CLAIMS

What is claimed is:

1. A method for detecting a yaw-to-wind abnormality, comprising:

(a) acquiring a wind direction deviation angle within a specified time period, wherein the wind direction deviation angle is an angle defined between a wind direction and a central axis of a nacelle of a wind turbine;

(b) calculating a power performance index, wherein the power performance index is a dimensionless number to characterize power generation performance of the wind turbine;

determining an optimal wind direction deviation angle based on the power performance index,

(i) wherein the optimal wind direction deviation angle is a wind direction deviation angle corresponding to optimal power generation performance of the wind turbine within the specified time period; and

(ii) wherein determining the optimal deviation angle based on the power performance index comprises:

(1) dividing the wind direction deviation angle into m angular intervals, wherein m is a positive integer greater than 1, and each angular interval comprises at least one wind direction deviation angle, wherein the wind direction deviation angle one-to-one corresponds to the power performance index;

(2) calculating an average value of power performance indices of an i^{th} angular interval among the m angular intervals;

(3) determining a confidence interval corresponding to the i^{th} angular interval based on the average value and a preset confidence probability;

(4) comparing lower boundary values of confidence intervals corresponding to the m angular intervals;

(5) determining an angular interval corresponding to a confidence interval with a maximum lower boundary value as an optimal angular interval, wherein the optimal angular interval is an angular interval which the optimal deviation angle

falls within; and

(6) determining a lower boundary value of the optimal angular interval as the optimal deviation angle.

(c) determining a current wind direction deviation angle according to probability distribution of the wind direction deviation angle, wherein the current wind direction deviation angle is a wind direction deviation angle with a greatest probability of occurrence within the specified time period; and

(d) determining that the yaw-to-wind abnormality is detected if a difference between the optimal wind direction deviation angle and the current wind direction deviation angle is greater than a preset threshold.

2. The method according to claim 1, wherein before acquiring the wind direction deviation angle, the method further comprises:

acquiring raw data of the wind turbine within the specified time period, wherein the raw data of the wind turbine comprises operating data of the wind turbine, environmental data of the wind turbine, and operating data of adjacent wind turbines, wherein the operating data of the wind turbine comprises a raw output power of the wind turbine; and

calculating the power performance index comprises:

extracting data characteristics of the raw data of the wind turbine;

acquiring an expected output power of the wind turbine based on the data characteristics of the raw data of the wind turbine by invoking a power regression model; and

acquiring the power performance index based on the expected output power of the wind turbine and the raw output power of the wind turbine.

3. The method according to claim 2, wherein after acquiring the raw data of the wind turbine, the method further comprises:

acquiring cleaned data by cleaning the raw data of the wind turbine, wherein the cleaning is to remove abnormal data in the raw data of the wind turbine, and the abnormal data comprises at least one of: stuck data, overrun data, and data that does not conform to physical

principles; and

acquiring the expected output power of the wind turbine based on the data characteristics of the raw data of the wind turbine by invoking the power regression model if a data volume of the cleaned data is greater than a preset data volume.

4. The method according to claim 3, wherein acquiring the cleaned data by cleaning the raw data of the wind turbine comprises:

acquiring the cleaned data by single-point cleaning the raw data of the wind turbine, wherein in the single-point leaning, only target data is taken into consideration in detecting whether the target data is abnormal; and/or

acquiring the cleaned data by multi-point cleaning the raw data of the wind turbine, wherein in the multi-point cleaning, both target data and at least one piece of other data are taken into consideration in detecting whether the target data is abnormal.

~~6~~5. The method according to claim 1, wherein determining the current wind direction deviation angle according to the probability distribution of the wind direction deviation angle comprises:

determining an angular interval with a maximum probability value among the m angular intervals as the current deviation angle; or

determining an angular interval corresponding to a median of the wind direction deviation angles of the m angular intervals as the current deviation angle.

6. The method according to any one of claims 1 to 5, wherein after determining the current deviation angle, the method further comprises:

calculating a percentage of a data volume of the optimal angular interval; and

determining whether the difference between the optimal deviation angle and the current deviation angle meets the preset threshold if the percentage is greater than a preset percentage.

7. An apparatus for detecting a yaw-to-wind abnormality, comprising:

(a) a deviation angle acquiring module, configured to acquire a wind direction deviation

angle within a specified time period, wherein the wind direction deviation angle is an angle defined between a wind direction and a central axis of a nacelle of a wind turbine;

(b) an index calculating module, configured to calculate a power performance index, wherein the power performance index is a dimensionless number to characterize power generation performance of the wind turbine;

(c) a first determining module, configured to determine an optimal wind direction deviation angle based on the power performance index,

(i) wherein the optimal wind direction deviation angle is a wind direction deviation angle corresponding to optimal power generation performance of the wind turbine within the specified time period; and

(ii) wherein, to determine the optimal deviation angle based on the power performance index, the first determining module is configured to:

(1) divide the wind direction deviation angle into m angular intervals, wherein m is a positive integer greater than 1, and each angular interval comprises at least one wind direction deviation angle, wherein the wind direction deviation angle one-to-one corresponds to the power performance index;

(2) calculate an average value of power performance indices of an i^{th} angular interval among the m angular intervals;

(3) determine a confidence interval corresponding to the i^{th} angular interval based on the average value and a preset confidence probability;

(4) compare lower boundary values of confidence intervals corresponding to the m angular intervals;

(5) determine an angular interval corresponding to a confidence interval with a maximum lower boundary value as an optimal angular interval, wherein the optimal angular interval is an angular interval which the optimal deviation angle falls within; and

(6) determine a lower boundary value of the optimal angular interval as the optimal deviation angle.

(d) a second determining module, configured to determine a current wind direction deviation angle according to probability distribution of the wind direction deviation angle,

wherein the current wind direction deviation angle is a wind direction deviation angle with a greatest probability of occurrence within the specified time period; and

(e) a result determining module, configured to determine that a yaw-to-wind abnormality is detected if a difference between the optimal wind direction deviation angle and the current wind direction deviation angle is greater than a preset threshold.

8. A computer device, comprising a processor and a memory storing at least one instruction, at least one program, a code set or an instruction set therein, wherein the at least one instruction, the at least program, the code set or the instruction set, when loaded and executed by the processor, causes the processor to perform steps of the method as defined in any one of claims 1 to 6.

9. A non-transitory computer-readable storage medium storing at least one computer program therein, wherein the at least one computer program, when loaded and run by a processor, causes the processor to perform steps of the method as defined in any one of claims 1 to 6.