresponding to the second operating parameter in the battery pack is a trigger abnormal point by combining the analysis value; if it is, marking the detection location point in time;

A determination unit: determining the first marking point from the marking results as the trigger time of the corresponding trigger abnormal point.

In this embodiment, the analysis value is the numerical value obtained based on the slope and curve shape of each second operating parameter at corresponding time points under the same parameter type, calculated as follows: Given the final trend equation $y'(r)$, at the corresponding time α , the slope is $(y'(\alpha))'$, and the analysis value $F1(\alpha)$ of the second operating parameter at the corresponding time is calculated as:

$$F1(\alpha) = |(y'(\alpha))' - k01| \times |y'(\alpha) - y1|$$

where $k01$ is the standard slope and $y1$ is the standard trend value.

In this embodiment, the detection location point refers to a specific position or component within the battery pack for detecting the second operating parameters.

In this embodiment, time marking is the process of marking detection location points in real-time based on the results of the second operating parameters and analysis values during battery pack detection.

In this embodiment, a marking point is the time point determined by the time marking unit to indicate the moment of occurrence of an abnormality in the battery pack.

The working principle and advantageous effect of the above technical solution are as follows: By real-time monitoring and analyzing battery pack parameters, the abnormal trigger time and location points are determined, providing crucial fault diagnosis information. This helps in early detection, quick localization, and taking maintenance actions, facilitating the analysis and decision-making based on equation results, improving system reliability and safety.

Embodiment 8:

Based on the above Embodiment 1, the information processing module includes:

A feature extraction unit: integrating information of the same battery pack under alarm conditions of different parameter types to extract the feature type and feature time of each parameter abnormal part, classifying according to the standard table of preset monitoring data for the battery pack;

An abnormal extraction unit: constructing an abnormal feature information table corresponding to different parameter types of the battery pack and, based on the frequently occurring abnormal parts and times, determining the parts of the battery pack requiring inspection and maintenance and identifying the abnormal states.

In this embodiment, alarm situations are abnormal conditions occurring under different parameter types of the battery pack, including over-voltage, under-voltage, over-temperature, and low-temperature parameter abnormalities.

In this embodiment, integration is the process of combining information from the same battery pack under different parameter types of alarm situations.

In this embodiment, characteristic types are the different specific abnormal characteristics exhibited by the battery pack under alarm conditions for different parameter types, including but not limited to voltage abnormalities, temperature abnormalities, and charge/discharge abnormalities.

In this embodiment, characteristic time is the time point at which abnormal

features appear under different parameter types of alarm situations for the battery pack.

In this embodiment, the standard table is a predefined standardized table for monitoring data of the battery pack, recording the normal range of various parameter types, abnormal feature types, and their corresponding preset standards.

In this embodiment, abnormal feature information refers to the abnormal characteristics exhibited by the battery pack under different parameter types of alarm situations, including but not limited to abnormal locations, abnormal types, and abnormal times.

The working principle and advantageous effect of the above technical solution are as follows: By integrating alarm information of the battery pack across different parameter types using the feature extraction unit, an abnormal feature information table is constructed and analyzed and classified using the abnormal extraction unit. Its working principle facilitates a comprehensive analysis of the abnormal features of the battery pack, improving the quality level of the obtained data, refining the analysis results, and enhancing system reliability and safety.

It is evident that those skilled in the art can make various modifications and alterations to the present invention without departing from its spirit and scope. Therefore, if such modifications and alterations fall within the scope of the claims of the present invention and their equivalent techniques, the present invention is intended to encompass these modifications and alterations.

CLAIMS

1. An intelligent monitoring system for a substation battery pack, wherein comprising:

5 A data acquisition module: utilizing a measurement device to collect basic operating parameters of the battery pack and performing preprocessing on these basic operating parameters to obtain first operating parameters;

A data analysis module: performing matching and standardization on the first operating parameters to obtain second operating parameters, and using the second operating parameters to perform trend analysis on the operating state and
10 abnormalities of the battery pack;

A value determination module: based on the trend analysis results, determining several trigger abnormal points of the battery pack, the trigger time of each abnormal point, and obtaining abnormal continuous information within a preset time period following the trigger time for each trigger abnormal point; based on preset alarm rules,
15 obtaining several abnormal alarm values corresponding to the battery pack, and recording them within a monitoring platform corresponding to the battery pack;

An information processing module: processing the recorded information under different abnormal alarms for the same battery pack in the monitoring platform to identify frequently occurring abnormal areas and establish a detection scheme for the
20 battery pack.

2. The intelligent monitoring system for a substation battery pack according to Claim 1, wherein the data acquisition module includes:

25 An access numbering unit: setting a first access number for the access port of the battery pack according to different types, and setting a second access number for the different types of measurement devices to be connected;

A device matching unit: prior to connecting the measurement device, performing a one-to-one match between the first access number and the second access number for subsequent parameter acquisition of the battery pack.

3. The intelligent monitoring system for a substation battery pack according to Claim 1, wherein the data acquisition module further includes:

A parameter classification unit: classifying the basic operating parameters collected by the measurement device into different parameter types based on the physical meaning of the basic operating parameters;

A parameter processing unit: preprocessing the basic operating parameters under different parameter types to obtain the corresponding first operating parameters.

4. The intelligent monitoring system for a substation battery pack according to Claim 3, wherein the data analysis module includes:

A matching unit: performing time matching on the first operating parameters corresponding to the same parameter type at different time intervals to obtain a mapped matching parameter set $[(x_1, t_1), (x_2, t_2) \cdots (x_n, t_n)]$, where t_n represents the time interval mapped by the n-th parameter x_n , t_1 represents the time interval mapped by the first parameter x_1 , and t_2 represents the time interval mapped by the second parameter x_2 ;

A standardization unit: standardizing the current parameter set to obtain the corresponding second operating parameter mapping set $[(x'_1, t_0), (x'_2, t_0) \cdots (x'_n, t_0)]$;

Where the time interval of each parameter is standardized as follows:

$$t_0 = \begin{cases} \frac{1}{n} \times \sum_{i=1}^n t_i \times (1 + \delta 1^2), \frac{\left(\frac{t_i - t_{min}}{t_{max} - t_{min}}\right)_{max}}{\frac{1}{n} \sum_{i=1}^n \frac{t_i - t_{min}}{t_{max} - t_{min}}} \geq 1.3 \\ \frac{1}{n} \times \sum_{i=1}^n t_i \times (1 - \delta 1^2), \frac{\left(\frac{t_i - t_{min}}{t_{max} - t_{min}}\right)_{max}}{\frac{1}{n} \sum_{i=1}^n \frac{t_i - t_{min}}{t_{max} - t_{min}}} < 1.3 \end{cases}$$

Where t_i represents the time interval mapped by the i-th parameter x_i ; t_0 represents the standardized time interval; $\delta 1^2$ represents the variance based on all $\frac{t_i - t_{min}}{t_{max} - t_{min}}$; and $\left(\frac{t_i - t_{min}}{t_{max} - t_{min}}\right)_{max}$ represents the maximum value among all $\frac{t_i - t_{min}}{t_{max} - t_{min}}$;

Based on the standardized time interval, the corresponding standardized mapped

parameter is obtained as:

$$x'_i = \left(x_i + \frac{\sqrt{\sum (x_i - x_{avg})^2}}{n} \right) \times t_0$$

Where x'_i represents the standardized mapped parameter of the i-th parameter x_i .

5

5. The intelligent monitoring system for a substation battery pack according to Claim 4, wherein the data analysis module further includes:

A characteristic parameter unit: obtaining the variance and mean of the second operating parameter mapping set under the corresponding parameter type and calculating the characteristic parameter of the second operating parameter mapping set:

10

$$x_0 = \frac{|(x_{max} - \sigma) + (x_{min} - \sigma)|}{n \times \varepsilon + 0.5} + \ln\left(\frac{x_{max}}{x_{min} + \varepsilon} + 1\right)$$

Where x_0 represents the characteristic parameter under the corresponding parameter type, x_{max} represents the maximum parameter value in the second operating parameter mapping set, x_{min} represents the minimum parameter value, σ represents the mean, and ε represents the variance of the second operating parameter mapping set;

15

A trend construction unit: drawing parameters of the second operating parameter mapping set based on time intervals to obtain a point-like discrete image and obtaining the slope and curve shape of the trend line of the point-like discrete image.

20

6. The intelligent monitoring system for a substation battery pack according to Claim 5, wherein the trend construction unit includes:

An equation construction subunit: selecting observations from the point-like discrete image that meet the observation standard and constructing an initial trend equation of the trend line of the point-like discrete image:

25

$$a_1 \times r^{t_1} + a_2 \times r^{t_2} + \dots + a_m \times r^{t_m} + e = y(r)$$

Where a_1 represents the first observation value of the trend line; a_2

represents the second observation value; a_m represents the m-th observation value;
 r^{t_1} represents the observation time of the first observation value; r^{t_2} represents the
 observation time of the second observation value; r^{t_m} represents the observation
 time of the m-th observation value; $y(r)$ represents the initial trend equation; e
 5 represents the constant of the trend equation;

Iterative analysis is performed on the observations and trend equation constant
 using the following formula to calculate the iteration values of the corresponding
 observations and the iterative constant of the trend equation constant:

$$S(e, a_j) = \sum (y_j - e - a_j \times r^{t_j})$$

10 Where, taking partial derivatives of e and a_j , setting the partial derivatives to
 zero, and solving for the iterative constant e' of e and the iterative value a'_j of a_j ;
 $S(e, a_j)$ is the iterative analysis function; y_j represents the initial trend equation of
 the j-th observation value a_j ; r^{t_j} represents the observation time of the j-th
 observation value a_j , with j taking values of 1,2,3,...,m;

15 Based on the iterative results, the final trend equation $y'(r)$ is obtained as:

$$a'_1 \times r^{t_1} + a'_2 \times r^{t_2} + \dots + a'_m \times r^{t_m} + e' = y'(r)$$

From the final trend equation, the slope and curve shape of the trend line at each
 time point corresponding to the second operating parameters are obtained.

20 7. The intelligent monitoring system for a substation battery pack according to
 Claim 1, wherein the value determination module includes:

An analysis determination unit: based on the slope and curve shape at each time
 point corresponding to the second operating parameters under the same parameter
 type, determining the analysis value at the corresponding time point;

25 A time marking unit: determining whether the detection location point
 corresponding to the second operating parameter in the battery pack is a trigger
 abnormal point by combining the analysis value; if it is, marking the detection location
 point in time;

A determination unit: determining the first marking point from the marking results as the trigger time of the corresponding trigger abnormal point.

8. The intelligent monitoring system for a substation battery pack according to
5 Claim 1, wherein the information processing module includes:

A feature extraction unit: integrating information of the same battery pack under alarm conditions of different parameter types to extract the feature type and feature time of each parameter abnormal part, classifying according to the standard table of preset monitoring data for the battery pack;

- 10 An abnormal extraction unit: constructing an abnormal feature information table corresponding to different parameter types of the battery pack and, based on the frequently occurring abnormal parts and times, determining the parts of the battery pack requiring inspection and maintenance and identifying the abnormal states.

REVENDICATIONS

1. Un système de surveillance intelligent pour un pack de batteries de sous-station, comprenant :

5 Un module d'acquisition de données : utilisant un dispositif de mesure pour collecter les paramètres de fonctionnement de base du pack de batteries et effectuant un prétraitement de ces paramètres de base pour obtenir des premiers paramètres de fonctionnement ;

10 Un module d'analyse de données : effectuant un appariement et une standardisation des premiers paramètres de fonctionnement pour obtenir des seconds paramètres de fonctionnement, et utilisant ces seconds paramètres pour effectuer une analyse de tendance de l'état de fonctionnement et des anomalies du pack de batteries ;

15 Un module de détermination de valeur : sur la base des résultats de l'analyse de tendance, déterminant plusieurs points anormaux de déclenchement du pack de batteries, le temps de déclenchement de chaque point anormal, et obtenant des informations continues anormales dans une période de temps prédéfinie suivant le temps de déclenchement pour chaque point anormal de déclenchement ; sur la base de règles d'alarme prédéfinies, obtenant plusieurs valeurs d'alarme anormales
20 correspondant au pack de batteries, et les enregistrant sur une plateforme de surveillance correspondante ;

25 Un module de traitement de l'information : traitant les informations enregistrées sous différentes alarmes anormales pour le même pack de batteries dans la plateforme de surveillance afin d'identifier les zones anormales fréquemment rencontrées et établir un schéma de détection pour le pack de batteries.

2. Le système de surveillance intelligent pour un pack de batteries de sous-station selon la revendication 1, dans lequel le module d'acquisition de données comprend :

Une unité de numérotation d'accès : attribuant un premier numéro d'accès pour

le port d'accès du pack de batteries selon différents types, et attribuant un second numéro d'accès pour les différents types de dispositifs de mesure à connecter ;

Une unité d'appariement de dispositifs : avant de connecter le dispositif de mesure, effectuant une correspondance un à un entre le premier numéro d'accès et le second numéro d'accès pour l'acquisition ultérieure des paramètres du pack de batteries.

3. Le système de surveillance intelligent pour un pack de batteries de sous-station selon la revendication 1, dans lequel le module d'acquisition de données comprend également :

Une unité de classification des paramètres : classifiant les paramètres de fonctionnement de base collectés par le dispositif de mesure en différents types de paramètres en fonction de leur signification physique ;

Une unité de traitement des paramètres : effectuant un prétraitement des paramètres de fonctionnement de base selon les différents types de paramètres pour obtenir les premiers paramètres de fonctionnement correspondants.

4. Le système de surveillance intelligent pour un pack de batteries de sous-station selon la revendication 3, dans lequel le module d'analyse de données comprend :

Une unité d'appariement : effectuant une correspondance temporelle sur les premiers paramètres de fonctionnement correspondant au même type de paramètre à différents intervalles de temps pour obtenir un ensemble de paramètres appariés $[(x_1, t_1), (x_2, t_2) \cdots (x_n, t_n)]$, où t_n représente l'intervalle de temps apparié par le n-ième paramètre x_n , t_1 représente l'intervalle de temps apparié par le premier paramètre x_1 , et t_2 représente l'intervalle de temps apparié par le second paramètre x_2 ;

Une unité de standardisation : standardisant l'ensemble des paramètres actuels pour obtenir l'ensemble de paramètres de fonctionnement standardisé correspondant $[(x'_1, t_0), (x'_2, t_0) \cdots (x'_n, t_0)]$;

Où l'intervalle de temps de chaque paramètre est standardisé comme suit :

$$t_0 = \begin{cases} \frac{1}{n} \times \sum_{i=1}^n t_i \times (1 + \delta 1^2), \frac{\left(\frac{t_i - t_{min}}{t_{max} - t_{min}}\right)_{max}}{\frac{1}{n} \sum_{i=1}^n \frac{t_i - t_{min}}{t_{max} - t_{min}}} \geq 1.3 \\ \frac{1}{n} \times \sum_{i=1}^n t_i \times (1 - \delta 1^2), \frac{\left(\frac{t_i - t_{min}}{t_{max} - t_{min}}\right)_{max}}{\frac{1}{n} \sum_{i=1}^n \frac{t_i - t_{min}}{t_{max} - t_{min}}} < 1.3 \end{cases}$$

Où t_i représente l'intervalle de temps apparié par le i-ème paramètre x_i ; t_0 représente l'intervalle de temps standardisé ; $\delta 1^2$ représente la variance basée sur tous les $\frac{t_i - t_{min}}{t_{max} - t_{min}}$; et $\left(\frac{t_i - t_{min}}{t_{max} - t_{min}}\right)_{max}$ représente la valeur maximale parmi tous les

5 $\frac{t_i - t_{min}}{t_{max} - t_{min}}$;

Sur la base de l'intervalle de temps standardisé, le paramètre standardisé correspondant est obtenu comme suit :

$$x'_i = \left(x_i + \frac{\sqrt{\sum (x_i - x_{avg})^2}}{n} \right) \times t_0$$

Où x'_i représente le paramètre standardisé apparié du i-ème paramètre x_i .

10

5. Le système de surveillance intelligent pour un pack de batteries de sous-station selon la revendication 4, dans lequel le module d'analyse de données comprend également :

15 Une unité de paramètres caractéristiques : obtenant la variance et la moyenne de l'ensemble de paramètres de fonctionnement standardisé sous le type de paramètre correspondant et calculant le paramètre caractéristique de l'ensemble de paramètres de fonctionnement standardisé :

$$x_0 = \frac{|(x_{max} - \sigma) + (x_{min} - \sigma)|}{n \times \varepsilon + 0.5} + \ln\left(\frac{x_{max}}{x_{min} + \varepsilon} + 1\right)$$

20 Où x_0 représente le paramètre caractéristique sous le type de paramètre correspondant, x_{max} représente la valeur maximale du paramètre dans l'ensemble de paramètres de fonctionnement standardisé, x_{min} représente la valeur minimale du paramètre, σ représente la moyenne, et ε représente la variance de l'ensemble de paramètres de fonctionnement standardisé ;

Une unité de construction de tendance : traçant les paramètres de l'ensemble de paramètres de fonctionnement standardisé en fonction des intervalles de temps pour obtenir une image discrète de type point et obtenant la pente et la forme de la courbe de la ligne de tendance de cette image discrète.

5

6. Le système de surveillance intelligent pour un pack de batteries de sous-station selon la revendication 5, dans lequel l'unité de construction de tendance comprend :

Une sous-unité de construction d'équation : sélectionnant des observations de l'image discrète de type point qui répondent à la norme d'observation et construisant une équation initiale de tendance de la ligne de tendance de cette image discrète :

10

$$a_1 \times r^{t_1} + a_2 \times r^{t_2} + \dots + a_m \times r^{t_m} + e = y(r)$$

Où a_1 représente la première valeur d'observation de la ligne de tendance ; a_2 représente la seconde valeur d'observation ; a_m représente la m-ième valeur d'observation ; r^{t_1} représente le temps d'observation de la première valeur d'observation ; r^{t_2} représente le temps d'observation de la seconde valeur d'observation ; r^{t_m} représente le temps d'observation de la m-ième valeur d'observation ; $y(r)$ représente l'équation initiale de tendance ; e représente la constante de l'équation de tendance ;

15

Une analyse itérative est effectuée sur les observations et la constante de l'équation de tendance à l'aide de la formule suivante pour calculer les valeurs d'itération des observations correspondantes et la constante itérative de l'équation de tendance :

20

$$S(e, a_j) = \sum (y_j - e - a_j \times r^{t_j})$$

Où, en prenant les dérivées partielles de e et a_j , en les annulant, et en résolvant la constante itérative e' de e et la valeur itérative a'_j de a_j ; $S(e, a_j)$ est la fonction d'analyse itérative ; y_j représente l'équation initiale de tendance de la j-ième valeur d'observation a_j ; r^{t_j} représente le temps d'observation de la j-ième valeur d'observation a_j , avec j prenant les valeurs 1,2,3,...,m ;

25

Sur la base des résultats itératifs, l'équation finale de tendance $y'(r)$ est obtenue comme suit :

$$a'_1 \times r^{t_1} + a'_2 \times r^{t_2} + \dots + a'_m \times r^{t_m} + e' = y'(r)$$

À partir de l'équation finale de tendance, la pente et la forme de la courbe de la
5 ligne de tendance à chaque point dans le temps correspondant aux seconds paramètres de fonctionnement sont obtenues.

7. Le système de surveillance intelligent pour un pack de batteries de sous-station selon la revendication 1, dans lequel le module de détermination de valeur comprend :

10 Une unité de détermination d'analyse : sur la base de la pente et de la forme de la courbe à chaque point dans le temps correspondant aux seconds paramètres de fonctionnement sous le même type de paramètre, déterminant la valeur d'analyse au point dans le temps correspondant ;

15 Une unité de marquage temporel : déterminant si le point de localisation de détection correspondant au second paramètre de fonctionnement dans le pack de batteries est un point anormal de déclenchement en combinant la valeur d'analyse ; s'il l'est, marquant le point de localisation de détection dans le temps ;

20 Une unité de détermination : déterminant le premier point marqué à partir des résultats de marquage comme le temps de déclenchement du point anormal de déclenchement correspondant.

8. Le système de surveillance intelligent pour un pack de batteries de sous-station selon la revendication 1, dans lequel le module de traitement de l'information comprend :

25 Une unité d'extraction de caractéristiques : intégrant les informations du même pack de batteries sous des conditions d'alarme de différents types de paramètres pour extraire le type de caractéristique et le temps de caractéristique de chaque partie anormale de paramètre, classifiant selon le tableau standard des données de surveillance prédéfinies pour le pack de batteries ;

30 Une unité d'extraction anormale : construisant un tableau d'informations sur les

caractéristiques anormales correspondant aux différents types de paramètres du pack de batteries et, sur la base des parties et des temps anormaux fréquemment rencontrés, déterminant les parties du pack de batteries nécessitant inspection et maintenance et identifiant les états anormaux.

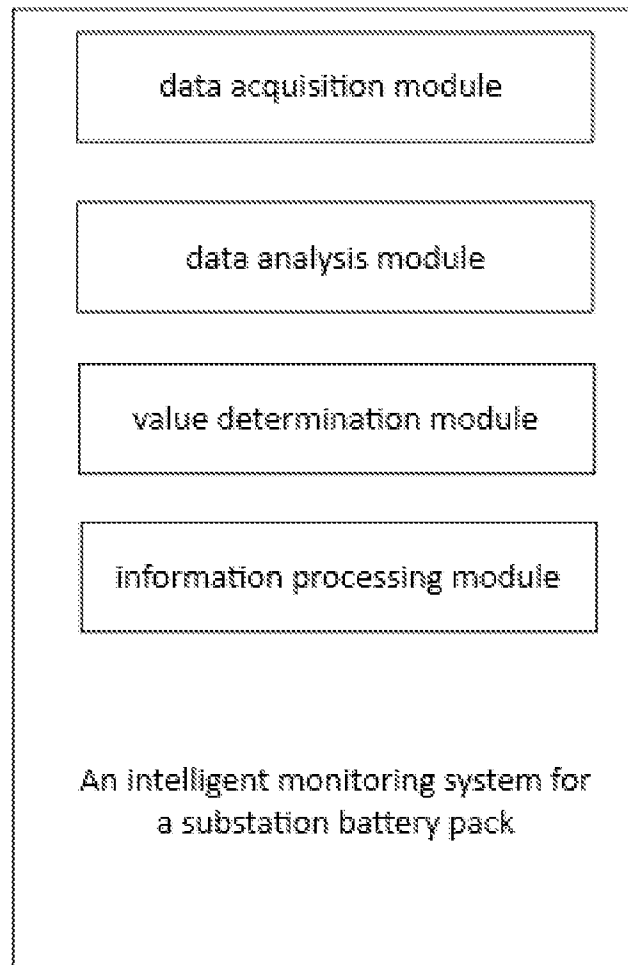


FIG.1