

DESCRIPTION

Title of Invention

DISPLAY DEVICE, DISPLAY METHOD, CONTROL DEVICE, AND
COMPUTER PROGRAM

Technical Field

[0001]

The present invention relates to a display device, a display method, a control device, and a computer program.

Background Art

[0002]

In the related art, a sensor has been provided in target equipment to be monitored such as a plant to monitor an operating status of the target equipment to be monitored based on data acquired by the sensor. In a case where abnormality has occurred in the target equipment to be monitored, an alarm is issued, and guide information in which a countermeasure guideline is described is displayed to support an operator. The guide information is created by a skilled person by spending a large amount of time to thoroughly examine various types of information based on knowledge and experience of the skilled person.

[0003]

In addition, PTL 1 discloses a "plant operation history storage unit" (Paragraph [0038]) that "records an operation performed in each operation state", and a "plant monitoring device" that "classifies an operation history for each predetermined operation state" and that creates and displays "operation guide data indicating a recommended operation for each operation state" (Paragraph [0040]).

Citation List

Patent Literature

[0004]

[PTL 1] Japanese Unexamined Patent Publication No.
2014-32633

Summary of Invention

Technical Problem

[0005]

However, the guide information created based on the knowledge and the like of the skilled person is inevitably highly personal. Thus, an inexperienced operator cannot easily create the same guide information.

[0006]

In addition, the plant monitoring device disclosed in PTL 1 simply displays the recommended operation to be performed in a routine work such as excluding a device

under inspection from the target to be monitored, based on the operation history in the past. Meanwhile, the countermeasure guideline at a time of issuing the alarm generally does not involve a plant operation. Thus, it is difficult to create the guide information at the time of issuing the alarm based on the operation history of the plant in the past.

[0007]

Furthermore, while it is disclosed that the plant monitoring device disclosed in PTL 1 "selects an operation guide pattern to be referred to from an "operation guide selection pattern list" (Paragraph [0047] and Fig. 6), the operation guide pattern is simply acquired from the operation history of the plant in the past, and addition of new information is not permitted.

[0008]

Therefore, an object of the present invention is to provide a display device, a display method, a control device, and a computer program that enable even an inexperienced operator to easily add new guide information.

Solution to Problem

[0009]

The present disclosure provides a display device including a display screen, in which the display device is

configured to display a region for adding guide information to be displayed at a time of generating a warning related to an operating status of a plant on the display screen.

[0010]

Furthermore, the display device may be configured to display the guide information in a first region of the display screen, and display the region for adding the guide information in a second region that is parallel to the first region of the display screen.

[0011]

Furthermore, the display device may be configured to display at least one word included in information describing an operating status of the plant in the past, and display the information including the selected word on the display screen.

[0012]

Furthermore, the word may be extracted by executing a step of calculating a feature amount of the at least one word based on the information describing the operating status of the plant in the past, and a step of calculating importance of the at least one word based on the feature amount of the word, and the display device may be configured to display the word on the display screen together with the importance of the word.

[0013]

The present disclosure provides a display method including a step of displaying a region for adding guide information to be displayed at a time of generating a warning related to an operating status of a plant on a display screen of a display device.

[0014]

The present disclosure provides a control device that controls a display device including a display screen, in which the control device is configured to display a region for adding guide information to be displayed at a time of generating a warning related to an operating status of a plant on the display screen.

[0015]

The present disclosure provides a computer program causing a computer for controlling a display device including a display screen to execute a step of displaying a region for adding guide information to be displayed at a time of generating a warning related to an operating status of a plant on the display screen.

Brief Description of Drawings

[0016]

Fig. 1 is a schematic diagram illustrating an overall configuration of a plant.

Fig. 2 is a functional block diagram of the plant, a DCS, and an operation support system.

Fig. 3 is an example of guide information displayed on a display screen of a display device.

Fig. 4 is a functional block diagram of an important word extraction unit.

Fig. 5 is an example in which a list of excerpts from a daily operation log or the like and a free entry frame are parallelly displayed.

Fig. 6 is a diagram illustrating a physical configuration of an operation support system 30.

Fig. 7 is a flowchart of an operation support method including a display method according to the present embodiment.

Description of Embodiments

[0017]

Hereinafter, an embodiment of the present invention will be described using the drawings. The following embodiment is an illustration for describing the present invention, and the present invention is not intended to be limited to only the embodiment.

Target equipment to be monitored to which the present invention is applied includes a plant. For example, a plant such as a power generation plant including a boiler, an

incineration plant, a chemical plant, or a wastewater treatment plant in which process data can be acquired is targeted. In addition to the illustration of the process data in the power generation plant described in the following embodiment, the process data in the incineration plant of a waste or the like includes, for example, an input air amount and an input air temperature of an incineration furnace, a gas temperature and composition factors of a furnace outlet, and measurement data such as a temperature, a pressure, a flow rate, and a combustion state of each part measured by a sensor or the like. The process data in the chemical plant includes, for example, a difference in temperature between processes or between two or more thermocouples, an operation pressure, a product flow parameter (a velocity, density, or the like), a flow rate of cooling water, an output measurement value, and valve sensor data. The process data in the wastewater treatment plant includes, for example, raw water input and output flow rates of a tank, a water level, processed water quality, and manipulated variables of device operation of various pumps and the like output from each sensor and from each electricity meter.

[0018]

[Description of Plant]

Fig. 1 is a schematic diagram illustrating an overall configuration of a plant 1 that is an example of the target to be monitored to which the present invention is applied. For example, the plant 1 according to the present embodiment is a power generation plant including a circulating fluidized bed boiler (circulating fluidized bed type) that generates vapor by combusting fuel while circulating a circulation material such as silica sand that is fluidized at a high temperature. As the fuel of the plant 1, not only fossil fuel such as coal but also, for example, non-fossil fuel (woody biomass, waste tires, waste plastic, sludge, or the like) can be used. The vapor generated in the plant 1 is used for driving a turbine 100.

[0019]

The plant 1 is configured to combust the fuel in a furnace 2, separate the circulation material from exhaust gas via a cyclone 3 that functions as a solid-gas separation device, and return the separated circulation material to the furnace 2 to be circulated. The separated circulation material is sent back to a lower part of the furnace 2 via a circulation material recovery pipe 4 connected to a part below the cyclone 3. A lower part of the circulation material recovery pipe 4 and the lower part of the furnace 2 are connected through a loop seal part 4a in which a flow path is narrowed. Accordingly, the lower

part of the circulation material recovery pipe 4 is in a state where a predetermined amount of the circulation material is stored. The exhaust gas in which the circulation material is removed by the cyclone 3 is supplied to a rear flue 5 via an exhaust gas flow path 3a.

[0020]

The boiler includes the furnace 2 for combusting the fuel and a heat exchanger for generating water vapor or the like using heat obtained by combustion. A fuel feed port 2a through which the fuel is supplied is provided in a middle part of the furnace 2. A gas outlet 2b through which combustion gas is exhausted is provided in an upper part of the furnace 2. The fuel that is supplied to the furnace 2 from a fuel supply device, not illustrated, is supplied to the inside of the furnace 2 through the fuel feed port 2a. In addition, a furnace wall pipe 6 for heating boiler feedwater is provided in a furnace wall of the furnace 2. The boiler feedwater that flows through the furnace wall pipe 6 is heated by combustion in the furnace 2.

[0021]

In the furnace 2, a solid matter including the fuel supplied from the fuel feed port 2a is fluidized by air for combustion and fluidization introduced from an air supply line 2c in the lower part, and the fuel is combusted at, for example, approximately 800°C to 900°C while being

fluidized. The combustion gas generated in the furnace 2 is introduced into the cyclone 3 with the circulation material. The cyclone 3 separates the circulation material and gas from each other based on a centrifugal effect, returns the separated circulation material to the furnace 2 through the circulation material recovery pipe 4, and sends the combustion gas in which the circulation material is removed to the rear flue 5 from the exhaust gas flow path 3a.

[0022]

In the furnace 2, a part of the circulation material called an in-furnace bed material remains in a bottom part. The bed material may include a bed material or an exhaust impurity having a coarse particle size not suitable for circulation and fluidization. These bed materials not suitable as the circulation material may cause a fluidization failure. Thus, in order to suppress the fluidization failure, the in-furnace bed material is continuously or intermittently exhausted to the outside from an exhaust port 2d in the bottom part in the furnace 2. Metal or an unsuitable material having a coarse large particle size or the like is removed from the exhausted bed material on a circulation line, not illustrated. Then, the bed material is either supplied to the furnace 2 again or discarded. The circulation material of the furnace 2

circulates in a circulation system configured with the furnace 2, the cyclone 3, and the circulation material recovery pipe 4.

[0023]

The rear flue 5 has a flow path through which the gas exhausted from the cyclone 3 flows to a rear stage. The rear flue 5 includes, as an exhaust heat collection unit that collects heat of the exhaust gas, a superheater 10 that generates superheated vapor, and a coal economizer 12 that preheats the boiler feedwater. The exhaust gas flowing through the rear flue 5 is cooled by exchanging heat with the vapor or the boiler feedwater flowing through the superheater 10 and the coal economizer 12. In addition, a steam drum 8 in which the boiler feedwater that has passed through the coal economizer 12 is stored is provided. The steam drum 8 is also connected to the furnace wall pipe 6.

[0024]

The coal economizer 12 preheats the boiler feedwater by transferring the heat of the exhaust gas to the boiler feedwater. The coal economizer 12 is connected to a pump 7 by a pipe 21 and is connected to the steam drum 8 by a pipe 22. The boiler feedwater that is supplied to the coal economizer 12 from the pump 7 via the pipe 21 and that is preheated by the coal economizer 12 is supplied to the steam drum 8 via the pipe 22.

[0025]

A downcast pipe 8a and the furnace wall pipe 6 are connected to the steam drum 8. The boiler feedwater in the steam drum 8 moves down through the downcast pipe 8a to be introduced into the furnace wall pipe 6 on a lower part side of the furnace 2 and then, flows toward the steam drum 8. The boiler feedwater in the furnace wall pipe 6 is heated by combustion heat generated in the furnace 2 and evaporates into vapor in the steam drum 8.

[0026]

A saturated vapor pipe 8b through which the vapor inside the steam drum 8 is exhausted is connected to the steam drum 8. The saturated vapor pipe 8b connects the steam drum 8 to the superheater 10. The vapor in the steam drum 8 is supplied to the superheater 10 via the saturated vapor pipe 8b. The superheater 10 generates the superheated vapor by superheating the vapor using the heat of the exhaust gas. The superheated vapor is supplied to the turbine 100 outside the plant 1 through a pipe 10a and is used for power generation.

[0027]

A pressure and a temperature of the vapor exhausted from the turbine 100 are lower than a pressure and a temperature of the vapor exhausted from the superheater 10. The pressure and the temperature of the vapor supplied to

the turbine 100 are not particularly limited and are approximately 10 to 17 MPa and approximately 530°C to 570°C, respectively. The pressure and the temperature of the vapor exhausted from the turbine 100 are approximately 3 to 5 MPa and approximately 350°C to 400°C, respectively.

[0028]

A condenser 102 is provided downstream of the turbine 100. The vapor exhausted from the turbine 100 is supplied to the condenser 102 to be condensed into saturated water in the condenser 102 and then, is supplied to the pump 7. A generator that converts kinetic energy obtained by rotation of the turbine 100 into electrical energy is connected to the turbine 100.

[0029]

A pump 7a supplies makeup water in order to constantly maintain a water level of the condenser 102. In Fig. 1, a makeup water flow rate u_1 (an example of "process data") supplied by the pump 7a is illustrated.

[0030]

The process data handled in the present embodiment may be arbitrary data related to the plant 1. For example, the process data may be data (an example of the "process data") obtained by measuring a state of the plant 1 via a sensor and, more specifically, may include a measurement value such as a temperature, a pressure, and a flow rate of the

plant 1. In Fig. 1, a boiler feedwater flow rate u_2 (an example of the "process data") supplied to the coal economizer 12 from the pump 7 is illustrated. Furthermore, in Fig. 1, a boiler outlet vapor flow rate u_3 (an example of the "process data") supplied to the turbine 100 from the superheater 10 is illustrated, and a saturated vapor flow rate u_4 (an example of the "process data") supplied to the superheater 10 from the steam drum 8 is illustrated. The makeup water flow rate u_1 may be controlled in accordance with the saturated vapor flow rate u_4 . In addition, the boiler feedwater flow rate u_2 may be controlled to be adjusted while both of the boiler outlet vapor flow rate u_3 (or a superheated vapor flow rate) and a liquid surface level of the steam drum 8 are monitored.

[0031]

In a case where a hole has occurred in a pipe system constituting the plant 1, the makeup water flow rate u_1 rises, or a difference in flow rate between the boiler feedwater flow rate u_2 and the boiler outlet vapor flow rate u_3 is increased. A distributed control system (DCS; Fig. 2) 20 receives the process data of the plant 1 such as the makeup water flow rate u_1 , the boiler feedwater flow rate u_2 , the boiler outlet vapor flow rate u_3 , and the saturated vapor flow rate u_4 from the plant 1 to monitor an operating status of the plant 1 and to monitor whether or

not abnormality has occurred in the plant 1. As will be described later, a monitoring device 40 evaluates the process data based on an alarm determination logic set for each type of abnormality and, in a case where it is determined that abnormality has occurred, causes a display device 50 to issue an alarm.

[0032]

While the makeup water flow rate u_1 , the boiler feedwater flow rate u_2 , the boiler outlet vapor flow rate u_3 , and the saturated vapor flow rate u_4 are illustrated as the process data, the process data related to the plant 1 may be other data. The process data related to the plant 1 may be other data such as a temperature and a pressure or data calculated based on a plurality of pieces of the process data, or may be data that is acquired from the sensor or the like and that is not obtained by calculation processing.

[0033]

Fig. 2 is a functional block diagram of the plant 1, the DCS 20, and an operation support system 30 according to the present embodiment.

[0034]

The DCS 20 is a distributed control system for controlling the plant 1. The DCS 20 acquires the process data from the sensor or the like installed in the plant 1

and supplies a control signal for controlling the plant 1 based on the process data to the plant 1.

[0035]

The operation support system 30 includes an edge/cloud computing unit 32 that acquires the process data from the DCS 20, the monitoring device 40 that acquires the process data from the edge/cloud computing unit 32 and that monitors the plant 1 based on the process data, and the display device 50 that displays the operating status of the plant 1 for an operator. The monitoring device 40 (an example of a "control device") also functions as a control device that controls the display device 50. Specifically, the monitoring device 40 acquires the process data, determines whether or not abnormality is present based on the process data, and in a case where it is determined that abnormality has occurred, causes the display device 50 to issue an alarm (an example of a "warning"). In issuing the alarm, the monitoring device 40 acquires information such as guide information (described later) to be displayed in issuing the alarm from a database, described later, and displays the information on a display screen of the display device 50.

[0036]

The edge/cloud computing unit 32 includes a plurality of edge servers that are distributedly disposed in an edge

part of a network, and a cloud data server that collects the process data from the plurality of edge servers and that provides the process data to the monitoring device 40. By including the edge/cloud computing unit 32, the process data can be suitably collected from a large-scale monitoring device or from a plurality of distributed monitoring devices. However, the operation support system 30 may not include the edge/cloud computing unit 32. In this case, the operation support system 30 acquires the process data from the DCS 20 through the network.

[0037]

The monitoring device 40 includes an alarm display control unit 42 and a storage unit 44.

The alarm display control unit 42 includes a process data acquisition unit 42A that acquires the process data from the edge/cloud computing unit 32, an alarm determination unit 42B that determines whether or not it is required to issue an alarm based on the process data acquired by the process data acquisition unit 42A, an alarm information display unit 42C that, in a case where the alarm determination unit 42B determines that it is required to issue an alarm, issues an alarm and displays, on the display device 50, alarm-related information including the guide information for a guide as to a method of a countermeasure at a time of issuing the alarm, and a

standard guide setting unit 42D for setting standard guide information to be displayed on the display device 50.

[0038]

Furthermore, the alarm display control unit 42 is configured to add the guide information. Specifically, an important word extraction unit 42E for extracting important words (an example of a "word") from a daily operation report DB 44C, and a guide addition setting unit 42F that displays importance of the extracted important words and a part of a daily operation report including the important words on the display device 50 as a candidate of the guide information to be added and that receives input of additional guide information to be added to the standard guide information are provided.

[0039]

The storage unit 44 of the monitoring device includes an alarm information DB 44A, a guide information DB 44B, and the daily operation report DB 44C. First, each database of the storage unit 44 will be described.

[0040]

The alarm information DB 44A stores the alarm determination logic (determination reference) for determining whether or not an alarm indicating abnormality or the like of the plant 1 is generated based on the process data, and alarm history information (information

including identification information of the alarm and a generation date and time and the like of the alarm) issued in the past. Specifically, the alarm determination logic is stored for each alarm in association with the identification information of the alarm, classification information of the alarm, and an evaluation item name of the process data related to the alarm. The alarm determination logic may define the determination reference as to whether or not a value of the process data exceeds a threshold based on the process data acquired from a single sensor, or may define the determination reference based on the process data acquired from a plurality of types of sensors in accordance with a predetermined algorithm (including an algorithm based on a predetermined trained model generated by machine learning and an algorithm based on a formula or a mathematical model derived by performing multivariate analysis or the like on the process data of a plurality of sensors).

[0041]

The guide information DB 44B stores the guide information for the guide as to the method of the countermeasure at the time of issuing the alarm. The guide information includes the standard guide information set in advance by the standard guide setting unit 42D and the

additional guide information added by the guide addition setting unit 42F.

[0042]

For example, in the guide information DB 44B, a sentence describing a method titled "1. Monitoring Point (How to Read Graph)" for perceiving an event from the graph and a sentence describing a method titled "2. Method of Countermeasure" for adjusting a state of the process data are recorded for each alarm. The method for adjusting the state of the process data is, for example, a method for adjusting a state where the process data of interest exceeds a threshold to set the process data within the threshold.

[0043]

Fig. 3 illustrates an example of the guide information displayed on the display screen of the display device 50 in a case where the issued alarm is "circulation system temperature difference 1". A definition of a difference in temperature in the furnace and a calculation formula are described in "1. Monitoring Point (How to Read Graph)". The operator can check the method of perceiving an event from the graph from the description and easily understands what kind of event has occurred. An item to be checked by the operator in accordance with a magnitude of the difference in temperature in the furnace is listed in "2. Method of

Countermeasure". The method for adjusting the state of the process data can be checked from the description. The guide information may include not only text information, a formula, and the like but also an image, a graph with legends, and the like. Furthermore, a function of displaying a time at which the same alarm is issued in the past may be provided.

[0044]

The daily operation report DB 44C stores information related to the actual operating status of the plant 1. The information related to the actual operating status of the plant 1 includes, for example, a daily operation log (daily operation report) recorded by the operator in order to hand over an observation result of an operating status of equipment for which the operator is responsible in the plant 1 to a subsequent operator. The daily operation report may be created for each device such as the boiler and the turbine or may be created for the entire plant. In addition, the daily operation report is preferably created periodically (for example, at least once a day). The information related to the actual operating status of the plant 1 may include a monthly operation report and maintenance information, an inspection record, repair information, and a history of failure of the equipment for which the operator is responsible.

[0045]

Next, each functional block of the alarm display control unit 42 will be described.

The process data acquisition unit 42A acquires the process data from the edge/cloud computing unit 32.

[0046]

The alarm determination unit 42B determines whether or not abnormality or the like has occurred in the plant 1 based on the process data and, in a case where it is determined that abnormality has occurred, causes the display device 50 to issue an alarm. Specifically, the alarm determination unit 42B reads out the alarm determination logic (determination reference) recorded in the alarm information DB 44A and evaluates the process data in accordance with the alarm determination logic. For example, the alarm determination unit 42B determines whether or not abnormality such as a burst (a state such as a boiler tube leakage where a metal material such as a tube and a pipe constituting the boiler is damaged to form a hole and where the vapor inside the boiler leaks to the outside, including a state where there is a strong possibility of occurrence of the burst in the future; the same applies below) that may occur in the plant 1 has occurred by evaluating predetermined process data based on the alarm determination logic and, in a case where it is

determined that a burst has occurred, causes the display device 50 to issue an alarm. At the same time, the alarm determination unit 42B records the occurrence of the abnormality in the alarm information DB 44A.

[0047]

In a case where the alarm determination unit 42B determines that it is required to issue an alarm, the alarm information display unit 42C displays information for the operator to check whether or not the alarm is appropriate on the display device 50. On the display screen of the display device 50, information related to the alarm in the past and in the present acquired from the alarm determination unit 42B is displayed in a list form. In addition, in a case where the operator double-clicks (selects) a predetermined alarm, the alarm information display unit 42C acquires the guide information corresponding to the selected alarm and displays the guide information on the display screen.

[0048]

The standard guide setting unit 42D sets the standard guide information that is the guide information set in advance in the guide information corresponding to the countermeasure guideline of the alarm (including information for specifying the process data or the like to be checked by the operator in order to determine whether or

not the alarm is appropriate at the time of issuing the alarm). The standard guide information is typically highly versatile information that is set by a skilled operator based on knowledge and experience of the skilled operator before operating the plant (or is information that can be set before operating the plant).

[0049]

The important word extraction unit 42E extracts the important words (an example of the "word") from the daily operation report DB 44C in order to assist the operator in setting the additional guide information. The important word extraction unit 42E illustrated in the present embodiment extracts the important words by extracting a plurality of words from the daily operation report or the like using a known natural language processing technique and by calculating importance of the plurality of words. Fig. 4 illustrates a functional block diagram of the important word extraction unit 42E. As illustrated in the drawing, the important word extraction unit 42E includes an information extraction unit 42E1 that extracts a word which may be the important word from the daily operation report, a feature amount calculation unit 42E2 that calculates statistical information of each word extracted by the information extraction unit 42E1, and an importance

calculation unit 42E3 that calculates importance of each word based on the statistical information of each word.

[0050]

The information extraction unit 42E1 executes morphemic analysis of dividing the daily operation report in a natural language or other information into morphemes and of specifying a morpheme of which a word class is noun, and unnecessary word class filtering and unnecessary word filtering of removing postpositional particles or other word classes and an unnecessary word that cannot be the important word among the morphemes.

[0051]

The feature amount calculation unit 42E2 calculates the statistical information such as the number of times the word extracted by the information extraction unit 42E1 appears. Specifically, a frequency of appearance (an example of a "feature amount"), an n-gram collocation frequency (an example of the "feature amount"), and a frequency distribution (an example of the "feature amount") of each word are calculated. The n-gram collocation frequency is a frequency of collocation of N adjacent words.

[0052]

The importance calculation unit 42E3 calculates information indicating the importance of each word based on

the statistical information of each word calculated by the feature amount calculation unit 42E2. For example, the importance calculation unit 42E3 calculates information indicating the importance based on at least one of Term Frequency (TF), Inverse Document Frequency (IDF), TF-IDF, or a concatenation frequency.

[0053]

Here, TF (an example of "importance") is a value calculated by dividing the number of times a predetermined word included in one document j (or a sentence j) appears by a total number of words included in the document j (or the sentence j). IDF (an example of the "importance") is a value calculated as a logarithmic value of a value obtained by dividing a total number of documents (or a total number of sentences) by the number of documents (or the number of sentences) in which a predetermined word appears. TF indicates a frequency of appearance of the predetermined word for each document (or for each sentence). IDF has a low value for a word that is transversely used over a plurality of documents (or sentences). TF-IDF is a value obtained by multiplying TF by IDF. Accordingly, TF-IDF (an example of the "importance") is an index having a high value for a word that is not generally used transversely and that mainly appears in a part of a document (or a sentence). For example, the importance calculation unit

42E3 extracts a word having a high value of TF-IDF as the important word and displays the word on the display device 50 together with the value of TF-IDF (an example of the "importance"). Equation 1 shows an example of a formula for calculating $TF(tf_i, j)$, $IDF(idf_i)$, and $TF-IDF(tfidf)$.

[Equation 1]

$$tf(t_i, d_j) = \frac{\text{Number of times word } t_i \text{ appears in document } d_j}{\text{Sum of number of times all words of document } d_j \text{ appear}} = \frac{f(t_i, d_j)}{\sum_{t_k \in d_j} f(t_k, d_j)}$$

$$idf(t_i) = \log \left(\frac{\text{Total number of documents}}{\text{Number of documents in which word } t_i \text{ appears} + 1} \right) = \log \left(\frac{N}{df(t_i) + 1} \right)$$

$$tfidf(t_i, d_j) = tf(t_i, d_j) \cdot idf(t_i)$$

[0054]

The importance calculation unit 42E3 may calculate the information indicating the importance of each word based on the concatenation frequency (an example of the

"importance"). For example, the concatenation frequency may be calculated based on the FLR method of counting a frequency with which a word and another word are used as a set, and a word having a high value may be extracted as the important word. A word (for example, "circulating particles") having high importance is generally used as a set with another word (for example, "temperature of a lower part of a lower furnace") having high importance. Thus, a word having high importance can also be extracted using the concatenation frequency. Fig. 4 illustrates an example of an important word list L1 that is an example of the important words extracted by the important word extraction unit 42E and of the importance (score).

[0055]

The guide addition setting unit 42F sets the additional guide information to be added to the standard guide information. The additional guide information is typically the guide information based on information obtained by the operator by, for example, observing the plant after the operation of the plant starts. Since the additional guide information is information obtained by actually operating the plant, the additional guide information corresponds to information on which circumstances specific to the plant are reflected.

[0056]

Accordingly, while the standard guide information corresponds to the guide information having a strong possibility of being applicable to other plants other than the plant 1, the additional guide information is the guide information having a possibility of being not applicable to other plants other than the plant 1.

[0057]

The guide addition setting unit 42F displays a free entry frame FL (an example of a "region for adding guide information") for receiving the additional guide information on the display screen of the display device 50. The guide addition setting unit 42F receives information input in the free entry frame by the operator as the additional guide information and records the information in the guide information DB 44B.

[0058]

Furthermore, in order to assist the operator in inputting the additional guide information, the guide addition setting unit 42F according to the present embodiment displays the standard guide information and the list L1 (Fig. 4) showing the important words and the importance in a different region of the display screen of the display device 50.

[0059]

In addition, in a case where one of the important words is selected by the operator, the guide addition setting unit 42F accesses the daily operation report DB 44C to read a part of the daily operation report or the like including the selected important word and displays the part of the daily operation report or the like in a different region of the display screen of the display device 50.

[0060]

Accordingly, the guide addition setting unit 42F is configured to display the standard guide information (Fig. 3) corresponding to the guide information before addition, the list L1 (Fig. 4) showing the important words and the importance, the part excerpted from the daily operation log or the like including the selected important word, and the free entry frame at the same time in a case where the operator inputs the additional guide information.

[0061]

It is preferable that the standard guide information (Fig. 3) and the free entry frame are configured to be displayed parallelly (that is, linearly at the same position in a vertical direction or a horizontal direction of the display screen). For example, the standard guide information may be displayed in a region (an example of a "first region") on the left side of the display screen, and the free entry frame may be displayed in a region (an

example of a "second region") on the right side of the display screen. By performing such display, it is possible to input content that does not contradict the standard guide information as the additional guide information while checking the standard guide information.

[0062]

In addition, in a case where a different important word of the list L1 is selected by the operator, the guide addition setting unit 42F accesses the daily operation report DB 44C to read a part of the daily operation report or the like including the newly selected important word and displays the part of the daily operation report or the like in a different region of the display screen of the display device 50. By performing such display, it is possible to input the additional guide information with reference to the daily operation report or the like related to a plurality of important words.

[0063]

Fig. 5 illustrates an example in which a list L2 of excerpts from the daily operation log or the like including "circulating particles" and the free entry frame FL (guide entry field) are parallelly displayed on the display screen of the display device 50 in a case where the operator selects the important word "circulating particles". As illustrated in the drawing, the guide addition setting unit

42F may display the selected important word in a highlighted manner.

[0064]

As illustrated in the drawing, the guide addition setting unit 42F may create the list L2 in which sentences including the important words are excerpted from the daily operation log or the like for a plurality of dates and times. By excerpting the sentences including the important words for a plurality of dates and times, a related sentence can be efficiently found.

[0065]

In addition, the guide addition setting unit 42F may create the list L2 in which a sentence contributing to the importance (for example, a sentence having high TF) is displayed at a higher position.

[0066]

Furthermore, the guide addition setting unit 42F may access the alarm information DB 44A to create the list L2 in which a sentence or the like created on a day (or earlier or later) on which an alarm corresponding to the additional guide information is generated is displayed at a higher position. The display device according to this aspect displays the region for adding the guide information to be displayed at a time of generating a warning related to the operating status of the plant on the display screen

and displays, at the same time, information related to an operating status of the plant in the past at the time of generating the same warning (or in the same category) as the warning.

[0067]

Fig. 6 is a diagram illustrating a physical configuration for implementing the operation support system 30 according to the present embodiment. The edge/cloud computing unit 32 can employ a known physical configuration and thus, will not be described. Hereinafter, a physical configuration of the operation support system 30 excluding the edge/cloud computing unit 32 will be described.

[0068]

The operation support system 30 includes a central processing unit (CPU) 30A corresponding to a calculation unit, a random access memory (RAM) 30B and a read only memory (ROM) 30C corresponding to a storage unit, a communication unit 30D, an input unit 30E, and a display unit 30F. These configurations are connected to each other to be capable of transmitting and receiving data through a bus. While a case where the operation support system 30 is configured with one computer will be described in the present example, the operation support system 30 may be configured with a plurality of computers. For example, the display unit 30F may be configured with a plurality of

displays. In addition, the configurations illustrated in Fig. 6 are merely an example, and a part of the configurations may not be provided. Furthermore, a part of the configurations may be provided at a remote location. For example, a part of the ROM 30C may be provided at a remote location and may be configured to communicate through a communication network.

[0069]

The CPU 30A is a calculation unit that performs control processing, calculation processing, and the like included in the present disclosure by executing a computer program or the like recorded in the ROM 30C or the like. The CPU 30A includes a processor. The CPU 30A receives various types of information (including the process data) from the RAM 30B, the ROM 30C, the communication unit 30D, the input unit 30E, and the like, and displays a calculation processing result and the like on the display unit 30F or stores the calculation processing result and the like in the RAM 30B or in the ROM 30C.

[0070]

The RAM 30B functions as a cache memory in the storage unit and may be configured with, for example, a volatile semiconductor storage element such as an SRAM and a DRAM.

[0071]

The ROM 30C functions as a main memory in the storage unit and may be configured with, for example, a non-volatile semiconductor storage element such as a flash memory in which information can be electrically rewritten, or with an HDD in which information can be magnetically rewritten. For example, the ROM 30C may store the computer program and data for executing processing including each control and each calculation processing illustrated in the present disclosure.

[0072]

The communication unit 30D is an interface for connecting the operation support system 30 to other devices such as the DCS 20. The communication unit 30D may be connected to a communication network such as the Internet.

[0073]

The input unit 30E receives input and the like of data (including the selection of the important word and input of the additional guide information in the present disclosure) from the operator and may include, for example, a mouse, a keyboard, and a touch panel.

[0074]

The display unit 30F visually displays a calculation result of the CPU 30A and may be configured with, for example, a liquid crystal display (LCD).

[0075]

In the physical configurations, each function constituting the alarm display control unit 42 of the monitoring device 40 can be implemented by executing the computer program mainly via the CPU 30A. Each database constituting the storage unit 44 can be implemented mainly by the ROM 30C. The display device 50 can be implemented mainly by the display unit 30F.

[0076]

[Display Method]

Hereinafter, a series of operation support methods including a display method for creating the guide information to be displayed in issuing an alarm to the operator using the operation support system 30 will be described. Fig. 7 is a flowchart including the display method.

[0077]

First, the standard guide information is created. The skilled operator inputs the standard guide information in which the countermeasure guideline (including information for specifying the process data or the like to be checked by the operator in order to determine whether or not the alarm is appropriate at the time of issuing the alarm) is summarized, for each alarm based on the standard guide setting unit 42D of the operation support system 30. The standard guide information is typically highly versatile

guide information that is created in advance before the operation of the plant 1 is started, and may include information usable for other plants of the same type. The input standard guide information is registered in the guide information DB 44B.

[0078]

Then, the operation of the plant 1 is started. The operator records the daily operation log every day based on the actual operating status of the plant 1. The daily operation log is stored and accumulated in the daily operation report DB 44C. In addition, the alarm determination unit 42B determines whether or not abnormality has occurred by evaluating predetermined process data based on the alarm determination logic. In a case where it is determined that abnormality has occurred, the monitoring device 40 causes the display device 50 to issue an alarm and to display the guide information. The guide information displayed in this case corresponds to the standard guide information set in advance. The operator performs a countermeasure with respect to the alarm based on the standard guide information.

[0079]

After a sufficient period elapses, the operator starts setting the additional guide information for a predetermined alarm. First, the important word extraction

unit 42E accesses the daily operation report DB 44C to acquire information related to the actual operating status, such as the daily operation log (step S71).

[0080]

Next, the important word extraction unit 42E extracts the important words based on the acquired information (step S72). The list of the important words and of the importance, the current guide information, and the free entry frame FL are displayed on the display screen of the display device 50. For example, the guide information and the free entry frame FL are parallelly displayed in the horizontal direction of the display screen.

[0081]

The important word extraction unit 42E may be configured to extract different important words depending on content of the alarm. For example, the importance calculation unit 42E3 may be configured to calculate the importance such that the importance of a predetermined word is set to be high in advance with respect to the predetermined alarm. In addition, the information extraction unit 42E1 may be configured to filter and exclude a word less related to the alarm from the important words in accordance with the content of the alarm.

[0082]

The operator checks the list of the important words and of the importance (step S73) and selects an important word with reference to the importance (score) (step S74). In a case where one of the important words is selected by the operator, the guide addition setting unit 42F accesses the daily operation report DB 44C to read a part of the daily operation report or the like including the selected important word and displays the part of the daily operation report or the like in a different region of the display screen of the display device 50. In this case, information suitable for the additional guide information can be efficiently found by displaying a plurality of candidates of the sentences including the important word.

[0083]

The operator, while checking the guide information and the excerpts from the daily operation report or the like (step S75), determines whether or not information to be added to the guide information is present (step S76).

[0084]

In a case where it is determined that information to be added to the guide information is present (YES), the operator inputs the additional guide information to be added into the free entry frame FL based on the excerpts or the like from the daily operation report or the like (step S77). The guide addition setting unit 42F receives

information input in the free entry frame FL by the operator as the additional guide information and records the information in the guide information DB 44B. Then, the guide information including the additional guide information is displayed on the display screen of the display device 50 in issuing the alarm.

[0085]

Here, the additional guide information may be information based on a difference in specifications of devices of the plant. While the devices of the plant have different specifications depending on a power generation scale and the like of the plant, the standard guide information may describe only the countermeasure guideline that applies to general boilers without considering such a difference in the specifications of the devices. For example, a boiler that is one of the devices of the plant has different regulation values of sulfur oxide (SOx) and of nitrogen oxide (NOx) depending on specifications thereof. Accordingly, a denitrification device and a desulfurization device may be included or not included depending on the boiler. In addition, different temperatures and pressures may be required depending on the boiler. The inventors of the present application have focused on this point and have conceived an idea of creating the guide information on which circumstances such

as a difference in the specifications of the devices of the plant specific to the plant are reflected, by enabling addition of the guide information instead of fixing the guide information.

[0086]

Furthermore, by focusing on information such as the daily operation log that is created for different purposes and that is accumulated, it is configured to access the information related to the actual operating status of the plant and to display the information at the same time in adding the guide information. Thus, a load of creating the guide information is reduced, and even an inexperienced operator can easily add new guide information in which circumstances specific to the plant are taken into consideration.

[0087]

In addition, it is configured that the information related to the actual operating status of the plant is not simply displayed and is narrowed down to information having high importance to be viewed by a guide creator such as the operator. Thus, the load of creating the guide information can be further reduced.

[0088]

In addition, various modifications can be made to the present invention without departing from the concept

thereof. For example, a machine learning technique may be used for extracting the important words and for calculating the importance. In this case, training data in which a reward is provided in a case where actual addition to the additional guide information is made may be created. In addition, identification information of the operator who has created the daily operation log may be used as one factor. A machine learning model includes machine learning models that use a neural network such as a convolutional neural network (CNN), a regression model such as Gaussian process regression, and a tree algorithm such as a decision tree. The edge/cloud computing unit 32 can also be used for collecting information for machine learning. In addition, a part of components in an embodiment can be added to another embodiment within the scope of ordinary creativity of those skilled in the art. In addition, a part of components in an embodiment can be substituted with a corresponding component of another embodiment.

Reference Signs List

[0089]

1 Plant

2a Fuel feed port

2b Gas outlet

2c Air supply line

2d Exhaust port

3 Cyclone

3a Exhaust gas flow path

4 Circulation material recovery pipe

4a Loop seal part

5 Rear flue

6 Furnace wall pipe

7 Pump

30 Operation support system

30D Communication unit

30E Input unit

30F Display unit

32 Cloud computing unit

40 Monitoring device

42 Alarm display control unit

42A Process data acquisition unit

42B Alarm determination unit

42C Alarm information display unit

42D Standard guide setting unit

42E Important word extraction unit

42F Guide addition setting unit

44 Storage unit

50 Display device

100 Turbine

102 Condenser

CLAIMS

1. A display device comprising:

a display screen,

wherein the display device is configured to display a region for adding guide information to be displayed at a time of generating a warning related to an operating status of a plant on the display screen.

2. The display device according to claim 1,

wherein the display device is configured to

display the guide information in a first region of the display screen, and

display the region for adding the guide information in a second region that is parallel to the first region of the display screen.

3. The display device according to claim 1 or 2,

wherein the display device is configured to

display at least one word included in information describing an operating status of the plant in the past, and

display the information including the selected word on the display screen.

4. The display device according to claim 3,
wherein the word is extracted by executing

a step of calculating a feature amount of the at least one word based on the information describing the operating status of the plant in the past, and

a step of calculating importance of the at least one word based on the feature amount of the word, and

the display device is configured to display the word on the display screen together with the importance of the word.

5. A display method comprising:

a step of displaying a region for adding guide information to be displayed at a time of generating a warning related to an operating status of a plant on a display screen of a display device.

6. A control device that controls a display device including a display screen,

wherein the control device is configured to display a region for adding guide information to be displayed at a time of generating a warning related to an operating status of a plant on the display screen.

7. A computer program causing a computer for controlling a display device including a display screen to execute:

a step of displaying a region for adding guide information to be displayed at a time of generating a warning related to an operating status of a plant on the display screen.