

DESCRIPTION

Title of Invention

CONDITION ANALYZING DEVICE, DISPLAY METHOD, AND PROGRAM

5

TECHNICAL FIELD

[0001]

The present invention relates to a condition analyzing device, a display method,
10 and a program.

Priority is claimed on Japanese Patent Application No. 2017-019899, filed on
February 6, 2017, the content of which is incorporated herein by reference.

BACKGROUND ART

15

[0002]

In a facility such as a power plant, in order to monitor an operation condition of
a device, a current clamp is clamped at a predetermined location of the device, and a
current signal is measured. In this case, a monitoring device performs fast Fourier
transform on the measured current signal, so as to generate a frequency domain graph of
20 a current, and displays the frequency domain graph (for example, refer to Patent
Document 1). A checker observes the displayed frequency domain graph, and detects
and identifies an abnormality of the device. Specifically, the checker specifies a
parameter representing a predetermined operation of the device on the basis of an
observation result of the frequency domain graph, and specifies an operation condition
25 associated with the parameter.

Citation List

Patent Literature

[0003]

5 [Patent Document 1] Japanese Patent No. 5828948

DISCLOSURE OF INVENTION

Technical Problem

[0004]

10 However, reading the frequency domain graph requires skill, and thus it is difficult for a non-expert to identify a device condition from the frequency domain graph. The frequency domain graph represents an instantaneous condition of the device, but how a condition changes from the past condition is not represented in the frequency domain graph. Thus, it is difficult to predict a condition change of the device only by
15 observing the frequency domain graph. According to a parameter specified from the frequency domain graph, an operation condition associated with the parameter can be specified, but it is difficult to specify a condition not associated with an individual parameter.

An object of the present invention is to provide a condition analyzing device, a
20 display method, and a program capable of easily identifying a condition of a target equipment and a condition change.

Solution to Problem

[0005]

25 According to a first aspect of the present invention, there is provided a condition

analyzing device including a current acquisition unit that acquires a current signal flowing through a target equipment; a parameter calculation unit that is configured to calculate values of a plurality of parameters which change due to a condition of the target equipment and have a correlation between each parameter, on the basis of the current
5 signal at a timing related to a constant period; and a display information generating unit that is configured to generate display information in which a division line representing a predetermined threshold value used as a criteria of a condition for the target equipment, a first graphic representing values of the plurality of parameters related to a certain timing, and a second graphic representing a variation of values of the plurality of parameters
10 calculated at a different timing are arranged on a coordinate space by axis corresponding each parameter.

[0006]

According to a second aspect of the present invention, in the condition analyzing device according to the first aspect, the display information generating unit is configured
15 to generate the display information including a prescribed message in a case where at least one value of the plurality of parameters related to a different timing exceeds the threshold value.

[0007]

According to a third aspect, in the condition analyzing device according to the
20 first aspect, the display information generating unit is configured to make display form of the first graphic different from each other between a case where at least one value of the plurality of parameters related to a different timing exceeds the threshold value and a case where the at least one value does not exceed the threshold value.

[0008]

25 According to a fourth aspect, in the condition analyzing device according to any

one of the first to third aspects, a condition of the target equipment includes a normal condition in which the target equipment is normal, an abnormal condition in which the target equipment is abnormal, and a caution condition corresponding to a condition in which the condition of the target equipment transitions to the abnormal condition, and the display information generating unit is configured to generate the display information including a first division line for dividing the normal condition from the caution condition and a second division line for dividing the caution condition from the abnormal condition as the division line.

[0009]

According to a fifth aspect, in the condition analyzing device according to any one of the first to fourth aspects, the target equipment is a device including a motor rotating around a rotor and an auxiliary of rotating machine along with the rotor, and the plurality of parameters is a plurality of parameters selected from the group consisting of a parameter representing an overall condition of the target equipment, a parameter representing a condition of the rotor, a parameter representing a misalignment condition between the rotor and the auxiliary, a parameter representing an effective value of a current flowing through the motor, a parameter representing quality of a power supply related to the current, and a parameter representing a condition of the auxiliary.

[0010]

According to a sixth aspect of the present invention, a display method includes the steps of: acquiring a current signal flowing through a target equipment; calculating values of a plurality of parameters which change due to a condition of the target equipment and have a correlation between each parameter, on the basis of the current signal at a timing related to a constant period; calculating a variation of values of the plurality of parameters calculated at a different timing; and displaying display

information in which a division line representing a threshold value used as a criteria of a condition for the target equipment, a first graphic representing values of the plurality of parameters related to a certain timing, and a second graphic representing the variation are arranged on a coordinate space by axis corresponding each parameter.

5 [0011]

According to a seventh aspect of the present invention, there is provided a program causing a computer to execute the steps of: acquiring a current signal flowing through a target equipment; calculating values of a plurality of parameters which change due to a condition of the target equipment and have a correlation between each parameter,
10 on the basis of the current signal at a timing related to a constant period; calculating a variation of values of the plurality of parameters calculated at a different timing; and generating display information in which a division line representing a threshold value used as a criteria of a condition for the target equipment, a first graphic representing values of the plurality of parameters related to a certain timing, and a second graphic
15 representing the variation are arranged on a coordinate space by axis corresponding each parameter.

Advantageous Effects of Invention

[0012]

20 According to at least one of the aspects, the condition analyzing device is configured to calculate a parameter on the basis of a current signal, and generate display information for displaying the parameter along with a division line representing a threshold value. Consequently, it is possible to specify a condition of a target equipment on the basis of the displayed information without having skill. The condition analyzing
25 device is configured to generate display information for displaying a graphic representing

a variation of a parameter. Consequently, it is possible to recognize transition of a condition of a target equipment on the basis of the displayed information. The condition analyzing device disposes a graphic representing a parameter on a coordinate space with a plurality of parameters having a correlation between each parameter being each taken
 5 as an axis. Consequently, it is possible to specify a condition not associated with an individual parameter by visually recognizing bias of a parameter or a variation of the parameter.

BRIEF DESCRIPTION OF DRAWINGS

10 [0013]

FIG. 1 is a schematic diagram showing a configuration of a condition analyzing system according to a first embodiment.

FIG. 2 is a schematic block diagram showing a configuration of a condition analyzing device according to the first embodiment.

15 FIG. 3 is a diagram showing an example of information stored in a parameter storage unit according to the first embodiment.

FIG. 4 is a diagram showing an example of information stored in a threshold value storage unit according to the first embodiment.

FIG. 5 is a flowchart showing a current parameter calculation process performed
 20 by the condition analyzing device according to the first embodiment.

FIG. 6 is a flowchart showing a current parameter display process performed by the condition analyzing device according to the first embodiment.

FIG. 7 is a diagram showing an example of a graph indicating a relationship between a KI parameter and an Lpole parameter.

25 FIG. 8 is a diagram showing an example of a graph indicating a relationship

between an IHD parameter and a THD parameter.

FIG. 9 is a diagram showing an example of a graph indicating a relationship between the Lpole parameter and an Lshaft parameter.

FIG. 10 is a schematic block diagram showing a configuration of a computer
5 according to at least one embodiment.

BEST MODE FOR CARRYING OUT THE INVENTION

[0014]

Hereinafter, with reference to the drawings, a first embodiment will be described
10 in detail.

FIG. 1 is a schematic diagram showing a configuration of a condition analyzing system according to the first embodiment.

A condition analyzing system 1 according to the first embodiment includes a condition analyzing device 10, a display device 20, a target equipment 30, a three-phase
15 AC power supply 40, power lines 50, and clamp ammeters 60.

The condition analyzing device 10 according to the first embodiment displays information representing a condition of the target equipment 30 that is an inspection target on the display device 20. The target equipment 30 according to the first embodiment is a rotary machine system includes a motor driven by a three-phase AC
20 power supply, and an auxiliary such as a pump or a fan rotated along with a rotor of the motor. The target equipment 30 is connected to the three-phase AC power supply 40 via the power lines 50. The power lines 50 are clamped by the clamp ammeters 60. The condition analyzing system 1 includes three clamp ammeters 60, and the respective clamp ammeters 60 clamp different power lines. In other embodiments, the condition
25 analyzing system 1 may include one or two clamp ammeters 60, and may not measure a

part of current among the three power lines 50. The clamp ammeters 60 measure magnitudes of currents flowing through the power lines 50, and output the measured magnitudes to the condition analyzing device 10 as digital signals (current signals). The condition analyzing device 10 displays information representing a condition of the target equipment 30 on the display device 20 on the basis of the current signals received from the clamp ammeters 60.

[0015]

FIG. 2 is a schematic block diagram showing a configuration of the condition analyzing device according to the first embodiment.

10 The condition analyzing device 10 includes a current acquisition unit 11, a parameter calculation unit 12, a parameter storage unit 13, a threshold value storage unit 14, a graph generation unit 15, a transition detection unit 16, and a display control unit 17.

[0016]

15 The current acquisition unit 11 acquires current signals that flow to the target equipment 30 via the power lines 50, from the clamp ammeters 60.

[0017]

The parameter calculation unit 12 calculates values of a plurality of parameters changing depending on a condition of the target equipment 30 on the basis of the current signals acquired by the current acquisition unit 11, at a timing related to a constant period.

20 Hereinafter, a parameter calculated by the parameter calculation unit 12 will be referred to as a current parameter. Specific examples of current parameters will be described later. At least two of a plurality of current parameters calculated by the parameter calculation unit 12 are parameters having a correlation.

[0018]

25 The parameter storage unit 13 stores a value of a current parameter calculated by

the parameter calculation unit 12 in association with a calculation time.

[0019]

The threshold value storage unit 14 stores a threshold value used as a criteria of a condition for the target equipment 30 with respect to each current parameter. The types of conditions of the target equipment 30 according to the first embodiment include a normal condition in which the target equipment 30 is normal, an abnormal condition in which the target equipment 30 is abnormal, and a caution condition corresponding to a condition in which a condition of the target equipment 30 may transition to an abnormal condition. In other words, the threshold value storage unit 14 stores, with respect to each current parameter, a first threshold value for dividing a condition into a normal condition and a caution condition and a second threshold value for dividing a condition into a caution condition and an abnormal condition.

[0020]

The graph generation unit 15 generates a graph image representing the current parameter value calculated by the parameter calculation unit 12 and a variation from the previous current parameter value to the present current parameter value. The graph image is a graph in which two current parameters having a correlation are expressed on a longitudinal axis and a transverse axis. A division line representing a threshold value related to each current parameter, a plot (first graphic) representing values of the two current parameters, and an arrow (second graphic) representing a variation are disposed in the graph image.

[0021]

The transition detection unit 16 detects that a value of each current parameter changes to exceed a threshold value stored in the threshold value storage unit 14.

25 [0022]

The display control unit 17 generates display information to be output to the display device 20 on the basis of the graph screen generated by the graph generation unit and a detection result in the transition detection unit 16. The display control unit 17 is an example of a display information generating unit.

5 [0023]

Here, a description will be provided of a current parameter calculated by the parameter calculation unit 12 according to the first embodiment. The parameter calculation unit 12 according to the first embodiment calculates a KI parameter, an Lpole parameter, an Lshaft parameter, an Irms parameter, a THD parameter, an IHD parameter,
10 an Lx parameter, and an Iub parameter.

[0024]

The KI parameter is a parameter representing an overall condition of the target equipment 30. The KI parameter is a Kullback-Leibler information amount for an inspection amplitude probability density function $f_t(x)$ obtained from a current signal and
15 a reference amplitude probability density variable $f_r(x)$ of a reference sine signal waveform indicating a rated current of the motor. Specifically, the KI parameter is obtained according to the following Equation (1).

[0025]

[Equation 1]

$$KI = \int_{-\infty}^{\infty} f_r(x) \log \frac{f_r(x)}{f_t(x)} dx \quad \dots (1)$$

20

[0026]

The Lpole parameter is a parameter representing a condition of the rotor of the target equipment 30. The Lpole parameter is a magnitude of a peak of a sideband of a

current spectrum at a frequency position separated by a predetermined frequency with a current spectrum peak as a center, in a frequency spectrum obtained through frequency domain transform on a current signal. The sideband related to the Lpole parameter is a sideband that varies due to a pole passing frequency of the motor.

5 [0027]

The Lshaft parameter is a parameter representing misalignment conditions of the rotor and the auxiliary of the target equipment 30. The Lshaft parameter is obtained by using a magnitude of a peak of a sideband of a current spectrum at a frequency position separated by a predetermined frequency with a current spectrum peak as a center, in a
10 frequency spectrum obtained through frequency domain transform on a current signal. The sideband related to the Lshaft parameter is a sideband that varies due to an actual rotational frequency of the motor.

[0028]

The Irms parameter is a parameter for monitoring a rotary machine load and a
15 condition variation of the target equipment 30. The Irms parameter is a current effective value that is obtained by dividing a sum of squares of current values at respective sampling timings by the number of sampling timings, and by obtaining a root thereof.

[0029]

The IHD parameter is a ratio between the maximum harmonic component and a
20 power supply frequency component of a current signal. The IHD parameter may be obtained by extracting a harmonic component from a current signal and dividing the maximum value of the harmonic component in a preset order by a power supply frequency effective value.

The THD parameter a ratio between all harmonic components and a power
25 supply frequency component of a current signal. The THD parameter may be obtained

by extracting harmonic components from a current signal and dividing a root of a sum of squares of the respective harmonic components by a power supply frequency effective value of the current signal. Both of the IHD parameter and the THD parameter are parameters representing the quality of the three-phase AC power supply 40.

5 [0030]

The Lx parameter is a parameter representing a condition of the auxiliary of the target equipment 30. The Lx parameter is a magnitude of a peak of a sideband of a current spectrum at a frequency position separated by a predetermined frequency with a current spectrum peak as a center, in a frequency spectrum obtained through frequency
10 domain transform on a current signal. The sideband related to the Lx parameter is a sideband that varies due to a blade passing frequency of a pump or a blower, a sideband that varies due to an engagement frequency of a gear device, a sideband that varies due to a rotational frequency of a pulley belt, or a sideband that varies due to a slip frequency of a rotor bar.

15 The Lx parameter indicated by a magnitude of a peak of a sideband that varies due to a blade passing frequency of the pump or the blower will be referred to as an Lbp parameter. The Lx parameter indicated by a magnitude of a peak of a sideband that varies due to an engagement parameter of the gear device will be referred to as an Lgz parameter. The Lx parameter indicated by a magnitude of a peak of a sideband that
20 varies due to a rotational frequency of the pulley belt will be referred to as an Lbr parameter. The Lx parameter indicated by a magnitude of a peak of a sideband that varies due to a slip frequency of the rotor bar will be referred to as an Lrs parameter. The pump, the blower, the gear device, the pulley belt, and the rotor bar are examples of auxiliaries of the target equipment 30.

25 [0031]

The Iub parameter is a parameter representing power supply quality or a deterioration status of a stator and an inverter of the motor. The Iub parameter may be obtained by dividing a difference between the maximum value and the minimum value of current effective values of three-phase current signals by a sum of the maximum value and the minimum value. In other words, the Iub parameter is a parameter representing a three-phase current balance of current signals.

[0032]

The KI parameter increases in a case where a condition of the rotor deteriorates, and the Lpole parameter decreases in a case where a condition of the rotor deteriorates.

10 In other words, the KI parameter and the Lpole parameter has a correlation with respect to a condition of the rotor of the target equipment 30.

The KI parameter increases in a case where an unbalance condition of a shaft system of the motor deteriorates, and the Lshaft parameter and the various Lx parameters decrease in a case where an unbalance condition of the shaft system of the motor

15 deteriorates. In other words, the KI parameter and the Lshaft parameter and the various Lx parameters have a correlation with respect to an unbalance condition of the shaft system of the motor of the target equipment 30. The KI parameter increases in a case where a misalignment condition of the shaft system of the motor deteriorates, and the Lshaft parameter decreases in a case where a misalignment condition of the shaft system
20 of the motor deteriorates. In other words, the KI parameter and the Lshaft parameter have a correlation with respect to a misalignment condition of the shaft system of the motor of the target equipment 30.

Both of the KI parameter and the Irms parameter increase in a case where a load variation condition deteriorates. In other words, the KI parameter and the Irms parameter
25 have a correlation with respect to a load variation condition of the target equipment 30.

The KI parameter, the THD parameter, the IHD parameter, and the Iub parameter all increase in a case where a condition of the stator of the motor or power supply quality deteriorates. In other words, the KI parameter, the THD parameter, the IHD parameter, and the Iub parameter have a correlation with respect to a condition of the stator or power supply quality of the target equipment 30.

Both of the Lpole parameter and the Lshaft parameter decrease in a case where a condition of the motor deteriorates. In other words, the Lpole parameter and the Lshaft parameter have a correlation with respect to a condition of the rotor of the target equipment 30.

10 [0033]

FIG. 3 is a diagram showing an example of information stored in the parameter storage unit according to the first embodiment.

As shown in FIG. 3, for each measurement time point that is a timing related to a constant period (for example, half a day or a day), the parameter storage unit 13 stores the measurement time point, the KI parameter, the Lpole parameter, the Lshaft parameter, the Irms parameter, the THD parameter, the IHD parameter, the Lx parameter, and the Iub parameter to be associated with each other.

[0034]

FIG. 4 is a diagram showing an example of information stored in the threshold value storage unit according to the first embodiment.

As shown in FIG. 4, the threshold value storage unit 14 stores the range of the value for a normal condition, the range of the value for a caution condition, and the range of the value for an abnormal condition for each of the KI parameter, the Lpole parameter, the Lshaft parameter, the Irms parameter, the THD parameter, the IHD parameter, the Lx parameter, and the Iub parameter. A threshold value for separating the range of the value

for a normal condition from the range of the value for a caution condition is a first condition threshold value, and a threshold value for separating the range of the value for a caution condition from the range of the value for an abnormal condition is a second threshold value. In other words, storing the range of the value for a normal condition, the range of the value for a caution condition, and the range of the value for an abnormal condition is equivalent to storing the first threshold value and the second threshold value.

[0035]

In the first embodiment, the range of the value for a normal condition, the range of the value for a caution condition, and the range of the value for an abnormal condition for each current parameter are as follows. The following ranges are only examples, and are not limited thereto in other embodiments.

[0036]

The range of the value of the KI parameter for a normal condition is less than 1.0. The range of the value of the KI parameter for a caution condition is equal to or more than 1.0 and less than 1.5. The range of the value of the KI parameter for an abnormal condition is more than 1.5. In other words, the first threshold value related to the KI parameter is 1.0, and the second threshold value related to the KI parameter is 1.5.

[0037]

The range of the value of the Lpole parameter for a normal condition is more than 50 dB. The range of the value of the Lpole parameter for a caution condition is more than 40 dB and equal to or less than 50 dB. The range of the value of the Lpole parameter for an abnormal condition is equal to or less than 40 dB. In other words, the first threshold value related to the Lpole parameter is 50 dB, and the second threshold value related to the Lpole parameter is 40 dB.

[0038]

The range of the value of the Lshaft parameter for a normal condition is more than 50 dB. The range of the value of the Lshaft parameter for a caution condition is more than 40 dB and equal to or less than 50 dB. The range of the value of the Lshaft parameter for an abnormal condition is equal to or less than 40 dB. In other words, the first threshold value related to the Lshaft parameter is 50 dB, and the second threshold value related to the Lshaft parameter is 40 dB.

[0039]

The range of the value of the Irms parameter for a normal condition is less than variation $\pm 10\%$. The range of the value of the Irms parameter for a caution condition is equal to or more than variation $\pm 10\%$ and less than variation $\pm 20\%$. The range of the value of the Irms parameter for an abnormal condition is equal to or more than variation $\pm 20\%$. In other words, the first threshold value related to the Irms parameter is variation $\pm 10\%$, and the second threshold value related to the Irms parameter is variation $\pm 20\%$.

[0040]

The range of the value of the THD parameter for a normal condition is less than 5%. The range of the value of the THD parameter for a caution condition is equal to or more than 5% and less than 10%. The range of the value of the THD parameter for an abnormal condition is equal to or more than 10%. In other words, the first threshold value related to the THD parameter is 5%, and the second threshold value related to the THD parameter is 10%.

[0041]

The range of the value of the IHD parameter for a normal condition is less than 3%. The range of the value of the IHD parameter for a caution condition is equal to or more than 3% and less than 5%. The range of the value of the IHD parameter for an

abnormal condition is equal to or more than 5%. In other words, the first threshold value related to the IHD parameter is 3%, and the second threshold value related to the IHD parameter is 5%.

[0042]

5 The range of the value of the Lx parameter for a normal condition is more than 50 dB. The range of the value of the Lx parameter for a caution condition is more than 40 dB and equal to or less than 50 dB. The range of the value of the Lx parameter for an abnormal condition is equal to or less than 40 dB. In other words, the first threshold value related to the Lx parameter is 50 dB, and the second threshold value related to the
10 Lx parameter is 40 dB.

[0043]

 The range of the value of the Iub parameter for a normal condition is less than 3%. The range of the value of the Iub parameter for a caution condition is equal to or more than 3% and less than 5%. The range of the value of the Iub parameter for an
15 abnormal condition is equal to or more than 5%. In other words, the first threshold value related to the Iub parameter is 3%, and the second threshold value related to the Iub parameter is 5%.

[0044]

 Here, a description will be made of an operation of the condition analyzing
20 device 10 according to the first embodiment.

 FIG. 5 is a flowchart showing a current parameter calculation process performed by the condition analyzing device according to the first embodiment.

 The condition analyzing device 10 performs a current parameter calculation process for each timing related to a constant period. The current acquisition unit 11 of
25 the condition analyzing device 10 acquires a current signal from the clamp ammeter 60

(step S1). The current acquisition unit 11 acquires the current signal for each sampling timing, and thus the current signal acquired by the current acquisition unit 11 indicates a change of a magnitude of a current in a predetermined period. Next, the parameter calculation unit 12 performs frequency domain transform on the current signal so as to generate a frequency domain waveform (step S2). A method of the frequency domain transform may include FFT.

The parameter calculation unit 12 calculates a current parameter on the basis of the current signal acquired step S1 and the frequency domain waveform generated in step S2 (step S3). The parameter calculation unit 12 records the calculated current parameter in the parameter storage unit 13 in association with the present time (step S4).

The condition analyzing device 10 performs the current parameter calculation process for each timing related to a constant period, and can thus record a time series of the current parameters in the parameter storage unit 13.

[0045]

FIG. 6 is a flowchart showing a current parameter display process performed by the condition analyzing device according to the first embodiment.

In a case where an instruction for displaying current parameters is given according to a user's operation, the condition analyzing device 10 receives input of a set of display target current parameters (step S11). The input of a set of current parameters is performed by receiving the user's selection from a list of current parameter pairs (for example, a pair of the Lshaft parameter and the Lpole parameter, a pair of the THD parameter and the IHD parameter, and a pair of the KI parameter and the Lx parameter) having a correlation between each parameter set in advance in the condition analyzing device 10. In other embodiments, the input of a set of current parameters may be performed by the user inputting any two parameters.

[0046]

Next, the graph generation unit 15 of the condition analyzing device 10 draws a coordinate space with the respective current parameters related to the selected pair as axes G1 (step S12). In other words, the graph generation unit 15 draws the axes G1
 5 orthogonal to each other expressing the current parameters forming the pair. In the present embodiment, the term “draw” indicates that graphics are arranged in a virtual space (virtual plane). Next, the graph generation unit 15 reads a first threshold value and a second threshold value associated with each current parameter related to the selected pair from the threshold value storage unit 14, and draws a division line G2 (first division
 10 line) representing the first threshold value and a division line G2 (second division line) representing the second threshold value (step S13). The division line G2 representing a threshold value related to a certain current parameter is a line parallel to the axis G1 representing the certain current parameter. Next, the graph generation unit 15 draws a plot G3 representing values of the respective current parameters related to the selected
 15 pair, the values (values after being changed) being recorded last in the parameter storage unit 13, on the coordinate space (step S14).

[0047]

Next, the graph generation unit 15 draws an arrow G4 extending from a coordinate representing values of the respective current parameters related to the selected
 20 pair, the values (values before being changed) being recorded second from last in the parameter storage unit 13, to a coordinate representing the values after being changed on the coordinate space (step S15). In this case, a difference between a measurement time point associated with the values before being changed and a measurement time point associated with the values after being changed is the same as a time related to a constant
 25 period. The arrow G4 becomes longer as the difference between the values before being

changed and the values after being changed increases. In other words, the arrow G4 becomes longer as a variation of a current parameter increases.

[0048]

Next, the transition detection unit 16 determines whether or not at least one
 5 value of the current parameters related to the selected pair changes to exceed the first threshold value or the second threshold value on the basis of the first threshold value and the second threshold value stored in the threshold value storage unit 14 (step S16). In a case where the value of the current parameter changes to exceed the first threshold value or the second threshold value (step S16: YES), the graph generation unit 15 draws a
 10 prescribed message (for example, “a condition of the target equipment 30 has changed to a caution condition”) (step S17). The message is continuously displayed until a predetermined time elapses from a timing at which the value of the current parameter exceeds the threshold value. In other embodiments, a prescribed message may be drawn only in a case where the value of the current parameter changes to exceed the first
 15 threshold value or the second threshold value and thus a condition deteriorates. In other embodiments, a display form of the plot G3 may be made different instead of drawing a prescribed message. Examples of a display form of the plot G3 may include a color of the plot G3, a size of the plot G3, and the presence or absence of blinking of the plot G3.

In a case where the value of the current parameter does not exceed the first
 20 threshold value and the second threshold value (step S16: NO), the graph generation unit 15 does not draw a prescribed message.

[0049]

The display control unit 17 generates display information on the basis of the graphic drawn by the graph generation unit 15, and outputs the display information to the
 25 display device 20 (step S18). Consequently, the display device 20 displays a graph in

which the division line G2 representing the threshold values of the current parameters, the plot G3 representing values of the pair of current parameters, and the arrow G4 representing a variation of values of the current parameters calculated at different timings are disposed.

5 [0050]

FIG. 7 is a diagram showing an example of a graph indicating a relationship between the KI parameter and the Lpole parameter.

In a case where the user selects a pair of the KI parameter and the Lpole parameter in step S11, a graph as shown in FIG. 7 is displayed on the display device 20.

10 According to the graph shown in FIG. 7, it is possible to determine a condition of the target equipment 30 on the basis of the KI parameter and the Lpole parameter. The KI parameter and the Lpole parameter have a correlation with respect to a condition of the rotor of the target equipment 30. Thus, the user can easily check a condition of the rotor of the target equipment 30 from the graph shown in FIG. 7. Specifically, the KI
15 parameter increases in a case where a condition of the rotor deteriorates, and the Lpole parameter decreases in a case where a condition of the rotor deteriorates. In other words, in a case where a condition of the rotor deteriorates, typically, a position of the plot G3 moves in a lower right direction. On the other hand, in a case where a movement direction of the plot G3 is not the lower right direction, it is possible to be determined
20 that an event that is different from normal deterioration in the rotor occurs. In a case where the user selects a pair of the KI parameter and the Lshaft parameter, and in a case where the user selects the KI parameter and the Lx parameter, a graph similar to the graph shown in FIG. 7 is displayed on the display device 20.

[0051]

25 FIG. 8 is a diagram showing an example of a graph indicating a relationship

between the IHD parameter and the THD parameter.

In a case where the user selects a pair of the IHD parameter and the THD parameter in step S11, a graph as shown in FIG. 8 is displayed on the display device 20.

According to the graph shown in FIG. 8, it is possible to determine a condition of the

5 target equipment 30 on the basis of the IHD parameter and the THD parameter. The IHD parameter and the THD parameter have a correlation with respect to a condition of the stator of the motor or power supply quality of the target equipment 30. Thus, the user can easily check a condition of the stator of the motor or power supply quality of the target equipment 30 from the graph shown in FIG. 8. Specifically, the IHD parameter and the THD parameter increase in a case where a condition of the stator of the motor or power supply quality deteriorates. In other words, in a case where a condition of the stator or power supply quality deteriorates, typically, a position of the plot G3 moves in a lower right direction. On the other hand, in a case where a movement direction of the plot G3 is not the lower right direction, it is possible to be determined that an event that is different from normal deterioration in a condition of the stator of the motor or power supply quality occurs.

[0052]

FIG. 9 is a diagram showing an example of a graph indicating a relationship between the Lpole parameter and the Lshaft parameter.

20 In a case where the user selects a pair of the Lpole parameter and the Lshaft parameter in step S11, a graph as shown in FIG. 9 is displayed on the display device 20.

According to the graph shown in FIG. 9, it is possible to determine a condition of the

target equipment 30 on the basis of the Lpole parameter and the Lshaft. The Lpole parameter and the Lshaft parameter have a correlation with respect to a condition of the

25 rotor of the target equipment 30. Thus, the user can easily check a condition of the rotor

of the target equipment 30 from the graph shown in FIG. 9. Specifically, the Lpole parameter and the Lshaft parameter decreases in a case where a motor condition deteriorates. Here, the Lpole parameter and the Lshaft parameter are parameters that change according to deterioration in different parts of the motor. Therefore, the user
 5 observes an inclination of a movement direction of the plot G3, and can thus estimate a location where abnormality occurs in the motor.

[0053]

In a case where a condition of the target equipment 30 indicated by each current parameter is desired to be checked, the user is only necessary to check the graph related
 10 to a pair of the KI parameter and the Lpole parameter, the graph related to a pair of the KI parameter and the Lshaft parameter, the graph related to a pair of the KI parameter and the Lx parameter, and the graph related to a pair of the IHD parameter and the THD parameter. Alternatively, the user may check the graph related to a pair of the Lpole
 15 parameter and the Lshaft parameter, the graph related to a pair of the KI parameter and the Lx parameter, and the graph related to a pair of the IHD parameter and the THD parameter.

[0054]

As mentioned above, according to the first embodiment, the condition analyzing device 10 generates display information in which the division line G2 representing a
 20 threshold value, the plot G3 representing values of current parameters, and the arrow G4 representing a variation of the values of the current parameters are arranged on a coordinate space with a plurality of current parameters that have a correlation with each other being each taken as an axis. Consequently, even if the user does not have skill in reading of a frequency domain graph, the user can recognize how a condition of the
 25 target equipment 30 changes. As described above, according to the first embodiment, the

user can recognize conditions other than conditions associated with the individual current parameters. In other embodiments, values of current parameters may be represented by a graphic other than the plot G3. For example, the arrow G4 of the first embodiment is a graphic representing a variation of a current parameter, but the head thereof indicates a value of a current parameter related to a certain timing, and thus the arrow G4 can be said to be a graphic representing the value of the current parameter. In other embodiments, a variation of a current parameter may be represented by a graphic other than the arrow G4. For example, a magnitude of a variation of a current parameter may be displayed in a chart form, and may be represented by a color of the plot G3.

10 [0055]

According to the first embodiment, in a case where at least one value of a plurality of parameters related to different timings exceeds a threshold value, the condition analyzing device 10 generates display information including a prescribed message. Consequently, the user can immediately recognize that a condition of the target equipment 30 has changed. In other embodiments, the condition analyzing device 10 may make display form of the plot G3 different from each other in cases where at least one value of a plurality of parameters related to different timings exceeds a threshold value and does not exceed the threshold value. With this configuration, in the same manner as in the first embodiment, the user can immediately recognize that a condition of the target equipment 30 has changed.

[0056]

As mentioned above, one embodiment has been described in detail with reference to the drawings, but a specific configuration is not limited to the above configurations, and various design changes may occur.

25 For example, the condition analyzing device 10 according to the embodiment

displays a graph related to a pair of current parameters on the display device 20, but is not limited thereto. For example, the condition analyzing device 10 according to other embodiments may display a high-order graph related to a set of three or more current parameters on the display device 20.

5 The condition analyzing device 10 according to the embodiment generates display information in which the division line G2 representing a threshold value and the plot G3 representing a value of a current parameter are arranged on a coordinate space with a plurality of current parameters that have a correlation with each other being each taken as an axis, but is not limited thereto. For example, the condition analyzing device
10 10 according to other embodiments may generate display information representing a value of a certain current parameter related to a certain time point and a variation thereof. In such embodiments, the user can also recognize how a condition of the target equipment 30 changes.

[0057]

15 The condition analyzing device 10 according to the embodiment performs display control by outputting display information to the display device 20 that is directly connected thereto, but is not limited thereto. For example, the condition analyzing device 10 according to other embodiments may not perform display control, and may record display information on a recording medium or transmit the display information to
20 another display device 20 connected thereto via a network.

[0058]

 The target equipment 30 according to the embodiment is a rotary machine system in which the motor and the auxiliary are coaxially rotated, but is not limited thereto. For example, the target equipment 30 according to other embodiments may have
25 a configuration in which the motor and the auxiliary are connected to each other via a

machine system such as a gear device.

[0059]

In the condition analyzing device 10 according to the embodiment, a condition of the target equipment 30 is classified into three categories such as a normal condition, an abnormal condition, and a caution condition, but is not limited thereto. For example, in the condition analyzing device 10 according to other embodiments, a condition of the target equipment may be classified into two categories such as a normal condition and an abnormal condition, and may be classified into four or more categories.

[0060]

FIG. 10 is a schematic block diagram showing a configuration of a computer according to at least one embodiment.

A computer 90 includes a CPU 91, a main storage device 92, an auxiliary storage device 93, and an interface 94.

The condition analyzing device 10 is mounted on the computer 90. The operation of each processing unit is stored in the auxiliary storage device 93 in the form of a program. The CPU 91 reads the program from the auxiliary storage device 93, develops the program on the main storage device 92, and performs the process according to the program. The CPU 91 secures a storage region corresponding to each storage unit in the main storage device 92 according to the program.

[0061]

Examples of the auxiliary storage device 93 may include a hard disk drive (HDD), a solid state drive (SSD), a magnetic disk, a magneto-optical disc, a compact disc read only memory (CD-ROM), a digital versatile disc read only memory (DVD-ROM), and a semiconductor memory. The auxiliary storage device 93 may be an internal medium directly connected to a bus of the computer 90, and may be an external medium

connected to the computer 90 via the interface 94 or a communication line. In a case where the program is delivered to the computer 90 via the communication line, the computer 90 may develop the delivered program on the main storage device 92, and may perform the process. In at least one embodiment, the auxiliary storage device 93 is an
 5 example of a non-transitory medium.

[0062]

The program may realize some of the functions. The program may be a so-called difference file (difference program) realizing the functions in combination with another program that is already stored in the auxiliary storage device 93.

10

Industrial Applicability

[0063]

The condition analyzing device, the display method, and the program according to the present specification enable a condition of a target equipment and a condition
 15 change thereof to be easily identified.

Reference Signs List

[0064]

1: CONDITION ANALYZING SYSTEM

20

10: CONDITION ANALYZING DEVICE

11: CURRENT ACQUISITION UNIT

12: PARAMETER CALCULATION UNIT

13: PARAMETER STORAGE UNIT

14: THRESHOLD VALUE STORAGE UNIT

25

15: GRAPH GENERATION UNIT

	16: TRANSITION DETECTION UNIT
	17: DISPLAY CONTROL UNIT
	20: DISPLAY DEVICE
	30: TARGET EQUIPMENT
5	40: THREE-PHASE AC POWER SUPPLY
	50: POWER LINE
	60: CLAMP AMMETER
	G1: AXIS
	G2: DIVISION LINE
10	G3: PLOT
	G4: ARROW

CLAIMS

What is claimed is:

1. A condition analyzing device comprising:
 - a current acquisition unit that acquires a current signal flowing through a target
 - 5 equipment;
 - a parameter calculation unit that is configured to calculate values of a plurality of parameters which change due to a condition of the target equipment and have a correlation between each parameter, on the basis of the current signal at a timing related to a constant period; and
 - 10 a display information generating unit that is configured to generate display information in which a division line representing a predetermined threshold value used as a criteria of a condition for the target equipment, a first graphic representing values of the plurality of parameters related to a certain timing, and a second graphic representing a variation of values of the plurality of parameters calculated at a different timing are
 - 15 arranged on a coordinate space by axis corresponding each parameter.
2. The condition analyzing device according to Claim 1,
 - wherein the display information generating unit is configured to generate the display information including a prescribed message in a case where at least one value of
 - 20 the plurality of parameters related to a different timing exceeds the threshold value.
3. The condition analyzing device according to Claim 1 or 2,
 - wherein the display information generating unit makes display form of the first graphic different from each other between a case where at least one value of the plurality
 - 25 of parameters related to a different timing exceeds the threshold value and a case where

the at least one value does not exceed the threshold value.

4. The condition analyzing device according to any one of Claims 1 to 3,
wherein a condition of the target equipment includes a normal condition in
5 which the target equipment is normal, an abnormal condition in which the target
equipment is abnormal, and a caution condition corresponding to a condition in which
the condition of the target equipment transitions to the abnormal condition, and
wherein the display information generating unit is configured to generate the
display information including a first division line for dividing the normal condition from
10 the caution condition and a second division line for dividing the caution condition from
the abnormal condition as the division line.

5. The condition analyzing device according to any one of Claims 1 to 4,
wherein the target equipment is a device including a motor rotating around a
15 rotor and an auxiliary of rotating machine along with the rotor, and
wherein the plurality of parameters are a plurality of parameters selected from
the group consisting of a parameter representing an overall condition of the target
equipment, a parameter representing a condition of the rotor, a parameter representing a
misalignment condition between the rotor and the auxiliary, a parameter representing an
20 effective value of a current flowing through the motor, a parameter representing quality
of a power supply related to the current, and a parameter representing a condition of the
auxiliary.

6. A display method comprising the steps of:
25 acquiring a current signal flowing through a target equipment;

calculating values of a plurality of parameters which change due to a condition of the target equipment and have a correlation between each parameter, on the basis of the current signal at a timing related to a constant period;

calculating a variation of values of the plurality of parameters calculated at a
5 different timing; and

displaying display information in which a division line representing a threshold value used as a criteria of a condition for the target equipment, a first graphic representing values of the plurality of parameters related to a certain timing, and a second graphic representing the variation are arranged on a coordinate space by axis
10 corresponding each parameter.

7. A program causing a computer to execute the steps of:

acquiring a current signal flowing through a target equipment;

calculating values of a plurality of parameters which change due to a condition
15 of the target equipment and have a correlation between each parameter, on the basis of the current signal at a timing related to a constant period;

calculating a variation of values of the plurality of parameters calculated at a different timing; and

generating display information in which a division line representing a threshold
20 value used as a criteria of a condition for the target equipment, a first graphic representing values of the plurality of parameters related to a certain timing, and a second graphic representing the variation are arranged on a coordinate space by axis corresponding each parameter.