

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 information related to an alarm generated in a plant.

Background Art

[0002]

In operation of a plant, a multiple number of alarms of multiple types are generated. PTL 1 discloses generation of a large amount of warning in plant monitoring.

Citation List

Patent Literature

[0003]

[PTL 1] Japanese Unexamined Patent Publication No.

2008-46925

Summary of Invention

Technical Problem

[0004]

Among alarms, there is an alarm that has low urgency or low importance and thus, does not require action even in a case where the alarm is generated. Thus, an operator of a plant determines whether or not to perform any kind of action with respect to the alarm when the alarm is generated. Identifying a generation tendency of the alarm in the past may be effective in order to determine whether or not action is required with respect to the alarm.

[0005]

An exemplary object of an aspect of the present invention is to provide a display device, a control device, and a control method that enable easy identification of a generation tendency of an alarm in the past.

Solution to Problem

[0006]

In order to solve the problem, a display device of an aspect of the present invention is a display device that displays an operation state of a plant, and displays statistical information of an alarm generated in the plant in association with a type of the alarm.

[0007]

The statistical information may include information about a tendency of change in a predetermined period.

[0008]

The tendency of change may include a tendency of change in an average number of generations of the alarm between a first period and a second period.

[0009]

The tendency of change may include a tendency of change in a standard deviation of the number of generations of the alarm between a first period and a second period.

[0010]

The tendency of change may include a tendency of change in a maximum value of the number of generations of the alarm per day between a first period and a second period.

[0011]

The statistical information may include information about the number of elapsed days from a first or last day on which the alarm is generated.

[0012]

The statistical information may include information about the number of elapsed days from a day on which the maximum number of issues of the alarm per day is made.

[0013]

In the display device, importance or urgency of action determined with respect to the alarm based on an average number of generations of the alarm in the predetermined period and on the number of days on which the alarm is generated in the predetermined period may be displayed.

[0014]

A control device of an aspect of the present invention is a control device that controls a display device which displays an operation state of a plant, the control device including an acquisition unit that acquires information about an alarm generated in the plant, a calculation unit that calculates statistical information related to the generation of the alarm for each type of the alarm based on the information acquired by the acquisition unit, and a display control unit that displays the calculated statistical information and the type of the alarm on the display device in association with each other.

[0015]

The control device may further include a reception unit that receives a selection of a period, in which the display control unit displays the statistical information in the selected period and the type of the alarm on the display device in association with each other.

[0016]

A control method of an 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 acquiring information about an alarm generated in the plant, calculating statistical information related to the generation of the alarm for each type of the alarm based on the information acquired by the acquisition unit, and displaying the calculated statistical information and the type of the alarm on the display device in association with each other.

[0017]

In the control method, a selection of a period may be received, and the displaying may include displaying the statistical information in the selected period and the type of the alarm on the display device in association with each other.

[0018]

A program of an aspect of the present invention is a program causing a computer to execute a control method of controlling a display device that displays an operation state of a plant, the control method including acquiring information about an alarm generated in the plant, calculating statistical information related to the generation of the alarm for each type of the alarm based on the information acquired by the acquisition unit, and

displaying the calculated statistical information and the type of the alarm on the display device in association with each other.

[0019]

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

[0020]

According to the present invention, it is possible to provide a display device, a control device, and a control method that enable identification of a generation tendency of an alarm in the past.

Brief Description of Drawings

[0021]

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

Fig. 2 is a block diagram illustrating a configuration 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 for describing an example of statistical information according to the present embodiment.

Fig. 5 is a diagram illustrating transitions among various display screens according to the present embodiment.

Fig. 6 is a diagram illustrating an example of a statistical information display screen according to the present embodiment.

Fig. 7 is a diagram illustrating an example of an alarm map display screen according to the present embodiment.

Fig. 8 is a flowchart illustrating an example of operation processing according to the present embodiment.

Description of Embodiments

[0022]

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.

[0023]

[Description of Plant]

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.

[0024]

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.

[0025]

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.

[0026]

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.

[0027]

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.

[0028]

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.

[0029]

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.

[0030]

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.

[0031]

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.

[0032]

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.

[0033]

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.

[0034]

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 u1 (an example of "process data") supplied by the pump 7a is illustrated.

[0035]

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 u2 (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 u3 (an example of the "process data") supplied to the turbine 100 from the superheater 10 is illustrated, and a saturated vapor flow rate u4 (an example of the "process data") supplied to the superheater 10 from the steam drum 8 is illustrated. The makeup water flow rate u1 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.

[0036]

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.

[0037]

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.

[0038]

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

[0039]

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.

[0040]

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 statistical calculation unit 312, a reception unit 313, a display control unit 314, and an alarm determination unit 315 as functional configurations. The storage unit 33 stores various types of data and, for example, stores alarm information DB 33A and alarm statistical information DB 33B.

[0041]

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 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.

[0042]

The alarm determination unit 315 determines whether or not abnormality or the like has occurred in the plant 1 based on the process data acquired by the acquisition unit 311, and determines that abnormality has occurred. Specifically, the alarm determination unit 315 evaluates the process data in accordance with the alarm determination logic set in advance. Based on the alarm determination

logic, the alarm determination unit 315 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. For example, the alarm determination unit 315 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.

[0043]

In a case where it is determined that abnormality has occurred, the alarm determination unit 315 outputs information (hereinafter, referred to as "alarm information") about the alarm for the process data to the statistical calculation unit 312 and to the display control unit 314. The alarm information is information about the alarm (warning) for the abnormality that has occurred, and includes, for example, an alarm item (type of the alarm), a generation date and time of the alarm, and a value (for example, a value of the makeup water flow rate u1 or of the

boiler feedwater flow rate u2 determined as being abnormal)
of the process data related to the alarm.

[0044]

The statistical calculation unit 312 calculates statistical information related to the generation of the alarm for each type of alarm based on the alarm information stored in the alarm information DB 33A (and the alarm information acquired from the alarm determination unit 315). The statistical information calculated by the statistical calculation unit 312 includes arbitrary statistical information related to the abnormality that has occurred in the plant 1. For example, the statistical information related to the generation of the alarm may be information about a generation tendency of the alarm collected based on a generation history of the alarm. For example, the statistical information may include at least any of an average value of the number of generations of the alarm per day, a standard deviation of the number of generations of the alarm per day, or a maximum value of the number of generations of the alarm per day. Above statistical values are not limited to values per day and may be values per another period (for example, one week, one month, or one year). In addition, the statistical information may include, for example, information about a

tendency of change in the statistical information between different periods.

[0045]

For example, the statistical calculation unit 312 calculates the statistical information related to the alarm generated in the plant 1 for each type of alarm at an arbitrary timing (for example, a timing at which the alarm is generated, daily, weekly, or monthly) set in advance. The type of the alarm for calculating the statistical information can be classified using an arbitrary method. For example, the type of the alarm may be classified for each sensor for measuring the state of the plant 1. In this case, for example, the type 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.

[0046]

A specific example of the statistical information will be described with reference to Fig. 4. Fig. 4 illustrates a specific example of the statistical information that can be calculated by the statistical calculation unit 312. Each statistical information can be calculated for each type of alarm. Specifically, the statistical information calculated for each of a plurality of different periods is illustrated

in Fig. 4. For example, a short term (last one week), a medium term (last 1.5 months), and a long term (past one year) are illustrated as the plurality of different periods. In addition, a plurality of types of the statistical information calculated for each period are illustrated. An average [times/day], a standard deviation [times/day], a maximum [times/day], and a ratio of days of issues [%] are illustrated as the plurality of types of the statistical information. Meanings of each statistical information are described in Fig. 4.

[0047]

In addition, in Fig. 4, information about a tendency of change in a predetermined period (for example, the short term and the medium term) is illustrated as the statistical information. The tendency of change is a tendency of change in the statistical information between a certain period (first period) and another period (second period). The tendency of change includes, for example, a tendency of change in an average number of generations of the alarm between the first period and the second period. In Fig. 4, for example, a value obtained by subtracting the average [times/day] in the past one year from the average [times/day] in the last one week is illustrated as the tendency of change in the short term. In addition, a value obtained by subtracting the average [times/day] in the past

one year from the average [times/day] in the last 1.5 months is illustrated as the tendency of change in the medium term.

[0048]

While the tendency of change for the average number of generations of the alarm is illustrated in Fig. 4, the present invention is not limited thereto. The statistical information that can be calculated by the statistical calculation unit 312 may include a tendency of change in the standard deviation of the number of generations of the alarm between the first period and the second period. The tendency of change in the standard deviation can be calculated by substituting the standard deviation of the number of generations of the alarm for the average number of generations of the alarm in calculating the tendency of change in the average number of generations of the alarm between the first period and the second period.

[0049]

In addition, the statistical information that can be calculated by the statistical calculation unit 312 may include a tendency of change in the maximum value of the number of generations of the alarm per day between the first period and the second period. The tendency of change in the standard deviation can be calculated by substituting the maximum value of the number of generations of the alarm

per day for the average number of generations of the alarm in calculating the tendency of change in the average number of generations of the alarm between the first period and the second period.

[0050]

In Fig. 4, furthermore, the latest issue [number of days], the earliest issue [number of days], and the maximum number of issues [number of days] are illustrated as the statistical information related to the number of elapsed days for the generation of the alarm. The latest issue [number of days] is the number of elapsed days from the last day on which the same type of the alarm is generated (the latest day on which the alarm is generated). For example, in a case where the current date is January 20, 2020 and where the latest day on which a target type of the alarm is generated is January 15, 2020, the latest issue [number of days] is 5.

[0051]

The earliest issue [number of days] is the number of elapsed days from the first day on which the same type of the alarm is generated (the earliest day). For example, in a case where the current date is January 20, 2020 and where the earliest day on which the target type of the alarm is generated is January 14, 2020, the earliest issue [number of days] is 6.

[0052]

The maximum number of issues [number of days] is the number of elapsed days from a day on which the maximum number of generations of the alarm of the same type per day is made. For example, in a case where the current date is January 20, 2020 and where the day on which the maximum number of generations of the alarm of the target type is made is January 17, 2020, the maximum number of issues [number of days] is 3.

[0053]

Fig. 2 will be described again. The reception unit 313 receives input of various types of information, instructions, selections, and the like corresponding to operations of an operator. The reception unit 313 receives, for example, an instruction for display screen transition, a designation, an input, or a selection of the planned stoppage period, and a selection of a period in which the alarm for calculating the statistical information is generated.

[0054]

The display control unit 314 generates display data based on the acquired process data, the alarm information, and various types of the statistical information calculated based on the alarm information and displays a display screen based on the display data on the display device 32.

That is, the display control unit 314 controls display of information related to an operation state of the plant 1 on the display device 32, such as display of the process data and of the statistical information of the alarm and issuing of the alarm. An example of the screen displayed on the display device 32 will be described later.

[0055]

The alarm information DB 33A stores the alarm information acquired from the alarm determination unit 315. That is, the alarm information DB 33A stores the alarm information related to the alarm generated so far (history information of the alarm). The alarm information includes, for example, the alarm item (type of the alarm), the generation date and time of the alarm, and the value (for example, the value of the makeup water flow rate u1 or of the boiler feedwater flow rate u2 determined as being abnormal) of the process data related to the alarm.

[0056]

The alarm statistical information DB 33B stores the statistical information that is calculated by the statistical calculation unit 312 and that is related to the generation of the alarm in the plant. An example of the statistical information is described above.

[0057]

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 314. Various display screens displayed by the display device 32 will be described later.

[0058]

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.

[0059]

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.

[0060]

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.

[0061]

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.

[0062]

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. 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, information related to the generated alarm, and the planned stoppage period.

[0063]

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.

[0064]

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.

[0065]

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.

[0066]

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.

[0067]

In addition, the system 30 may include a high-capacity storage device configured with a hard disk drive (HDD) or the like separately from the configurations illustrated in Fig. 3. Data stored in the storage device is processed by the CPU 30a. In addition, data of a processing result of the CPU 30a is stored in the storage device.

[0068]

Fig. 5 is a diagram illustrating a summary of transitions among various display screens displayed on the display device 32 in the present embodiment. As illustrated in Fig. 5, the display device 32 displays a login display screen DP0, a statistical information display screen DP1, and an alarm map display screen DP2. Arrows between each display screen illustrated in Fig. 5 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 statistical information display screen DP1 and to the alarm map display screen DP2 based on an instruction 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. For example, a transition may be made to a screen (for example, a menu screen) not illustrated in Fig. 5 before a transition is made to a certain screen illustrated in Fig. 5. The statistical information display screen DP1 may have a plurality of types of screens. The alarm map display screen DP2 may have a plurality of types of screens.

[0069]

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 statistical information display screen DP1, the alarm map display screen DP2, and the like.

[0070]

The statistical information display screen DP1 is a screen on which the statistical information of the alarm generated in the plant 1 is displayed as the operation state of the plant. The statistical information displayed on the statistical information display screen DP1 is the

statistical information calculated by the statistical calculation unit 312. The statistical information of the alarm displayed on the statistical information display screen DP1 may be displayed in an aspect of being associated with the type of the generated alarm. Display of the statistical information in an aspect of being associated with the type of the generated alarm means an aspect in which the statistical information and the type of the alarm are displayed such that the statistical information for a certain type of the alarm can be easily identified. For example, display of the statistical information in an aspect of being associated with the type of the generated alarm includes display of the type of the alarm and of the statistical information corresponding to the type of the alarm adjacent to each other.

[0071]

The alarm map display screen DP2 is a screen displayed for assisting the operator of the plant 1 in determining whether or not any kind of action is required with respect to the generated alarm. For example, importance or urgency of action with respect to the generated alarm is displayed on the alarm map display screen DP2. For example, the importance or urgency of action may be determined based on the average number of generations of the alarm in the predetermined period and on the number of days on which the

alarm is generated in the predetermined period. A specific example of the alarm map display screen DP2 will be described later.

[0072]

Next, an example of the statistical information display screen DP1 displayed on the display device 32 will be described with reference to Fig. 6. The statistical information display screen DP1 illustrated in Fig. 6 includes a region R61 and a region R62.

[0073]

The region R61 shows the alarm information generated in the plant 1. The alarm information displayed in the region R61 includes the date and time of the alarm generated in the plant 1 (generation date and time) and an item of the generated alarm (alarm item). The alarm item indicates the type of the generated alarm. In the example illustrated in Fig. 6, for example, "alarm A" and "alarm B" are illustrated as the alarm item. In addition, the generation date and time and the alarm item are displayed in association with each other for the generated alarm.

[0074]

The region R62 shows various types of the statistical information of the alarm generated in the plant 1. The statistical information of the alarm includes the statistical information for the last one week, the last 1.5

months, and the past one year. The statistical information of the alarm further includes the statistical information of the tendency of change and of the number of elapsed days. Meanings of each statistical information are described with reference to Fig. 4. Thus, meanings of each statistical information will not be described here.

[0075]

As described above, according to the present embodiment, the display device 32 displays the statistical information of the alarm generated in the plant 1 in association with the type of the alarm. Consequently, the operator of the plant 1 can identify the statistical information for the generation of the alarm for each type of alarm so far. In addition, the operator can identify the generation tendency of the currently generated alarm (for example, whether or not the alarm is frequently generated) based on the statistical information. Consequently, the operator can determine the urgency or the importance of action with respect to the alarm.

[0076]

In addition, the statistical information displayed on the display device 32 includes information about the tendency of change in the predetermined period (for example, the short term or the medium term). Consequently, the operator of the plant 1 can identify the generation

tendency of the alarm so far and can determine the urgency or the importance of action with respect to the currently generated alarm by determining whether or not the alarm is different from the tendency so far through comparison with the generation tendency.

[0077]

Next, an example of the alarm map display screen DP2 displayed on the display device 32 will be described with reference to Fig. 7. In Fig. 7, an alarm map representing a relationship between the average number (average [times/day]) of generations of the alarm in the predetermined period (for example, one year) and a ratio (ratio of days of issues [%]) of days on which the alarm is generated in the predetermined period (for example, the same one year) is illustrated as the alarm map display screen DP2. For example, the ratio of days of issues [%] in one year (365 days) is calculated based on the following equation.

$$\text{Ratio of days of issues [\%]} = \{(\text{number of days on which alarm is generated in one year}) / 365\} \times 100$$

[0078]

Point a1 is a point plotted (mapped) at a position corresponding to the generated alarm on the alarm map based on the average [times/day] of alarms of the same type as the alarm and on the ratio of days of issues [%].

[0079]

In addition, the alarm map illustrated in Fig. 7 is divided into four regions of R61 to R64. R61 is a region in which both of the average [times/day] and the ratio of days of issues [%] are small. R62 is a region in which the average [times/day] is low and in which the ratio of days of issues [%] is high. R63 is a region in which the average [times/day] is low and in which the ratio of days of issues [%] is high. R64 is a region in which the average [times/day] is high and in which the ratio of days of issues [%] is low.

[0080]

In a case where the generated alarm is plotted in the region R61, the alarm is statistically not an alarm that has been frequently generated so far, and may be an unusual alarm. Thus, it may be determined that the urgency or importance of action is high.

[0081]

In a case where the generated alarm is plotted in the region R62, the ratio of days of issues [%] is high. Thus, the alarm is considered to be usually periodically generated, and it may be determined that the urgency or importance of action is low.

[0082]

In a case where the generated alarm is plotted in the region R63, the average [times/day] is high, and the ratio of days of issues [%] is also high. Thus, the alarm is considered to be usually periodically generated, and it may be determined that the urgency or importance of action is low.

[0083]

In a case where the generated alarm is plotted in the region R64, the ratio of days of issues [%] is low, and the average [times/day] is high. Thus, the generation of the alarm may be concentrated at a specific time (for example, when the plant 1 is started). In this case, it may be determined that the urgency or importance of action is low for the alarm.

[0084]

Point a1 is shown in the region R61. Thus, according to the above, the alarm map display screen DP2 shows that the alarm related to point a1 is an alarm having high urgency or importance of action. Similarly, according to the above, in a case where the point corresponding to the alarm is displayed in the region R62, R63, or R64, the alarm map display screen DP2 shows that the alarm has low urgency or importance of action.

[0085]

As described above, according to the present embodiment, the display device 32 displays the importance or urgency of action that is determined with respect to the alarm based on the average number of generations of the alarm in the predetermined period and on the number of days on which the alarm is generated in the predetermined period. Consequently, the operator of the plant 1 can easily determine whether or not to perform action with respect to abnormality related to the generated alarm.

It is also possible to identify a tendency of improvement or of deterioration in the operation state from a temporal change in the generation tendency of the alarm using the alarm map display screen DP2 illustrated in Fig. 7. For example, by comparing the alarm map display screen DP2 on which the alarm generated in the last one year is mapped with the alarm map display screen DP2 on which the alarm generated in the last one week is mapped, it is possible to identify in which region (in which region of the regions R61 to R64) of the alarm map display screen DP2 the number of alarms is increased or decreased in the last one week, by comparison with the last one year. By performing such analysis, it is possible to manage the operation of the plant or create policies in a macroscopic and long-term manner. In addition, a degree of impact of the generated alarm can be easily identified by changing a

method (for example, a size) of highlighted display of a mark to be mapped in accordance with the degree of impact of the generated alarm.

[0086]

[Display Method]

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. 8. 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.

[0087]

First, during the operation of the plant 1, the acquisition unit 311 acquires the process data of the plant 1 from the DCS 20 (S11). The acquisition unit 311 may store the process data sequentially supplied from the DCS 20 in the storage unit 33 or the like. Then, the alarm determination unit 315 evaluates the process data acquired in step S11 based on the alarm determination logic and determines whether or not an alarm is generated based on occurrence of abnormality in the plant 1. In a case where the alarm determination unit 315 determines that

predetermined abnormality has occurred in the plant 1 and determines that it is required to issue an alarm (Yes in step S13), the processing transitions to step S14. Otherwise (No in step S13), the processing illustrated in Fig. 8 ends.

[0088]

In step S14, the statistical calculation unit 312 calculates the statistical information for the generated alarm. For example, the statistical information is calculated based on the alarm information generated in the past and on the alarm information for the abnormality determined as having occurred in step S13. The alarm information for the abnormality determined as having occurred in step S13 may not be used for calculating the statistical information in step S14. An example of the calculated statistical information and a method of calculating the statistical information are already described with reference to Fig. 4 and the like.

[0089]

Next, the display control unit 314 performs a control for displaying the alarm information for the abnormality determined as having occurred in step S13 and the statistical information calculated in step S14 on the display device 32 (S15). For example, the display control unit 314 performs a control for displaying the statistical

information of the alarm generated in the plant 1 on the display device 32 in association with the type of the alarm. An example of the statistical information displayed by the display device 32 is described with reference to Fig. 6 and the like.

[0090]

Next, the display control unit 314 classifies the alarm for the abnormality determined as having occurred in step S13 (S16) and performs a control for displaying a classification result of the alarm on the display device 32 (S17). For example, the importance or urgency of action with respect to the alarm is determined based on the average number of generations of the alarm in the predetermined period and on the number of days on which the alarm is generated in the predetermined period. The alarm is classified based on a determination result. For example, the classification result of the alarm corresponding to the importance or urgency of action is displayed on the display device 32 as in the screen illustrated in Fig. 7.

[0091]

As described above, according to the present embodiment, for example, the display device 32 displays the statistical information of the alarm generated in the plant 1 in association with the type of the alarm. Consequently,

the generation tendency of the alarm in the past can be easily identified.

[0092]

As a modification example of the processing illustrated in Fig. 8, the system 30 may not perform the processing in steps S16 and S17, and the operator or the like may classify the alarm (determine the importance or urgency of action).

[0093]

Aspects described through the 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

[0094]

- 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 Statistical calculation unit
- 313 Reception unit
- 314 Display control unit
- 315 Alarm determination unit

CLAIMS

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

wherein statistical information for each type of an alarm generated in the plant is displayed in an aspect of being associated with the type of the alarm.

2. The display device according to claim 1,

wherein the statistical information includes information about a tendency of change in a predetermined period.

3. The display device according to claim 2,

wherein the tendency of change includes a tendency of change in an average number of generations of the alarm between a first period and a second period.

4. The display device according to claim 2,

wherein the tendency of change includes a tendency of change in a standard deviation of the number of generations of the alarm between a first period and a second period.

5. The display device according to claim 2,

wherein the tendency of change includes a tendency of change in a maximum value of the number of generations of the alarm per day between a first period and a second period.

6. The display device according to any one of claims 1 to 5,

wherein the statistical information includes information about the number of elapsed days from a first or last day on which the alarm is generated.

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

wherein the statistical information includes information about the number of elapsed days from a day on which the maximum number of issues of the alarm per day is made.

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

wherein importance or urgency of action determined with respect to the alarm based on an average number of generations of the alarm in the predetermined period and on the number of days on which the alarm is generated in the predetermined period is displayed.

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

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

a calculation unit that calculates statistical information related to the generation of the alarm for each type of the alarm based on the alarm information acquired by the acquisition unit; and

a display control unit that displays the calculated statistical information and the type of the alarm on the display device in association with each other.

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

a reception unit that receives a selection of a period,

wherein the display control unit displays the statistical information in the selected period and the type of the alarm on the display device in association with each other.

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

acquiring alarm information related to an alarm generated in the plant;

calculating statistical information related to the generation of the alarm for each type of the alarm based on the acquired alarm information; and

displaying the calculated statistical information and the type of the alarm on the display device in association with each other.

12. The control method according to claim 11, wherein a selection of a period is received, and the displaying includes displaying the statistical information in the selected period and the type of the alarm on the display device in association with each other.

13. A program causing a computer to execute a control method of controlling a display device that displays an operation state of a plant, the control method comprising:

acquiring alarm information related to an alarm generated in the plant;

calculating statistical information related to the generation of the alarm for each type of the alarm based on the acquired alarm information; and

displaying the calculated statistical information and the type of the alarm on the display device in association with each other.

14. The program according to claim 13,
wherein a selection of a period is received, and
the displaying includes displaying the statistical information in the selected period and the type of the alarm on the display device in association with each other.