

DESCRIPTION

Title of Invention

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

Technical Field

[0001]

The present invention relates to a display device, a control device, a control method, and a computer program for displaying an operation state of a plant.

Background Art

[0002]

In the related art, a sensor has been provided in a plant to monitor an operating status of the plant through a measurement value of the sensor. For example, PTL 1 discloses displaying information related to an object from a sensor in a case where the object on a display screen is selected, so that an operator can intuitively identify a target to be detected or a detection result of a sensor. In addition, PTL 2 discloses displaying a plurality of warning messages within a warning monitoring screen and displaying information about a graph of a corresponding warning

message in a case where an operator presses a graph display on a display screen.

Citation List

Patent Literature

[0003]

[PTL 1] Japanese Unexamined Patent Publication No.
1992-308895

[PTL 2] Japanese Unexamined Patent Publication No.
2016-115195

Summary of Invention

Technical Problem

[0004]

In the configuration of the related art, alarms generated in the plant can be displayed in time series. However, in the configuration of the related art, for example, in a case where a large number of alarms of a type are generated in a certain period, it is difficult to identify a generation frequency such as the number of times the alarm is generated.

[0005]

An exemplary object of an aspect of the present invention is to provide a display device, a control device,

a control method, and a computer program that can visualize a generation frequency of an alarm.

Solution to Problem

[0006]

In order to solve the above problem, a display device of an aspect of the present invention is a display device that displays an operation state of a plant, in which for a plurality of alarms generated in the plant, a generation frequency of each alarm type indicating a type of the alarm in a first period is displayed in an aspect of being arranged for each alarm type.

[0007]

In the display device, the displaying of the generation frequency of each alarm type in the first period in the aspect of being arranged for each alarm type may be displaying the generation frequency of each alarm type in the first period in a graph form.

[0008]

In the display device, the displaying of the generation frequency of each alarm type in the first period in the aspect of being arranged for each alarm type may be arranging and displaying bar graphs corresponding to the generation frequency of each alarm type in the first period

in a descending order or an ascending order of the generation frequency for each alarm type.

[0009]

In the display device, for the alarm type of which the generation frequency in the first period is displayed, a generation history of the alarm type in a second period included in the first period may be further displayed.

[0010]

In the display device, a generation history of a related event related to the alarm type in the second period may be further displayed together with the generation history of the alarm type in the second period.

[0011]

In the display device, the related event may be a process of the plant or may be the alarm of a different type from the alarm type of which the generation frequency in the first period is displayed.

[0012]

In the display device, the first period may be a period of a part of an operation period of the plant.

[0013]

In the display device, the generation frequency may be the number of generations.

[0014]

A control device of another aspect of the present invention is a control device that controls a display device that displays an operation state of a plant, the control device including an acquisition unit that acquires alarm information indicating an alarm generated in the plant, a calculation unit that calculates a generation frequency of each alarm type indicating a type of the alarm in a first period based on the alarm information, and a display control unit that causes the display device to display the calculated generation frequency of each alarm type in the first period in an aspect of being arranged for each alarm type.

[0015]

The control device may further include a generation unit that, for the alarm type of which the generation frequency in the first period is displayed, generates generation history information indicating a generation history of the alarm type in a second period included in the first period based on the alarm information, in which the display control unit causes the display device to further display the generated generation history information in the second period.

[0016]

In the control device, the display control may cause the display device to further display a graph form in which

generation of the alarm type is arranged in time series based on the generated generation history information in the second period.

[0017]

The control device may further include a reception unit that receives a selection of a related event related to the alarm type of which the generation frequency in the first period is displayed, in which the generation unit generates generation history information indicating a generation history of the selected related event in the second period based on process information of the plant or on the alarm information, and the display control unit causes the display device to display the generated generation history information of the related event in the second period together with the generated generation history information of the alarm type.

[0018]

In the control device, the display control unit may cause the display device to further display a graph form in which generation of the alarm type is arranged in time series based on the generated generation history information of the alarm type in the second period and in which generation of the related event is arranged in time series based on the generated generation history information of the related event in the second period.

[0019]

The control device may further include a correctness input unit configured to input correctness of generation of the alarm type of which the generation frequency in the first period is displayed.

[0020]

A control method of another aspect of the present invention is a control method of controlling a display device that displays an operation state of a plant, the control method including a step of acquiring alarm information indicating an alarm generated in the plant, a step of calculating a generation frequency of each alarm type indicating a type of the alarm in a first period based on the alarm information, and a step of causing the display device to display the calculated generation frequency of each alarm type in the first period in an aspect of being arranged for each alarm type.

[0021]

A program of another aspect of the present invention is a program for controlling a display device that displays an operation state of a plant, the program causing a computer to execute a step of acquiring alarm information indicating an alarm generated in the plant, a step of calculating a generation frequency of each alarm type indicating a type of the alarm in a first period based on

the alarm information, and a step of causing the display device to display the calculated generation frequency of each alarm type in the first period in an aspect of being arranged for each alarm type.

[0022]

Arbitrary combinations of the above components, and substitution of the components and expressions of the present invention with each other among a method, a device, a system, a computer program, a data structure, a recording medium, and the like are also valid as an aspect of the present invention.

Advantageous Effects of Invention

[0023]

According to the present invention, it is possible to visualize a generation frequency of an alarm.

Brief Description of Drawings

[0024]

Fig. 1 is a schematic diagram illustrating an overall configuration of a plant according to the present embodiment.

Fig. 2 is a diagram illustrating functional blocks of a system according to the present embodiment.

Fig. 3 is a diagram illustrating a physical configuration of the system according to the present embodiment.

Fig. 4 is a diagram illustrating transitions among various display screens according to the present embodiment.

Fig. 5 is a diagram illustrating an example of a dashboard display screen according to the present embodiment.

Fig. 6 is a diagram illustrating an example of a generation history screen according to the present embodiment.

Fig. 7 is a flowchart illustrating an example of operation processing according to the present embodiment.

Description of Embodiments

[0025]

Hereinafter, the present invention will be described through an embodiment of the invention with reference to the drawings. It should be noted that the following embodiment does not limit the invention according to the claims. In addition, not all combinations of features described in the embodiment are essential to the solution of the invention. The same or equivalent components, members, and processing illustrated in each drawing will be

designated by the same reference signs, and description will not be repeated as appropriate.

[0026]

Fig. 1 is a schematic diagram illustrating an overall configuration of a plant according to the present embodiment. First, a configuration of a plant 1 targeted by the present embodiment will be described using Fig. 1. For example, the plant 1 is a power generation plant (incineration plant) including a circulating fluidized bed boiler (circulating fluidized bed type), and includes a boiler 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. The plant targeted by the present embodiment is not limited to a power generation plant or an incineration plant including a boiler and may be a plant such as a chemical plant or a wastewater treatment plant in which process data can be acquired.

[0027]

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.

[0028]

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.

[0029]

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.

[0030]

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.

[0031]

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.

[0032]

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.

[0033]

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.

[0034]

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.

[0035]

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.

[0036]

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.

[0037]

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.

[0038]

The process data (data related to operation of the plant 1) 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 in accordance with adjustment 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.

[0039]

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 (Fig. 2) evaluates the process data based on an alarm determination logic set for each type of abnormality and, in a case where abnormality has occurred, issues an alarm.

[0040]

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 or data calculated based on a plurality of pieces of the process data. The process data related to the plant 1 may be other data such as a temperature and a pressure, or may be data that is acquired from the sensor or the like and that is not obtained by calculation processing.

[0041]

Next, a system 30 according to the present embodiment will be described using Fig. 2 and Fig. 3. Fig. 2 is a diagram illustrating functional blocks of the system 30 according to the present embodiment. Fig. 3 is a diagram illustrating a physical configuration of the system 30 according to the present embodiment.

[0042]

The DCS 20 is a distributed control system for controlling the plant 1 and, as illustrated in Fig. 2, acquires the process data from the sensor or the like provided in the plant 1 and supplies a control signal for controlling the plant 1 based on the process data to the plant 1.

[0043]

The system 30 includes a display device 32 and the monitoring device 40. The monitoring device 40 includes a control unit 31 and a storage unit 33. The control unit 31 includes, for example, an acquisition unit 311, a calculation unit 312, a generation unit 313, a reception unit 314, and a display control unit 315 as functional configurations. The storage unit 33 stores various types of data and, for example, stores a process information DB 33A, an alarm information DB 33B, and a generation history information DB 33C.

[0044]

For example, the acquisition unit 311 acquires the process data from the DCS 20. The acquisition unit 311 sequentially acquires the process data from the DCS 20 while the plant 1 is in operation. The acquired process data is stored in the process information DB 33A as information (hereinafter, referred to as "process information") related to processes of the plant 1. The plant 1 is "in operation" as long as at least a part of the plant 1 is operating. In addition, an operation period of the plant 1 is a period in which at least a part of the plant 1 is operating, and is a period except a stoppage period planned in advance for maintenance or the like.

[0045]

In addition, the acquisition unit 311 acquires alarm information from the DCS 20. The acquisition unit 311 acquires the alarm information from the DCS 20 at each issuing (an example of "generation") of an alarm during the operation of the plant 1. The alarm information indicates an alarm generated in the plant 1 and is information about an alarm (warning) with respect to abnormality that has occurred. The alarm information includes an alarm item (a type of alarm), an alarm generation date and time (a date and time at which the alarm is generated), an alarm level (a level (importance) or the like of the alarm; for example, classified as a high-level warning, a medium-level

warning, or a low-level warning), and a value (for example, a value of the makeup water flow rate u1 or the boiler feedwater flow rate u2 determined as being abnormal) of the process data related to the alarm, and the like.

[0046]

In the DCS 20, whether or not abnormality or the like has occurred in the plant 1 is determined, and the alarm information is generated in a case where it is determined that abnormality has occurred. The DCS 20 determines that abnormality has occurred in a case where, for example, any value included in the process data exceeds a predetermined threshold or has a predetermined change in tendency. More specifically, the DCS 20 may determine 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. The alarm information generated by the DCS 20 will be particularly referred to as "DCS alarm information". Even in the system 30, it may be determined that abnormality has occurred by determining whether or not

abnormality or the like has occurred in the plant 1 based on the process data acquired by the acquisition unit 311. The alarm information generated in this case will be particularly referred to as "system alarm information". Hereinafter, the DCS alarm information and the system alarm information will be collectively referred to as the "alarm information". The alarm information is stored in the alarm information DB 33B.

[0047]

The calculation unit 312 calculates a generation frequency of each alarm type indicating the type of alarm in a first period based on the alarm information stored in the alarm information DB 33B. The calculated generation frequency of each alarm type is an index indicating a frequency of the alarm of the alarm type generated in the plant 1 in a certain period in the past. The first period is a period of a part of the operation period of the plant 1 and is, for example, 24 hours. The first period may be a period set in advance or may be a period that can be changed as appropriate. Since the first period is a period of a part of the operation period of the plant 1, it is possible to display the generation frequency of each alarm type by focusing on a period extracted from the operation period of the plant 1, and, for example, it is possible to

easily identify the generation frequency of an alarm type that is generated in a specific time range.

[0048]

The generation frequency is, for example, the number of generations in the first period. Accordingly, it is possible to easily identify the number of generations of each alarm type in the first period.

[0049]

The generation frequency is not limited to the number of generations in the first period and may be a ratio of generation (for example, a ratio of the number of generations of an alarm type to an average number of generations of all alarm types in the first period), a frequency of generation (for example, a frequency of an alarm type in a case where the average number of generations of all alarm types in the first period is set as a reference value {for example, "1"}), and the like in the first period.

[0050]

For example, the calculation unit 312 calculates the generation frequency of each alarm type in the first period at an arbitrary timing (for example, a timing at which the alarm is generated, every second, every minute, or every hour) set in advance. The alarm types for calculating the generation frequency are classified using an arbitrary

method. For example, the types of the alarm may be classified for each sensor for measuring the state of the plant 1. In this case, for example, the types of the alarm may include types such as an alarm related to the makeup water flow rate, an alarm related to the boiler feedwater flow rate, an alarm related to the boiler outlet vapor flow rate, and an alarm related to the saturated vapor flow rate.

[0051]

In addition, the calculation unit 312 calculates the generation frequency of each alarm type in the first period based on the DCS alarm information. That is, the generation frequency of each alarm type in the first period calculated by the calculation unit 312 is calculated from the alarm information of the DCS 20.

[0052]

The generation unit 313 generates, based on the alarm information stored in the alarm information DB 33B, generation history information indicating a generation history, in a second period, of the alarm types of which the generation frequency in the first period is displayed on the display device 32 by the display control unit 315, described later. The generated generation history information of the alarm types is information related to the generation history of the alarm of the alarm types

generated in the plant 1 in a certain period in the past. The second period is a period included in the first period and is, for example, the same 24 hours as the first period. The second period may be a period set in advance or may be a period that can be changed as appropriate. In addition, the second period may be a period shorter than the first period, for example, 12 hours, 8 hours, or 6 hours.

[0053]

The generation history information includes, for example, an alarm generation timing (for example, a generation date and time of the alarm type), an alarm generation interval (for example, a time interval at which the alarm type is generated), and alarm generation density (for example, a ratio of generation (or a percentage of generation) of the alarm type within a certain time) in the second period.

[0054]

For example, the generation unit 313 generates the generation history information of each alarm type in the second period at an arbitrary timing (for example, a timing at which the alarm is generated, a timing of operation by an operator, every second, every minute, or every hour) set in advance. The alarm types for generating the generation history information are classified using the same method as the alarm types for calculating the generation frequency.

[0055]

In addition, the generation unit 313 generates the generation history information of each alarm type in the second period based on the DCS alarm information. That is, the generation history information of each alarm type in the second period generated by the generation unit 313 is generated from the alarm information of the DCS 20.

[0056]

The reception unit 314 receives input of various types of information, instructions, selections, and the like corresponding to operations of the operator. The reception unit 314 receives, for example, an instruction for display screen transition, a designation, an input, or a selection of the planned stoppage period, a selection of the alarm types displayed on the display device 32, and a selection of related events related to the alarm types displayed on the display device 32.

[0057]

The related events related to the alarm types are processes of the plant 1 or are alarms of a different type from the alarm types of which the generation frequency in the first period is displayed on the display device 32. For example, the processes of the plant 1 are events performed in the plant 1, such as measuring of the state of the plant 1 by the sensor and recording of operation in the plant 1.

Among the related event, the reception unit 314 receives a selection of related events related to the alarm types displayed on the display device 32. In addition, the alarms for selection by the reception unit 314 include both of an alarm (DCS alarm) in a case where it is determined that abnormality has occurred by determining whether or not abnormality or the like has occurred in the plant 1 via the DCS 20, and an alarm (system alarm) in a case where it is determined that abnormality has occurred by determining whether or not abnormality or the like has occurred in the plant 1 via the system 30. Among the alarms, the reception unit 314 receives a selection of an alarm of a different type from the alarm types of which the generation frequency in the first period is displayed on the display device 32.

[0058]

In addition, the generation unit 313 generates the generation history information in the second period with respect to the related events selected through the reception unit 314 based on the process information stored in the process information DB 33A or on the alarm information stored in the alarm information DB 33B. The generated generation history information is information related to the generation history of the process or the alarm type generated in the plant 1 in a certain period in the past.

[0059]

The generation history information includes, for example, a generation timing of a process or of an alarm (for example, a generation date and time of a process or of an alarm type), a generation interval of a process or of an alarm (for example, a time interval at which a process or an alarm type is generated), and generation density of a process or of an alarm (for example, a ratio of generation (or a percentage of generation) of a process or of an alarm type within a certain time) in the second period.

[0060]

For example, the generation unit 313 generates the generation history information of each related event in the second period at an arbitrary timing (for example, a timing at which the process or the alarm is generated, a timing of operation by the operator, every second, every minute, or every hour) set in advance. The alarm types for generating the generation history information may be classified using the same method as the alarm types for calculating the generation frequency or may be classified using a different method.

[0061]

The generation unit 313 generates the generation history information of each related event in the second period based on the DCS alarm information and on the system

alarm information. That is, as described above, since the related events may include both of the DCS alarm and the system alert, the generation history information of each related event in the second period generated by the generation unit 313 is generated from both of the alarm information of the DCS 20 and the alarm information of the system 30.

[0062]

The display control unit 315 generates display data based on the process data, the alarm information, the generation frequency in the first period, and the generation history information in the second period and displays a display screen based on the display data on the display device 32. That is, the display control unit 315 controls display of information related to the operation state of the plant 1 on the display device 32, such as display of the process data and of the generation frequency of each alarm type in the first period and display of the generation history information. An example of the screen displayed on the display device 32 will be described later.

[0063]

The process information DB 33A stores the process information (process data) acquired by the acquisition unit 311. That is, the process information DB 33A stores the

process information related to the processes generated so far (history information of the processes).

[0064]

The alarm information DB 33B stores the alarm information (DCS alarm information) acquired from the DCS 20 and the alarm information (system alarm information) acquired from the system 30 by the acquisition unit 311. That is, the alarm information DB 33B stores the alarm information related to the alarms generated so far (history information of the alarms) in both of the DCS 20 and the system 30.

[0065]

The generation history information DB 33C stores the generation history information indicating the generation history of the alarm types in the second period and the generation history information indicating the generation history of the related events in the second period generated by the generation unit 313.

[0066]

The display device 32 displays various display screens including information related to the operation of the plant 1 based on the display data supplied by the display control unit 315. Various display screens displayed by the display device 32 will be described later.

[0067]

The process information DB 33A, the alarm information DB 33B, and the generation history information DB 33C stored in the storage unit 33 are not limited to the example illustrated in Fig. 6. For example, in at least a part of the process information DB 33A, the alarm information DB 33B, and the generation history information DB 33C stored in the storage unit 33, arbitrary group units may be subdivided by performing predetermined normalization. In addition, information (data) stored in the process information DB 33A, the alarm information DB 33B, and the generation history information DB 33C is not limited to a case of being stored in the form of a database and, for example, may be stored in an arbitrary structure or form such as a table form, a block form, or a file form.

[0068]

As illustrated in Fig. 3, the system 30 physically includes a central processing unit (CPU) 30a, a random access memory (RAM) 30b, a read only memory (ROM) 30c, 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. Each functional block of the system 30 illustrated in Fig. 2 is implemented by the physical configurations illustrated in Fig. 3.

[0069]

While a case where the system 30 is configured with one computer will be described in the present embodiment, the system 30 may be implemented by a combination of a plurality of computers. For example, in addition to the display unit 30f, a display constituting a different display unit for displaying other information may be provided. In addition, the system 30 may be configured with a tablet terminal. By configuring the system 30 with a tablet terminal, it is possible to carry the system 30. For example, it is possible to use the system 30 while moving around in the plant 1. In addition, the configurations illustrated in Fig. 3 is merely an example. The system 30 may have a configuration other than the configurations or may not have a part of the configurations. In addition, a part of the configurations may be provided at a remote location. For example, the control unit 31 including the CPU 30a and the like may be provided at a remote location. In this case, the display device 32 including the display unit 30f and the like may be configured to acquire a control signal generated in the control unit 31 provided at the remote location through a network.

[0070]

The CPU 30a is a calculation unit that performs a control related to execution of a program stored in the RAM 30b or in the ROM 30c, and calculation and processing of

data. The CPU 30a is a calculation unit that executes a program (monitoring program) for displaying a graph and a description of the process data of the plant 1. The CPU 30a receives various types of data from the input unit 30e or from the communication unit 30d and displays a calculation result of data on the display unit 30f or stores the calculation result in the RAM 30b.

[0071]

In the storage unit, data can be rewritten in the RAM 30b. For example, the RAM 30b may be configured with a semiconductor storage element such as a DRAM or an SRAM. The RAM 30b may store the program executed by the CPU 30a and data such as the process data of the plant 1. The program and the data are merely an example, and the RAM 30b may store data other than the program and the data or may not store a part of the program and the data.

[0072]

In the storage unit, data can be read out from the ROM 30c. For example, the ROM 30c may be configured with a semiconductor storage element such as a flash memory or with an HDD. The ROM 30c may store, for example, a computer program for executing various types of processing illustrated in the present embodiment and data that is not rewritten. The data that is not rewritten includes, for example, information related to the plant 1 and to

specifications of components of the plant 1. In addition, the ROM 30c may store, for example, data such as the process data of the plant 1, indexes (an operation ratio, efficiency, and the like) related to the operation of the plant 1, and the planned stoppage period.

[0073]

The communication unit 30d is an interface that connects the system 30 to other devices. The communication unit 30d may be connected to a communication network such as the Internet.

[0074]

The input unit 30e receives input of data corresponding to operations performed by the operator and may include, for example, a keyboard and a touch panel.

[0075]

The display unit 30f has a screen on which the calculation result of the CPU 30a is visually displayed, and may be configured with, for example, a liquid crystal display (LCD). The display unit 30f may display the graph and the description of the process data. In addition, the display unit 30f may be provided by connecting a plurality of displays to configure one screen.

[0076]

The computer program for executing various types of processing illustrated in the present embodiment may be

provided as being stored in a computer-readable storage medium such as the ROM 30c or may be provided through a communication network connected by the communication unit 30d. In the system 30, various operations included in the present embodiment are implemented by executing the monitoring program via the CPU 30a. These physical configurations are merely an example and may not be independent configurations. For example, the system 30 may include a large-scale integration (LSI) in which the CPU 30a is integrated with the RAM 30b or with the ROM 30c.

[0077]

Fig. 4 is a diagram illustrating transitions among various display screens according to the present embodiment. As illustrated in Fig. 4, the display device 32 displays a login display screen DP0, a dashboard display screen DP1, and a generation history display screen DP2. Arrows between each display screen illustrated in Fig. 4 indicate that each display screen transitions based on instructions from the operator. That is, in the system 30, a transition can be made from the login display screen DP0 to the dashboard display screen DP1 and further from the dashboard display screen DP1 to the generation history display screen DP2 based on instructions from the operator. In a case where each display screen transitions in the system 30, the previous display screen may be replaced with

the subsequent display screen, or the subsequent display screen may be displayed together while the previous display screen is maintained. In addition, the above display screens are merely an example, and the display device 32 may display a display screen other than the display screens.

[0078]

The login display screen DP0 displays information required for the operator to log in to the system 30. The information required for login is, for example, a user ID and a password of the operator. The login display screen DP0 receives input of a user ID and of a password from the operator. A transition can be made from the login display screen DP0 to the dashboard display screen DP1 or the like.

[0079]

The dashboard display screen DP1 displays various latest indexes related to the operation of the plant 1 for each predetermined time. For example, the dashboard display screen DP1 displays a trend graph based on various indexes related to the operation of the plant 1. In addition, for example, the dashboard display screen DP1 displays an abnormality display indicating an occurrence or possibility of abnormality that has a possibility of stopping the plant 1, and a warning display indicating an occurrence or possibility of a warning in a case where the process data

related to the plant 1 is in a predetermined state. In addition, for example, the dashboard display screen DP1 displays the number and generation times of alarms. Furthermore, the dashboard display screen DP1 displays the generation frequency of each alarm type in the first period.

[0080]

The generation history display screen DP2 displays the generation history, in the second period, of the alarm type selected on the dashboard display screen DP1. In addition, the related events related to the alarm type selected on the dashboard display screen DP1 can be selected on the generation history display screen DP2. The generation history display screen DP2 can also display the generation history of the selected related event in the second period.

[0081]

Next, an example of the dashboard display screen DP1 will be described using Fig. 5. The dashboard display screen DP1 includes regions R10 to R13. The example illustrated in Fig. 5 is a part of the dashboard display screen DP1, and the actual dashboard display screen DP1 also includes regions other than the regions R10 to R13.

[0082]

In the region R10, "dashboard" is displayed as a status of the current screen. By displaying the region R10,

it is possible to easily identify which status the current screen is in.

[0083]

In the region R11 of the dashboard display screen DP1, the warning display indicating an occurrence of a warning in a case where the process data related to the plant is in the predetermined state is displayed as "latest alarm information". The warning display displays the predetermined state of the process data that affects operation efficiency of the plant 1, for example, a state that does not have a possibility of stopping the plant 1 unlike the burst and that decreases the operation efficiency of the plant 1. In the region R11, a generation history of the warning display is displayed in a state where time information indicating a time of generation and information indicating content are arranged in order of the time of generation. For example, at the top of the region R11, time information such as "MM/DD/YYYY hh:mm:ss" and information indicating content of warning such as "alarm A" are displayed in association with each other. This information displayed in the region R11 enables the operator of the plant 1 to recognize that the warning with respect to the alarm A is generated at hh:mm:ss on MM/DD/YYYY. The operator of the plant 1 can also recognize a history of the time information indicating a time of

occurrence of the predetermined state of another process data that affects the operation efficiency of the plant 1, and of the information indicating the content.

[0084]

Indexes such as efficiency related to the operation of the plant 1 are displayed in the region R12 of the dashboard display screen DP1. For example, one or a plurality of trend graphs having a vertical axis denoting indexes important for stable operation of the plant 1 and a horizontal axis denoting time are displayed in the region R12. Time at the rightmost end of the trend graphs is the latest time at which the indexes are calculated.

[0085]

In the region R13 of the dashboard display screen DP1, the generation frequency of each alarm type in the first period is displayed in the aspect of being arranged for each alarm type. Accordingly, the generation frequency of each alarm type in the first period can be visualized. Thus, for example, a defect that gradually progresses in a period can be prevented in advance by identifying the generation frequency of an alarm instead of simply identifying whether or not an alarm is generated.

[0086]

Specifically, for example, the number of times the DCS 20 determines abnormality (the number of generations) in

the past 24 hours is counted for each alarm type as "alarm count" information. Identification information for identifying the type of alarm may be displayed for "alarm 1", "alarm 2", and the like in Fig. 5. For example, the identification information may be a name of a specific sensor or an item name of an alarm detected by the sensor.

[0087]

Each bar graph having a length corresponding to the calculated number of generations in the first period counted for each alarm type is displayed in the aspect of a so-called Pareto chart in a descending order of the number of generations. Each bar graph displayed in the region R13 may be in an ascending order of the number of generations. By arranging and displaying the bar graphs corresponding to the generation frequency of each alarm type in the first period in the descending order or the ascending order of the generation frequency of each alarm type, the generation frequency of each alarm type in the first period can be easily visualized using a so-called Pareto chart.

[0088]

In a case where, for example, the operator moves a pointer or a cursor onto the bar graph of "alarm 1" in the region R13 and clicks (single-clicks), the content "alarm 1" of the alarm type and the number of generations "508" in the past 24 hours are displayed as illustrated in Fig. 5.

[0089]

In addition, in a case where, for example, the operator moves the pointer or the cursor onto the bar graph of "alarm 1" displayed in the region R13 and double-clicks, a transition is made from the dashboard display screen DP1 to the generation history display screen DP2.

[0090]

The generation frequency of each alarm type in the first period is not limited to the display in the example illustrated in Fig. 5. The generation frequency of each alarm type in the first period may be displayed in other forms as long as the generation frequencies are in the aspect of being arranged for each alarm type. The generation frequency of each alarm type in the first period may be displayed in a graph form, for example, a line graph, a cumulative graph, or a band graph.

[0091]

Next, an example of the generation history display screen DP2 will be described using Fig. 6. The generation history display screen DP2 includes regions R20 to R22.

[0092]

In the region R20, "generation date and time", "display method", "item", "alarm type", "maximum number to be displayed", and "search" are displayed. The operator can input each of a start time and an end time of the second

period for displaying the generation history of the selected alarm type by double-clicking "generation date and time" included in the region R20. For example, in a case where the first period of the generation frequency of each alarm type illustrated in Fig. 5 is the past 24 hours, a time within the past 24 hours can be input as the start time and the end time of the second period.

[0093]

One of "list", or "graph" can be selected in "display method" included in the region R20. In a case where "list" is selected in "display method", any of "ALL", "evaluation item", or "DCS" can be selected in "alarm type" included in the region R20. Meanwhile, in a case where "graph" is selected in "display method", the related events related to the selected alarm type can be selected in "item" included in the region R20. For example, maximum five (five items of) related events can be selected. In the example illustrated in Fig. 6, "graph" is selected in "display method", and two (two items of) related events are selected in "item".

[0094]

A numerical value can be input in "maximum number to be displayed" included in the region R20. In a case where the display of "search" included in the region R20 is selected (pressed), the generation history information of

the alarm type selected on the dashboard display screen DP1 and the generation history information of the related events selected in "item" included in the region R20 from the input start time to the input end time of the second period are displayed in the region R22.

[0095]

In the region R21, "generation date and time", "correctness determination", and "update" are displayed. The start time and the end time of the generation date and time input in the region R20 are displayed in "generation date and time" included in the region R21. One of "correct" or "incorrect" can be selected to be input in "correctness determination" included in the region R21. In other words, it is configured to input correctness of the generation of the alarm type selected on the dashboard display screen DP1 in "correctness determination" in the region R21. Accordingly, for example, the operator can register the correctness of the generation of the alarm type determined by viewing a graph, described later, by inputting the correctness into the system 30 or into the monitoring device 40. In a case where the display of "update" included in the region R21 is selected (pressed), the generation history information of the alarm type displayed in the region R22 and the generation history information of the related events are updated to the latest state.

[0096]

The generation history information of the alarm type in the second period is displayed in the region R22. By displaying the generation history information, in the second period, of the alarm type selected on the dashboard display screen DP1, it is possible to identify, for example, the generation interval, the generation density, and the generation timing of the alarm type in the second period.

[0097]

More specifically, a graph form in which the generation of the alarm type is arranged in time series based on the generation history information of the alarm type in the second period is displayed. In the example illustrated in Fig. 6, a graph in which each generation of the alarm type is plotted (drawn) in time series with a horizontal axis denoting time is displayed. By displaying the graph form in which the generation of the alarm type is arranged in time series based on the generation history information, in the second period, of the alarm type selected on the dashboard display screen DP1, it is possible to easily identify, for example, the generation interval, the generation density, and the generation timing of the alarm type in the second period.

[0098]

In addition, the generation history information of the related events in the second period is also displayed in the region R22. By displaying the generation history information of the related events in the second period together with the generation history information, in the second period, of the alarm type selected on the dashboard display screen DP1, it is possible to identify, for example, a causal relationship between the alarm type and the related events and the operation state of the plant at the time of generation of the alarm type.

[0099]

More specifically, a graph form in which the generation of the alarm type is arranged in time series based on the generation history information of the alarm type in the second period and in which the generation of the related events is arranged in time series based on the generation history information of the related events in the second period is displayed. In the example illustrated in Fig. 6, a graph in which each generation of the alarm type and of the related events is plotted (drawn) in time series with a horizontal axis denoting time is displayed. Here, in a case where the alarm type plotted as a white circle is, for example, an "alarm indicating that nitrogen oxide concentration in the exhaust gas exceeds a predetermined value", selecting, for example, an "alarm indicating that

oxygen concentration in the exhaust gas is below a predetermined value" as the related event plotted as a black rectangle displays, in the region R22, a graph form in which the generation history information of the alarm type in the second period and the generation history information of the related events in the second period are arranged in time series, and a causal relationship between both of the generation history information is perceived. By displaying the graph form in which the generation of the alarm type is arranged in time series based on the generation history information, in the second period, of the alarm type selected on the dashboard display screen DP1 and in which the generation of the related events is arranged in time series based on the generation history information of the related events in the second period, it is possible to easily identify, for example, the causal relationship between the alarm type and the related events and the operation state of the plant at the time of generation of the alarm type.

[0100]

As described above, the related events related to the alarm types are processes of the plant 1 or are alarms of a different type from the alarm types of which the generation frequency in the first period is displayed on the dashboard display screen DP1. Accordingly, it is possible to easily

identify the causal relationship between the alarm type selected on the dashboard display screen DP1 and other alarms or processes, a generation status of other alarms or processes at the time of generation of the alarm type, and the like.

[0101]

Next, a flow of processing performed by the system 30 according to the present embodiment will be described with reference to the flowchart in Fig. 7. This flowchart particularly illustrates a flow of processing of displaying the information related to the alarm generated in the plant 1. This processing is executed under control of the control unit 31. The content and order of steps illustrated below are merely an example, and the operation processing is not limited thereto.

[0102]

In addition, in the following description, it is assumed that the plant 1 is in operation, and that the acquisition unit 311 acquires the process data of the plant 1 through the DCS 20 and stores the process data in the process information DB 33A and acquires the alarm information (DCS alarm information) generated as a result of determining whether or not abnormality has occurred in the plant 1 via the DCS 20, and stores the alarm information in the alarm information DB 33B. In addition,

it is assumed that the alarm information (system alarm information) generated as a result of determining whether or not abnormality has occurred in the plant 1 via the system 30 is also stored in the alarm information DB 33B.

[0103]

The calculation unit 312 determines whether or not a predetermined time has elapsed (S11). Here, a length of the predetermined time is not particularly limited and, for example, may be in units of seconds such as 1 second, 5 seconds, 10 seconds, or 30 seconds or in units of minutes such as 1 minute or 2 minutes. It is preferable that the length of the predetermined period is as short as possible because a real-time property of information displayed on the dashboard display screen DP1 is improved. The length of the predetermined time may be arbitrarily settable by the operator or the like. The calculation unit 312 repeats step S11 until it is determined that the predetermined time has elapsed.

[0104]

In a case where it is determined that the predetermined period has elapsed (S11; Yes), the calculation unit 312 calculates the generation frequency of each alarm type in the first period based on the alarm information stored in the alarm information DB 33B (S12).

[0105]

Next, the display control unit 315 displays the generation frequency of each alarm type in the first period calculated by the calculation unit 312, in the region R13 of the dashboard display screen DP1 in the aspect of being arranged for each alarm type (S13). For example, as illustrated in Fig. 5, the display control unit 315 displays the bar graphs having a length corresponding to the generation frequency of each alarm type in the aspect of being in the descending order or the ascending order of the generation frequency.

[0106]

Next, the generation unit 313 determines whether or not one of a plurality of alarm types displayed in the region R13 of the dashboard display screen DP1 is selected (S14). As described above, for example, the operator can select an alarm type by moving the pointer or the cursor onto one of the bar graphs of each alarm type displayed in the region R13 and by double-clicking. The generation unit 313 repeats step S14 until it is determined that one of the plurality of alarm types is selected.

[0107]

In a case where it is determined that one of the plurality of alarm types is selected (S14; Yes), and where the operator selects the related events, the reception unit 314 receives the selection (S15). For example, the display

control unit 315 displays the generation history display screen DP2, and the reception unit 314 receives a selection of the related events related to the alarm type selected in step S14 in accordance with an operation of the operator performed on the region R20 of the generation history display screen DP2.

[0108]

Next, the generation unit 313 generates the generation history information indicating the generation history, in the second period, of the alarm type selected in step S14 based on the alarm information stored in the alarm information DB 33B and generates the generation history information indicating the generation history, in the second period, of the related events of the selection received in step S15 based on the process information stored in the process information DB 33A or on the alarm information stored in the alarm information DB 33B (S16).

[0109]

Next, the display control unit 315 displays the generation history information of the alarm type in the second period and the generation history information of the related events in the second period generated in step S15 in the region R22 of the generation history display screen DP2 (S17). The display of the generation history information of the alarm type in the second period and of

the generation history information of the related events in the second period may be in the graph form illustrated in Fig. 6 or may be in a list form. This ends the processing.

[0110]

As described above, according to the present embodiment, the generation frequency of each alarm type in the first period is displayed in the aspect of being arranged for each alarm type. Accordingly, the generation frequency of each alarm type in the first period can be visualized. Thus, for example, a defect that gradually progresses in a period can be prevented in advance by identifying the generation frequency of an alarm instead of simply identifying whether or not an alarm is generated.

[0111]

Aspects described through the above embodiment can be appropriately combined, changed, or improved to be used in accordance with their application. The present invention is not limited to the disclosure of the embodiment. It is apparent from the disclosure of the claims that such combined, changed, or improved embodiments may also fall within the technical scope of the present invention.

Reference Signs List

[0112]

1 Plant

- 2 Furnace
 - 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
 - 7a Pump
- 8 Steam drum
 - 8a Downcast pipe
 - 8b Saturated vapor pipe
- 10 Superheater
 - 10a Pipe
- 12 Coal economizer
- 13 Region
- 21 Pipe
- 22 Pipe
- 30 System
 - 30a CPU
 - 30d Communication unit

30e Input unit
30f Display unit
31 Control unit
32 Display device
100 Turbine
102 Condenser
311 Acquisition unit
312 Calculation unit
313 Generation unit
314 Reception unit
315 Display control unit

CLAIMS

1. A display device that displays an operation state of a plant,

wherein for a plurality of alarms generated in the plant, a generation frequency of each alarm type indicating a type of the alarm in a first period is displayed in an aspect of being arranged for each alarm type.

2. The display device according to claim 1,

wherein the displaying of the generation frequency of each alarm type in the first period in the aspect of being arranged for each alarm type is displaying the generation frequency of each alarm type in the first period in a graph form.

3. The display device according to claim 2,

wherein the displaying of the generation frequency of each alarm type in the first period in the aspect of being arranged for each alarm type is arranging and displaying bar graphs corresponding to the generation frequency of each alarm type in the first period in a descending order or an ascending order of the generation frequency for each alarm type.

4. The display device according to any one of claims 1 to 3,

wherein for the alarm type of which the generation frequency in the first period is displayed, a generation history of the alarm type in a second period included in the first period is further displayed.

5. The display device according to claim 4,

wherein a generation history of a related event related to the alarm type in the second period is further displayed together with the generation history of the alarm type in the second period.

6. The display device according to claim 5,

wherein the related event is a process of the plant or is the alarm of a different type from the alarm type of which the generation frequency in the first period is displayed.

7. The display device according to any one of claims 1 to 6,

wherein the first period is a period of a part of an operation period of the plant.

8. The display device according to any one of claims 1 to 7,

wherein the generation frequency is the number of generations.

9. A control device that controls a display device that displays an operation state of a plant, the control device comprising:

an acquisition unit that acquires alarm information indicating an alarm generated in the plant;

a calculation unit that calculates a generation frequency of each alarm type indicating a type of the alarm in a first period based on the alarm information; and

a display control unit that causes the display device to display the calculated generation frequency of each alarm type in the first period in an aspect of being arranged for each alarm type.

10. The control device according to claim 9, further comprising:

a generation unit that, for the alarm type of which the generation frequency in the first period is displayed, generates generation history information indicating a generation history of the alarm type in a second period

included in the first period based on the alarm information,

wherein the display control unit causes the display device to further display the generated generation history information in the second period.

11. The control device according to claim 10,

wherein the display control causes the display device to further display a graph form in which generation of the alarm type is arranged in time series based on the generated generation history information in the second period.

12. The control device according to claim 10 or 11, further comprising:

a reception unit that receives a selection of a related event related to the alarm type of which the generation frequency in the first period is displayed,

wherein the generation unit generates generation history information indicating a generation history of the selected related event in the second period based on process information of the plant or on the alarm information, and

the display control unit causes the display device to display the generated generation history information of the

related event in the second period together with the generated generation history information of the alarm type in the second period.

13. The control device according to claim 12, wherein the display control unit causes the display device to further display a graph form in which generation of the alarm type is arranged in time series based on the generated generation history information of the alarm type in the second period and in which generation of the related event is arranged in time series based on the generated generation history information of the related event in the second period.

14. The control device according to claim 13, further comprising:

a correctness input unit configured to input correctness of generation of the alarm type of which the generation frequency in the first period is displayed.

15. A control method of controlling a display device that displays an operation state of a plant, the control method comprising:

a step of acquiring alarm information indicating an alarm generated in the plant;

a step of calculating a generation frequency of each alarm type indicating a type of the alarm in a first period based on the alarm information; and

a step of causing the display device to display the calculated generation frequency of each alarm type in the first period in an aspect of being arranged for each alarm type.

16. A program for controlling a display device that displays an operation state of a plant, the program causing a computer to execute:

a step of acquiring alarm information indicating an alarm generated in the plant;

a step of calculating a generation frequency of each alarm type indicating a type of the alarm in a first period based on the alarm information; and

a step of causing the display device to display the calculated generation frequency of each alarm type in the first period in an aspect of being arranged for each alarm type.