

PLANT MONITORING SUPPORT SYSTEM, PLANT MONITORING SUPPORT
METHOD, AND STORAGE MEDIUM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority to and incorporates by reference the entire contents of Japanese Patent Application No. 2021-015284 filed in Japan on February 2, 2021.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present disclosure relates to a plant monitoring support system, a plant monitoring support method, and a storage medium for a plant monitoring support program, which support monitoring of a plant.

2. Description of the Related Art

[0003] In a large-scale plant such as a water and sewage plant, a power generation plant, a chemical plant, or an iron and steel plant, measurement devices such as sensors are disposed at important points of facilities provided in the plant, and measurement information sets that are information on measured values obtained by these measurement devices are collected and centrally monitored by a monitoring control device.

[0004] An operator performs monitoring control on the plant by inputting control information for controlling the plant while estimating a state of the plant from the measurement information sets collected by the monitoring control device, but in a large-scale plant, it is not easy to estimate the state of the plant from the measurement information sets because the amount of the measurement information collected by the monitoring control device is enormous.

[0005] In this situation, a plant monitoring support system has been proposed, which has a function of supporting operator's monitoring such as an anomaly detection function of detecting an anomaly of the measurement information. For example, Japanese Patent Application Laid-open No. 2016-81482 discloses a plant monitoring system configured to classify measurement information sets collected by a monitoring control device into categories, and calculates an alert level from a relationship between the categories in the classification and the measurement information sets to display the alert level.

[0006] In the plant described above, a mechanism for automatic control is incorporated in various kinds of facilities, and when one of measured values degrades due to some failure of a certain facility, the mechanism for

automatic control works to restore the degradation of the measured value to normal.

[0007] However, in a case where an underlying failure is not resolved, when the mechanism for automatic control works to restore the degradation of the measured value caused by the failure of the certain facility to normal, a transition of a state anomaly such as degradation of the measured value in another facility that has been normal may be caused, and some influence of such a transition of a state anomaly may lead to a phenomenon of the measured value that has been restored to normal becoming abnormal again. In such a case, the prior art described above may be unable to properly perform anomaly determination on the plant in some cases.

[0008] The present disclosure has been made in view of the above circumstances, and an object thereof is to provide a plant monitoring support system that supports monitoring of a state in which two or more state anomalies influence each other in a plant.

SUMMARY OF THE INVENTION

[0009] In order to solve the above-mentioned problems and achieve the object, one aspect of the present disclosure provides a plant monitoring support system comprising: an information collection unit to collect

measurement information outputted by a measurement device provided in a plant; a state determination information acquisition unit to acquire state determination information including determination condition information in which information on a condition for determining a state anomaly of the plant is included for each type of the state anomaly; a state anomaly determination unit to determine a type and a period of occurrence of the state anomaly having occurred in the plant, on the basis of the measurement information collected by the information collection unit and the state determination information acquired by the state determination information acquisition unit; an anomaly information generation unit to generate anomaly information including state anomaly transition information that indicates a transition of the state anomaly having occurred in the plant, on the basis of a determination result obtained by the state anomaly determination unit; and an information output unit to output the anomaly information generated by the anomaly information generation unit.

[0010] Another aspect of the present disclosure provides a plant monitoring support method implemented by a computer, the method comprising: a first step of collecting measurement information outputted by a measurement device provided in a plant; a second step of acquiring state

determination information including determination condition information in which information on a condition for determining a state anomaly of the plant is included for each type of the state anomaly; a third step of determining a type and a period of occurrence of the state anomaly having occurred in the plant, on the basis of the measurement information collected by the first step and the state determination information acquired by the second step; a fourth step of generating anomaly information including state anomaly transition information that indicates a transition of the state anomaly having occurred in the plant, on the basis of a determination result obtained by the third step; and a fifth step of outputting the anomaly information generated by the fourth step.

[0011] A further aspect of the present disclosure provides a storage medium in which a plant monitoring support program is stored, the program causing a computer to execute: a first step of collecting measurement information outputted by a measurement device provided in a plant; a second step of acquiring state determination information including determination condition information in which information on a condition for determining a state anomaly of the plant is included for each type of the state anomaly; a third step of determining a type and a period of occurrence of the state anomaly having occurred in the

plant, on the basis of the measurement information collected by the first step and the state determination information acquired by the second step; a fourth step of generating anomaly information including state anomaly transition information that indicates a transition of the state anomaly having occurred in the plant on the basis of a determination result obtained by the third step; and a fifth step of outputting the anomaly information generated by the fourth step.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. 1 is a diagram illustrating an example of a configuration of a plant monitoring support system according to a first embodiment;

FIG. 2 is a table illustrating an example of state determination information stored in a state determination information storage unit according to the first embodiment;

FIG. 3 is a table illustrating an example of state determination result information stored in a state determination result information storage unit according to the first embodiment;

FIG. 4 is a diagram illustrating an example of a state transition image displayed on an input/output device according to the first embodiment;

FIG. 5 is a flowchart illustrating an example of

processing performed by the plant monitoring support system according to the first embodiment;

FIG. 6 is a flowchart illustrating an example of state anomaly determination processing performed by the plant monitoring support system according to the first embodiment;

FIG. 7 is a flowchart illustrating an example of state transition determination processing performed by the plant monitoring support system according to the first embodiment;

FIG. 8 is a diagram illustrating an example of a hardware configuration of the plant monitoring support system according to the first embodiment;

FIG. 9 is a diagram illustrating an example of a configuration of a plant monitoring support system according to a second embodiment;

FIG. 10 is a diagram illustrating an example of a state transition image displayed on an input/output device according to the second embodiment;

FIG. 11 is a flowchart illustrating an example of state transition determination processing performed by the plant monitoring support system according to the second embodiment;

FIG. 12 is a diagram illustrating an example of a configuration of a plant monitoring support system

according to a third embodiment;

FIG. 13 is a flowchart illustrating an example of processing performed by the plant monitoring support system according to the third embodiment;

FIG. 14 is a flowchart illustrating an example of condition update processing performed by the plant monitoring support system according to the third embodiment;

FIG. 15 is a diagram illustrating an example of a configuration of a plant monitoring support system according to a fourth embodiment;

FIG. 16 is a diagram illustrating an example of a state transition image displayed on an input/output device according to the fourth embodiment;

FIG. 17 is a flowchart illustrating an example of related signal update processing performed by the plant monitoring support system according to the fourth embodiment;

FIG. 18 is a diagram illustrating an example of a configuration of a plant monitoring support system according to a fifth embodiment;

FIG. 19 is a diagram illustrating an example of a state transition image displayed on an input/output device according to the fifth embodiment;

FIG. 20 is a flowchart illustrating an example of

processing performed by the plant monitoring support system according to the fifth embodiment; and

FIG. 21 is a flowchart illustrating an example of state transition determination processing performed by the plant monitoring support system according to the fifth embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] Hereinafter, a plant monitoring support system, a plant monitoring support method, and a plant monitoring support program according to embodiments will be described in detail with reference to the drawings accompanied therewith.

[0014] First Embodiment.

FIG. 1 is a diagram illustrating an example of a configuration of a plant monitoring support system according to a first embodiment. A plant monitoring support system 100 illustrated in FIG. 1 supports monitoring of a plant 1. The plant 1 is, for example, a plant such as a water and sewage plant, a power generation plant, a chemical plant, or an iron and steel plant but may be a different plant other than these plants.

[0015] As illustrated in FIG. 1, the plant monitoring support system 100 includes an information collection unit 10, a measurement information storage unit 11, a state

determination information storage unit 12, a measurement information acquisition unit 13, a state determination information acquisition unit 14, a state anomaly determination unit 15, a state determination result information storage unit 16, an information acquisition unit 17, an anomaly information generation unit 18, an information output unit 19, and an input/output device 20.

[0016] The information collection unit 10 collects measurement information sets that are information on measurement signals including measured values obtained by a plurality of measurement devices 2_1 to 2_n provided in the plant 1, via a network (not illustrated). The character "n" is, for example, an integer of 2 or more. The network (not illustrated) is a wide area network (WAN) such as the Internet, a local area network (LAN), or the like. The information collection unit 10 causes the measurement information storage unit 11 to store the collected measurement information sets of the measurement devices 2_1 to 2_n in the unit 11.

[0017] In a case where the plant 1 is a water and sewage plant, the measurement devices 2_1 to 2_n correspond to, for example, a flow rate sensor and a biochemical oxygen demand (BOD) sensor that detects the BOD of influent water, a water temperature sensor, an NH_3 sensor, a dissolved oxygen sensor, an active microbe concentration sensor, a total

nitrogen concentration sensor, an ammoniacal nitrogen concentration sensor, or the like.

[0018] In a case where the plant 1 is a power generation plant, the measurement devices 2_1 to 2_n correspond to, for example, an electric voltage sensor, an electric current sensor, a temperature sensor, a position sensor, or the like. The following description will be made based on the assumption that the plant 1 is a water and sewage plant, but the present disclosure is not limited to such an example. Also, in the following description, the measurement devices 2_1 to 2_n may be represented as a measurement device 2 or measurement devices 2 when they are not distinguished therebetween.

[0019] As described above, the measurement device 2 outputs the measurement information that is the information of the measurement signal including the measured value. For example, in the case where the measurement device 2 is a flow rate sensor, the device 2 outputs the measurement information that is the information of the measurement signal including a flow rate as a measured value, and in the case where the measurement device 2 is a voltage sensor, the device 2 outputs the measurement information that is the information of the measurement signal including a voltage value as a measured value.

[0020] The state determination information storage unit

12 stores state determination information therein. The state determination information includes determination condition information including a determination condition that is a condition for determining a state anomaly of the plant 1 for each type of state anomalies, priority information indicating a degree of priority of a state anomaly, and related signal information indicating information of a related signal that is a signal related to a state anomaly.

[0021] FIG. 2 is a table illustrating an example of the state determination information stored in the state determination information storage unit according to the first embodiment. As illustrated in FIG. 2, state determination information 50 stored in the state determination information storage unit 12 includes "plant state", "determination condition", "priority", and "related signal" for each "plant state".

[0022] The "plant state" is information indicating the type of a state anomaly of the plant 1. The "determination condition" is information of the determination condition that is the condition for determining whether or not a state anomaly has occurred in the plant 1, and includes information of a determination expression, for example. The determination expression is, for example, a conditional expression using a signal set as the "related signal" in

the state determination information 50, which is not limited to a conditional expression defined by an upper limit value or a lower limit value, and can be a conditional expression in which a normal range and an abnormal range are arbitrarily defined for a complex distribution of the measured values.

[0023] In the example illustrated in FIG. 2, the determination condition is one determination expression including a signal threshold, but may include a plurality of determination expressions or may be a determination expression including a plurality of signals.

Alternatively, the determination condition may be a determination expression including a signal other than the signal set as the "related signal" in the state determination information 50. The "determination condition" associated with the "plant state" is an example of the determination condition information.

[0024] The "priority" is information indicating a degree of priority of a state anomaly, which is set according to a degree of influence of the state anomaly on the plant 1, the severity of the state anomaly for the plant 1, or the like. The "priority" associated with the "plant state" is an example of the priority information. The "related signal" corresponds to information on the related signal that is a signal related to a state anomaly. The "related

signal" associated with the "plant state" is an example of related signal information.

[0025] In the example illustrated in FIG. 2, a plant state of "state A" is associated with a determination condition of "S001<100", priority of "1", and related signals of "S001 and S003". In such a situation, when the value of the signal S001 is less than 100, it is determined that a state anomaly of the "state A" has occurred in the plant 1. Moreover, the priority of the state anomaly of the "state A" is "1", and the signals related to the state anomaly of the "state A" are the signal S001 and the signal S003.

[0026] Also, in the example illustrated in FIG. 2, a plant state of "state B" is associated with a determination condition of "S002<100", priority of "2", and related signals of "S002 and S003". In such a situation, when the value of the signal S002 is less than 100, it is determined that a state anomaly of the "state B" has occurred in the plant 1. Moreover, the priority of the state anomaly of the "state B" is "2", and the signals related to the state anomaly of the "state B" are the signal S002 and the signal S003.

[0027] Also, in the example illustrated in FIG. 2, a plant state of "state C" is associated with a determination condition of "S011<2400", priority of "3", and related

signals of "S011 and S013". In such a situation, when the value of the signal S011 is less than 2400, it is determined that a state anomaly of the "state C" has occurred in the plant 1. Moreover, the priority of the state anomaly of the "state C" is "3", and the signals related to the state anomaly of the "state C" are the signal S011 and the signal S013.

[0028] Also, in the example illustrated in FIG. 2, a plant state of "state D" is associated with a determination condition of "S003<860", priority of "1", and related signals of "S001, S002, and S003". In such a situation, when the value of the signal S003 is less than 860, it is determined that a state anomaly of the "state D" has occurred in the plant 1. Moreover, the priority of the state anomaly of the "state D" is "1", and the signals related to the state anomaly of the "state D" are the signal S001, the signal S002, and the signal S003.

[0029] Also, in the example illustrated in FIG. 2, a plant state of "state E" is associated with a determination condition of "S004<100", priority of "2", and related signals of "S004 and S005". In such a situation, when the value of the signal S004 is less than 100, it is determined that a state anomaly of the "state E" has occurred in the plant 1. Moreover, the priority of the state anomaly of the "state E" is "2", and the signals related to the state

anomaly of the "state E" are the signal S004 and the signal S005.

[0030] The state A, the state B, the state C, the state D, and the state E are the state anomalies of different facilities in the plant 1, but may include state anomalies of one and the same facility. In addition, the signal S001, the signal S002, the signal S003, the signal S004, the signal S005, the signal S011, and the signal S013 correspond to measurement signals outputted from the measurement devices 2, which are, for example, measurement signals including measured values of the measurement devices 2 provided in different facilities.

[0031] Note that, instead of an information format illustrated in FIG. 2, the state determination information 50 may be information individually including a determination condition information part that includes the "plant state" and the "determination condition", a priority information part that includes the "plant state" and the "priority", and a related signal information part that includes the "plant state" and the "related signal". The values "100", "2400", and "860" included in the above-mentioned conditional expressions are examples of their signal thresholds.

[0032] Returning to FIG. 1, the description of the plant monitoring support system 100 will be continued. The

measurement information acquisition unit 13 acquires the measurement information from the measurement information storage unit 11. The state determination information acquisition unit 14 acquires the state determination information 50 from the state determination information storage unit 12. The state anomaly determination unit 15 determines the type of a state anomaly occurring in the plant 1 and the period of occurrence of the state anomaly on the basis of the measurement information acquired by the measurement information acquisition unit 13 and the state determination information acquired by the state determination information acquisition unit 14.

[0033] For example, in a case where the state determination information 50 is in the state illustrated in FIG. 2, the state anomaly determination unit 15 determines that a state anomaly of the "state A" has occurred in the plant 1 when the value of the signal S001 is less than 100, and determines that a state anomaly of the "state B" has occurred in the plant 1 when the value of the signal S002 is less than 100.

[0034] The state anomaly determination unit 15 causes the state determination result information storage unit 16 to store therein the state determination result information including the result of the determination described above. The state determination result information is information

including information on the type of the state anomaly that has occurred in the plant 1 and information on the period of occurrence of the state anomaly for each type of a state anomaly that has occurred. In a case where different types of state anomalies are detected around the same time, the state anomaly determination unit 15 causes the state determination result information storage unit 16 to store state determination result information including respective information pieces on these different types of state anomalies.

[0035] FIG. 3 is a table illustrating an example of the state determination result information stored in the state determination result information storage unit according to the first embodiment. As illustrated in FIG. 3, state determination result information 51 stored in the state determination result information storage unit 16 includes "plant state" and "period of occurrence" for each of state anomalies that have occurred in the plant 1. The "plant state" is information indicating a type of a state anomaly that has occurred in the plant 1. The "period of occurrence" is information on a period of occurrence of a state anomaly, which includes information on an occurrence time that is a time of day when the state anomaly has started occurring and information on an end time that is a time of day when the state anomaly ends.

[0036] In the example illustrated in FIG. 3, there is a situation in which the state anomaly of the "state D" lasts from 6 o'clock to 6:30, the state anomaly of the "state E" lasts from 7 o'clock to 7:40, the state anomaly of the "state A" lasts from 8 o'clock to 8:30, and the state anomaly of the "state B" lasts from 8:20 to the current time.

[0037] Returning to FIG. 1, the description of the plant monitoring support system 100 will be continued. The information acquisition unit 17 acquires the state determination result information 51 from the state determination result information storage unit 16, acquires the measurement information from the measurement information storage unit 11, and acquires the state determination information 50 from the state determination information storage unit 12.

[0038] The anomaly information generation unit 18 generates anomaly information including state anomaly transition information and signal state information, on the basis of the state determination result information 51, measurement information, and state determination information 50 acquired by the information acquisition unit 17. The state anomaly transition information is information indicating a transition of a state anomaly that has occurred in the plant 1, and the signal state

information is information in which the type of a state anomaly occurring in the plant 1 and the period of occurrence of the state anomaly are associated with one or more related signals.

[0039] The anomaly information generation unit 18 includes a state transition determination unit 30 configured to determine a transition of a state anomaly that has occurred in the plant 1, a signal rank determination unit 31 configured to determine a rank of a related signal associated with a state anomaly that has occurred in the plant 1, and an information generation unit 32 configured to generate the anomaly information described above on the basis of a determination result obtained by each of the state transition determination unit 30 and the signal rank determination unit 31.

[0040] Here, it is assumed that the plant 1 is a water and sewage plant, and a state anomaly has occurred in a membrane filtration device provided in the water and sewage plant. A state anomaly of the membrane filtration device is caused by more than one factor such as clogging due to contamination of a membrane used therein or breakage of the membrane, and so it is difficult to directly detect the occurrence of these factors using the measurement device 2. However, when a state anomaly occurs in the membrane filtration device, the filtration flow rate decreases.

[0041] In order to stabilize the filtration flow rate of the membrane filtration device, the plant 1 often has automatic control such as feedback incorporated in the control of a water pump that supplies water to the membrane filtration device. The filtration flow rate of the membrane filtration device decreases when clogging occurs in the membrane filtration device due to adhesion of dirt or the like, and then an automatic control mechanism works and causes an increase in pressure of the water pump so as to keep the filtration flow rate constant.

[0042] Although the state anomaly in the filtration flow rate is resolved by the automatic control of the water pump, the pressure of the water pump increases to thereby lead to a possibility that a state anomaly in water quality or a state anomaly in treatment flow rate occurs. Then, since the automatic control for preventing a state anomaly in water quality or a state anomaly in treatment flow rate works, a state anomaly in filtration flow rate may occur again.

[0043] While the pressure of the water pump measured by the measurement device 2 continues to increase gradually on a several days to several weeks basis, a change in water quality, a change in treatment flow rate, or the like occurs as described above may occur, and regular cleaning work may be performed in some cases. Therefore, without

continuation of the state anomaly in filtration flow rate, the frequency of occurrence of the state anomaly in filtration flow rate may gradually increase while repeating occurrence and resolution of the state anomaly in filtration flow rate, thereby eventually lead to a case of an anomaly that affects the operation of the plant 1.

[0044] As described above, when a state anomaly occurs in the membrane filtration device in the plant 1, the transition of more than one type of state anomalies including the state anomaly in filtration flow rate is repeated by the automatic control, thereby eventually resulting in an anomaly such that the operation of the plant 1 is influenced. Moreover, such transition of the state anomaly may occur in other cases different from the case where the state anomaly occurs in the membrane filtration device.

[0045] In the circumstances, the state transition determination unit 30 extracts, from the state determination result information 51 acquired by the information acquisition unit 17, information regarding a state anomaly that has occurred in the plant 1 during a period from the current time back to a predetermined period ago, and determines the transition of the state anomaly that has occurred in the plant 1 in the extracted information. Hereinafter, the period from the current time

back to the predetermined period ago may be referred to as a state anomaly extraction period.

[0046] For example, in a case where the time interval between the occurrence times of two state anomalies having the closest occurrence times is within a preset time interval threshold, the state transition determination unit 30 can determine that these two state anomalies are transitional state anomalies, or otherwise, determine that these two state anomalies are not transitional state anomalies.

[0047] For example, it is assumed that the state determination result information 51 stored in the state determination result information storage unit 16 is in the state illustrated in FIG. 3. In this case, when the preset time interval threshold is 40 minutes or longer, the state transition determination unit 30 determines that the state anomaly that has occurred in the plant 1 has transitioned to the state D, the state E, the state A, and the state B in this order. Otherwise, when the preset time interval threshold is less than 20 minutes, the state transition determination unit 30 does not determine that it is the state anomaly that has transitioned through the state D and the state E, but determines that it is the state anomaly that has transitioned only through the state A and the state B.

[0048] Moreover, when the preset time interval threshold is 20 minutes or longer and less than 30 minutes, the state transition determination unit 30 determines that the state anomaly has transitioned from the state E to the state A and the state anomaly has transitioned from the state A to the state B, but the unit 30 determines that the state anomaly has not transitioned from the state D to the state E.

[0049] In addition, the state transition determination unit 30 can increase the time interval threshold that is a set value of the time interval between the current state anomaly and the next state anomaly, on the basis of at least one of the period of occurrence of the state anomaly, a threshold excess degree that is a degree of excess, from a signal threshold, of the value of a signal when the state anomaly is detected, and the priority of the state anomaly that has occurred.

[0050] For example, the state transition determination unit 30 can set the time interval threshold to be larger as the period of occurrence of the state anomaly is longer. The state transition determination unit 30 can also set the time interval threshold to be larger as the threshold excess degree is higher, the time interval threshold being the set value of the time interval between the state anomaly in question and the next state anomaly. The state

transition determination unit 30 can further set the time interval threshold to be larger as the priority of the state anomaly that has occurred is higher, the time interval threshold being the set value of the time interval between the state anomaly in question and the next state anomaly.

[0051] Note that the state transition determination unit 30 can also determine that two state anomalies are transitional state anomalies regardless of the time interval between the occurrence times of these two state anomalies having the closest occurrence times.

[0052] On the basis of the determination result of the state transition determination unit 30 and the state determination information 50 acquired by the information acquisition unit 17, the signal rank determination unit 31 determines the ranking of the related signals associated with the transitional state anomalies determined by the state transition determination unit 30.

[0053] For example, the signal rank determination unit 31 extracts information on the related signals associated with the transitional state anomalies determined by the state transition determination unit 30, from the related signal information included in the state determination information 50 acquired by the information acquisition unit 17. The signal rank determination unit 31 also extracts

information on the priorities associated with the transitional state anomalies, which are determined by the state transition determination unit 30, from the priority information included in the state determination information 50 acquired by the information acquisition unit 17.

[0054] Then, by combining the frequency of the extracted related signals and the extracted priorities, the signal rank determination unit 31 determines the ranking of the related signals in such a manner that the related signal having a higher degree of interest has a higher rank. For example, the signal rank determination unit 31 calculates a score of each related signal on the basis of the frequency of the extracted related signals and the extracted priorities, and determines the ranking of the related signals on the basis of the calculated scores.

[0055] In a case where the state determination result information 51 stored in the state determination result information storage unit 16 is in the state illustrated in FIG. 3, the transitional state anomalies determined by the state transition determination unit 30 have, for example, the state D, the state E, the state A, and the state B. In this case, the signal rank determination unit 31 extracts the information on the related signals and the information on the priorities, associated with the state D, the state E, the state A, and the state B, from the state

determination information 50 acquired by the information acquisition unit 17.

[0056] For example, it is assumed that the state determination information 50 acquired by the information acquisition unit 17 is in the state illustrated in FIG. 2. In this case, what are extracted by the signal rank determination unit 31 are: the priority of "1" and the related signals of "S001, S002, and S003", associated with the state D; the priority of "2" and the related signals of "S004 and S005", associated with the state E; the priority of "1" and the related signals of "S001 and S003", associated with the state A; and the priority of "2" and the related signals of "S002 and S003", associated with the state B.

[0057] The signal rank determination unit 31 calculates the score of each related signal on the basis of the information on the extracted related signals and the information on the extracted priorities. For example, the signal rank determination unit 31 calculates the score of the related signal by adding up reciprocals of the extracted priorities for each related signal.

[0058] In the example described above, since the priorities associated with the related signal of "S001" are "1" and "1", the score for the related signal of "S001" is "2" by calculation of $1+1=2$. In addition, since the

priorities associated with the related signal of "S002" are "2" and "1", the score for the related signal of "S002" is "3/2" by calculation of $(1/2)+1=3/2$.

[0059] Moreover, since the priorities associated with the related signal of "S003" are "1", "2", and "1", the score for the related signal of "S003" is "5/2" by calculation of $1+1/2+1=5/2$. In addition, since the priority associated with the related signal of "S004" is "2", the score for the related signal of "S004" is "1/2" by calculation of $1/2=1/2$.

[0060] Therefore, the scores for the related signals have gradually decreased values in the order of the related signal of "S003", the related signal of "S001", the related signal of "S002", and the related signal of "S004". The signal rank determination unit 31 thus determines that the related signal of "S003" is ranked first, the related signal of "S001" is ranked second, the related signal of "S002" is ranked third, and the related signal of "S004" is ranked fourth.

[0061] Note that the manner of determining the ranking of the related signals is not limited to the above-described example. For example, the signal rank determination unit 31 can calculate the scores of the related signals by adding up squares of the reciprocals of the extracted priorities for each related signal and

accordingly determine the ranking of the related signals. Otherwise, the signal rank determination unit 31 can determine the ranking of the related signals by assigning a larger value to higher priority and calculating the scores of the related signals by adding up a sum total value of the assigned values for each related signal.

[0062] The information generation unit 32 generates the anomaly information including the state anomaly transition information and the signal state information on the basis of the determination result obtained by the state transition determination unit 30, the determination result obtained by the signal rank determination unit 31, and the state determination result information 51 and measurement information acquired by the information acquisition unit 17.

[0063] For example, the information generation unit 32 generates the state anomaly transition information indicating the transition of the state anomaly determined by the state transition determination unit 30 on the basis of the determination result of the state transition determination unit 30 and the state determination result information 51 acquired by the information acquisition unit 17.

[0064] Here, it is assumed that the state determination result information 51 stored in the state determination

result information storage unit 16 is in the state illustrated in FIG. 3, and the transitional state anomalies determined by the state transition determination unit 30 have the state D, the state E, the state A, and the state B. In this case, the information generation unit 32 generates the state anomaly transition information including: time series information having an information part on the state D, an information part on the state E, an information part on the state A, and an information part on the state B sequentially arranged in time series in this order; and occurrence period information in which information on the occurrence start time and information on the end time are included in each of the information parts on the state anomalies arranged in such a manner.

[0065] The information generation unit 32 further generates the signal state information including information on the related signals which is associated with the type and period of occurrence of a state anomaly, on the basis of the determination result of the state transition determination unit 30, the determination result obtained by the signal rank determination unit 31, and the state determination result information 51 and measurement information acquired by the information acquisition unit 17.

[0066] Here, it is assumed that the state determination

result information 51 stored in the state determination result information storage unit 16 is in the state illustrated in FIG. 3, and the transitional state anomalies determined by the state transition determination unit 30 have the state D, the state E, the state A, and the state B. In this case, the information generation unit 32 generates the signal state information in which the type and the period of occurrence of each of the state D, the state E, the state A, and the state B are associated with a trend graph of the signal S003, the signal S001, the signal S002, the signal S004, and the signal S005 from the current time back to a predetermined period ago.

[0067] In a case where the number of the related signals associated with the transitional state anomalies determined by the state transition determination unit 30 exceeds a preset threshold, the information generation unit 32 extracts the related signals corresponding in number to the preset threshold starting from the related signal ranked higher in the above-mentioned manner, among the related signals associated with the transitional state anomalies, and generates the signal state information including information on the extracted related signals.

[0068] For example, in a case where the ranking of the related signals is in the order of the signal S003, the signal S001, the signal S002, and the signal S004, and the

preset threshold is "3", the information generation unit 32 incorporates the information on the signal S003, the information on the signal S001, and the information on the signal S002 in the signal state information and does not incorporate the information on the signal S004 in the signal state information. As a result, the information generation unit 32 can prevent the amount of information on the related signals included in the signal state information from being excessive.

[0069] The information output unit 19 outputs the anomaly information generated by the anomaly information generation unit 18. For example, the information output unit 19 can output the anomaly information generated by the anomaly information generation unit 18 to the input/output device 20 or transmit the anomaly information to a terminal device (not illustrated).

[0070] The input/output device 20 includes a display unit (not illustrated) and an input unit (not illustrated). The display unit (not illustrated) is, for example, a liquid crystal display (LCD) or an organic electroluminescence (EL) display. The input unit (not illustrated) is configured using, for example, a keyboard, a mouse, a keypad, a touch panel, or the like, which is operated by an operator who is a user of the plant monitoring support system 100.

[0071] On the basis of the anomaly information outputted from the anomaly information generation unit 18, the input/output device 20 displays a state transition image including information indicating the transition of the state anomalies, information indicating change in state of the related signals, and the like on the display unit (not illustrated).

[0072] FIG. 4 is a diagram illustrating an example of the state transition image displayed on the input/output device according to the first embodiment. As illustrated in FIG. 4, a state transition image 60 displayed on the input/output device 20 includes state anomaly transition information 61 that is information indicating the transition of one or more state anomalies, and signal state information 62 including information on one or more related signals associated with the type and the period of occurrence of the transitional state anomalies.

[0073] The state anomaly transition information 61 includes information 61a indicating types of the transitional state anomalies that have occurred in the plant 1 during the state anomaly extraction period that is a period from the current time back to the predetermined period ago, and information 61b on the period of occurrence of each state anomaly.

[0074] In the state anomaly transition information 61

illustrated in FIG. 4, there is represented a situation in which the state anomalies transition in the order of the state D, the state E, the state A, and the state B with the state anomaly of the "state D" lasting from 6 o'clock to 6:30, the state anomaly of the "state E" lasting from 7 o'clock to 7:40, the state anomaly of the "state A" lasting from 8 o'clock to 8:30, and the state anomaly of the "state B" lasting from 8:20 to the current time.

[0075] Moreover, in the state anomaly transition information 61, different colors are applied to a region in a frame surrounding the characters "state D", a region in a frame surrounding the characters "state E", a region in a frame surrounding the characters "state A", and a region in a frame surrounding the characters "state B", respectively.

In the example illustrated in FIG. 4, the difference in color is represented by a difference in hatching pattern.

[0076] The signal state information 62 is information in which the types and the periods of occurrence of the state anomalies are associated with trend graphs each of which indicates a state, during the state anomaly extraction period, of the related signal related to the state anomaly that has occurred in the plant 1 during the state anomaly extraction period.

[0077] In the signal state information 62 illustrated in FIG. 4, a trend graph 63a of the signal S003, a trend graph

63b of the signal S001, and a trend graph 63c of the signal S002 are arranged in this order as trend graphs each of which indicates change in state of the related signal in the state anomaly extraction period. The signal state information 62 illustrated in FIG. 4 indicates that the related signals are ranked in the order of the signal S003, the signal S001, and the signal S002 in descending order by the anomaly information generation unit 18.

[0078] Moreover, in the signal state information 62 illustrated in FIG. 4, to each of the trend graphs 63a, 63b, and 63c of the signals S003, S001, and S002, different colors are applied for the periods of occurrence of the state D, the state E, the state A, and the state B. In the example illustrated in FIG. 4, indicates the difference in color is represented by a difference in hatching pattern. Hereinafter, the trend graphs 63a, 63b, and 63c may be described as a trend graph 63 or trend graphs 63 when not individually distinguished therebetween case by case.

[0079] In the state transition image 60 illustrated in FIG. 4, the color codes of the state anomalies indicated in the state anomaly transition information 61 correspond to the color codes on the trend graph 63 of the related signal. Therefore, the operator can easily grasp the relationship between the change in state of the related signal and the transition of the state anomalies. Note

that, in the state transition image 60, the relationship between the change in state of the related signal and the transition of the state anomalies may be represented by a line type, display of a message, or the like instead of or in addition to the color codes.

[0080] As described above, in the state transition image 60, since the relationship between the change in state of the related signal and the transition of the state anomalies is explicitly indicated, it is possible to display on the display unit (not illustrated) of the input/output device 20 how an anomaly that has occurred in some facility spreads to another facility of the plant, for example.

[0081] In the example illustrated in FIG. 4, after the value of the signal S001 increases first, the state anomaly of the "state D" and the state anomaly of the "state E" occur, and due to the influence of these state anomalies, the value of the signal S002 increases to cause the state anomaly of the "state A", and finally, the value of the signal S003 also increases to cause the state anomaly of the "state B".

[0082] In a case where the evaluation is performed only on the basis of the latest time, the value of the signal S001 has already decreased at the current time, whereas the signal S002 and the signal S003 have higher degrees of

anomaly. Therefore, the evaluation based only on the latest time possibly overlooks an immediately preceding behavior of the signal S001, but the plant monitoring support system 100 can appropriately grasp the relationship between the change in state of the related signal and the transition of the state anomalies by virtue of the state transition image 60. As a result, the plant monitoring support system 100 can support monitoring of a state in which two or more state anomalies influence each other in the plant 1.

[0083] Next, processing performed by the plant monitoring support system 100 will be described using a flowchart. FIG. 5 is a flowchart illustrating an example of processing performed by the plant monitoring support system according to the first embodiment.

[0084] As illustrated in FIG. 5, the information collection unit 10 of the plant monitoring support system 100 determines whether or not measurement information has been acquired from the measurement device 2 via the network (not illustrated) (step S10). If determining that the measurement information has been acquired (Yes in step S10), the information collection unit 10 causes the measurement information storage unit 11 to store the acquired measurement information therein (step S11).

[0085] When the processing of step S11 is finished or if

it is determined that the measurement information has not been acquired (No in step S10), the state anomaly determination unit 15 of the plant monitoring support system 100 determines whether or not a state anomaly determination timing has come (step S12). The state anomaly determination timing is, for example, a timing that comes in a preset cycle, a timing at which the information collection unit 10 determines that the measurement information has been acquired, or the other timing like that.

[0086] If determining that the state anomaly determination timing has come (Yes in step S12), the state anomaly determination unit 15 executes state anomaly determination processing (step S13). The state anomaly determination processing in step S13 is processing in steps S20 to S25 illustrated in FIG. 6, and will be described in more detail later.

[0087] When the processing of step S13 is finished or if it is determined that the state anomaly determination timing has not come (No in step S12), the anomaly information generation unit 18 of the plant monitoring support system 100 determines whether or not a state transition determination timing has come (step S14). The state transition determination timing is, for example, a timing that comes in a preset cycle, a timing at which the

state anomaly determination unit 15 determines that a state anomaly has occurred in the plant 1, or the other timing like that.

[0088] If determining that the state transition determination timing has come (Yes in step S14), the anomaly information generation unit 18 executes state transition determination processing (step S15). The state transition determination processing in step S15 is processing in steps S30 to S33 illustrated in FIG. 7, and will be described in more detail later.

[0089] When finishing the processing of step S15 or if determining that the state transition determination timing has not come (No in step S14), the plant monitoring support system 100 ends the processing illustrated in FIG. 5.

[0090] FIG. 6 is a flowchart illustrating an example of the state anomaly determination processing performed by the plant monitoring support system according to the first embodiment. As illustrated in FIG. 6, the measurement information acquisition unit 13 of the plant monitoring support system 100 acquires the measurement information from the measurement information storage unit 11 (step S20). Moreover, the state determination information acquisition unit 14 of the plant monitoring support system 100 acquires the state determination information 50 from the state determination information storage unit 12 (step

S21).

[0091] The state anomaly determination unit 15 of the plant monitoring support system 100 determines whether or not a new state anomaly has occurred in the plant 1 on the basis of the measurement information acquired in step S20 and the state determination information 50 acquired in step S21 (step S22). If determining that a new state anomaly has occurred (Yes in step S22), the state anomaly determination unit 15 adds information on an occurrence time of the new state anomaly to the state determination result information stored in the state determination result information storage unit 16 (step S23).

[0092] When the processing of step S23 is finished, or if it is determined that no new state anomaly has occurred (No in step S22), the state anomaly determination unit 15 determines whether or not the state anomaly has ended (step S24). If determining that the state anomaly has ended (Yes in step S24), the state anomaly determination unit 15 adds information on an end time of the state anomaly to the state determination result information stored in the state determination result information storage unit 16 (step S25).

[0093] When finishing the processing of step S25 or if determining that the state anomaly has not ended (No in step S24), the plant monitoring support system 100 ends the

processing illustrated in FIG. 6.

[0094] FIG. 7 is a flowchart illustrating an example of the state transition determination processing performed by the plant monitoring support system according to the first embodiment. As illustrated in FIG. 7, the information acquisition unit 17 of the plant monitoring support system 100 acquires the state determination result information, the measurement information, and the state determination information 50 from the state determination result information storage unit 16, the measurement information storage unit 11, and the state determination information storage unit 12 (step S30).

[0095] The anomaly information generation unit 18 of the plant monitoring support system 100 generates the state anomaly transition information 61 on the basis of the state determination result information acquired by the information acquisition unit 17 (step S31). The anomaly information generation unit 18 further generates the signal state information 62 on the basis of the state determination result information, the measurement information, and the state determination information 50 which are acquired by the information acquisition unit 17 (step S32).

[0096] The information output unit 19 outputs the anomaly information including the state anomaly transition

information 61 and the signal state information 62 which are generated by the anomaly information generation unit 18 (step S33). When finishing the processing of step S33, the plant monitoring support system 100 ends the processing illustrated in FIG. 7.

[0097] FIG. 8 is a diagram illustrating an example of a hardware configuration of the plant monitoring support system according to the first embodiment. As illustrated in FIG. 8, the plant monitoring support system 100 includes a computer including a processor 101, a memory 102, a communication device 103, and an interface circuit 104.

[0098] The processor 101, the memory 102, the communication device 103, and the interface circuit 104 can transmit information to and receive information from one another via a bus 105, for example. The measurement information storage unit 11, the state determination information storage unit 12, and the state determination result information storage unit 16 are implemented by the memory 102. The processor 101 reads and executes a program or programs stored in the memory 102 to thereby implement functions of the information collection unit 10, the measurement information acquisition unit 13, the state determination information acquisition unit 14, the state anomaly determination unit 15, the information acquisition unit 17, the anomaly information generation unit 18, the

information output unit 19, and so on. The processor 101 is an example of a processing circuitry, which includes one or more of a central processing unit (CPU), a digital signal processor (DSP), and a system large scale integration (LSI) circuit.

[0099] The memory 102 includes one or more of a random access memory (RAM), a read only memory (ROM), a flash memory, an erasable programmable read only memory (EPROM), and an electrically erasable programmable read only memory (EEPROM (registered trademark)). The memory 102 may also be configured as a recording medium on which a computer-readable program is recorded. Such a recording medium includes one or more of a non-volatile or volatile semiconductor memory, a magnetic disk, a flexible memory, an optical disc, a compact disc, and a digital versatile disc (DVD). Note that the plant monitoring support system 100 may include an integrated circuit such as an application specific integrated circuit (ASIC) or a field programmable gate array (FPGA).

[0100] The plant monitoring support system 100 may be composed of a client device, may be composed of a server device, or may be composed of a client device and a server device. In a case where the plant monitoring support system 100 is composed of two or more devices, each of the two or more devices has, for example, the hardware

configuration illustrated in FIG. 8. Note that communication between the two or more devices is performed via the communication device 103. Alternatively, the plant monitoring support system 100 may have a configuration including two or more server devices. For example, the plant monitoring support system 100 may have a configuration including a processing server device and a data server device.

[0101] As described above, the plant monitoring support system 100 according to the first embodiment includes the information collection unit 10, the state determination information acquisition unit 14, the state anomaly determination unit 15, the anomaly information generation unit 18, and the information output unit 19. The information collection unit 10 collects the measurement information outputted from the measurement device 2 provided in the plant 1. The state determination information acquisition unit 14 acquires the state determination information 50 including the determination condition information in which the information on the condition for determining a state anomaly of the plant 1 is included for each of types of state anomalies. The state anomaly determination unit 15 determines the type and the period of occurrence of a state anomaly that has occurred in the plant 1 on the basis of the measurement information

collected by the information collection unit 10 and the state determination information 50 acquired by the state determination information acquisition unit 14. On the basis of the determination result of the state anomaly determination unit 15, the anomaly information generation unit 18 generates the anomaly information including the state anomaly transition information indicating the transition of the state anomaly that has occurred in the plant 1. The information output unit 19 outputs the anomaly information generated by the anomaly information generation unit 18. With this configuration, the plant monitoring support system 100 can support monitoring of a state in which two or more state anomalies influence each other in the plant 1.

[0102] Moreover, the state determination information 50 further includes the related signal information that is the information on the related signal that is a signal related to the state anomaly. On the basis of the determination result of the state anomaly determination unit 15, the measurement information, and the state determination information 50, the anomaly information generation unit 18 generates, as the anomaly information, the information including the signal state information in which the type and the period of occurrence of the state anomaly determined by the state anomaly determination unit 15 are

associated with the related signal. As a result, the plant monitoring support system 100 can present the relationship between the transition of the state anomaly and the change in state of the related signal to a user of the plant monitoring support system 100.

[0103] Moreover, the state determination information 50 further includes the priority information indicating the degree of priority of the state anomaly. The anomaly information generation unit 18 determines the related signal to be included in the signal state information on the basis of the determination result of the state anomaly determination unit 15 and the state determination information 50. As a result, the plant monitoring support system 100 can preferentially present the state of the related signal having a higher degree of influence of the state anomaly on the plant 1 or a higher degree of severity of the state anomaly to a user of the plant monitoring support system 100.

[0104] Moreover, on the basis of the determination result of the state anomaly determination unit 15 and the state determination information 50, the anomaly information generation unit 18 determines the ranking of the related signals to be included in the signal state information and generates, as the signal state information, the information in which the related signals are arranged according to the

determined ranking. As a result, the plant monitoring support system 100 can present the state of the related signal to a user of the plant monitoring support system 100 in descending order of the degree of influence of the state anomaly on the plant 1, the degree of severity of the state anomaly, or the like.

[0105] Second Embodiment.

A plant monitoring support system according to a second embodiment is different from the plant monitoring support system 100 according to the first embodiment in that it further has a function of outputting information on a transition of a state anomaly in the past including a transition of a state anomaly that matches or is similar to a transition of a state anomaly determined, and/or predicting a transition of a state anomaly on the basis of a transition of a state anomaly determined in the past. Hereinafter, components having functions similar to those of the first embodiment will be denoted by the same reference signs as those used in the first embodiment and description thereof is omitted, and so differences from the plant monitoring support system 100 of the first embodiment will be mainly described.

[0106] FIG. 9 is a diagram illustrating an example of a configuration of a plant monitoring support system according to the second embodiment. A plant monitoring

support system 100A illustrated in FIG. 9 is different from the plant monitoring support system 100 according to the first embodiment in that the system 100A includes an anomaly information generation unit 18A instead of the anomaly information generation unit 18, and it further includes a state transition history information storage unit 21 and a state transition prediction unit 22.

[0107] The anomaly information generation unit 18A is different from the anomaly information generation unit 18 according to the first embodiment in that the unit 18A includes a state transition determination unit 30A and an information generation unit 32A instead of the state transition determination unit 30 and the information generation unit 32.

[0108] The state transition determination unit 30A is different from the state transition determination unit 30 according to the first embodiment in that the unit 30A determines a transition of a state anomaly and further causing the state transition history information storage unit 21 to store state transition pattern information in which information on a state transition pattern that is a pattern of the determined transition of the state anomaly is associated with a pattern identifier (ID). Thus, state transition history information including the state transition pattern information generated by the state

transition determination unit 30A is stored in the state transition history information storage unit 21 by the state transition determination unit 30A.

[0109] The state transition pattern information generated by the state transition determination unit 30A is information including, in chronological order, information on the type of a state anomaly determined in the past by the state anomaly determination unit 15 and information on the period of occurrence of the state anomaly, but may be information on a directed graph network indicating a transition of a state anomaly determined in the past by the state anomaly determination unit 15 in a directed graph network.

[0110] On the basis of the state transition history information stored in the state transition history information storage unit 21 and the information on the transition of the state anomaly determined by the state anomaly determination unit 15, the state transition prediction unit 22 predicts a state anomaly that occurs in the plant 1 or determines a past state transition pattern that is the same as or similar to the current state transition pattern.

[0111] The state transition prediction unit 22 includes a history information acquisition unit 40, a similar information extraction unit 41, and a prediction processing

unit 42. The history information acquisition unit 40 acquires the state transition history information from the state transition history information storage unit 21, and acquires information on a state anomaly in a period from the current time back to a predetermined period ago from the state determination result information storage unit 16. The history information acquisition unit 40 further acquires the information indicating the raking of related signals determined by the signal rank determination unit 31, and acquires the measurement information from the measurement information storage unit 11.

[0112] The similar information extraction unit 41 extracts, from the state transition history information acquired by the history information acquisition unit 40, information on a past state transition pattern including a state transition pattern that matches or is similar to a pattern of transition of the state anomaly in the period from the current time back to the predetermined period ago.

[0113] The similar information extraction unit 41 extracts the information on the past state transition pattern in line with a comparison method such as exact match, forward match, or partial match with respect to the state transition pattern included in the state transition history information. The similar information extraction unit 41 outputs the extracted information on the past state

transition pattern to the information generation unit 32A as first prediction information.

[0114] Moreover, on the basis of the information indicating the ranking of the related signals acquired by the history information acquisition unit 40, the similar information extraction unit 41 acquires information on the related signal in the period in which the extracted past state transition pattern appears, from the measurement information storage unit 11 via the history information acquisition unit 40. The similar information extraction unit 41 outputs the information on the related signal acquired from the measurement information storage unit 11 to the information generation unit 32A as second prediction information.

[0115] The prediction processing unit 42 predicts a state anomaly that occurs in the plant 1 on the basis of the information on the state anomaly in the period from the current time back to the predetermined period ago, acquired by the history information acquisition unit 40, and state transition history information acquired by the history information acquisition unit 40. The prediction processing unit 42 outputs the information on the predicted state anomaly to the information generation unit 32A as the first prediction information.

[0116] When the state transition pattern information

included in the state transition history information is the information on the directed graph network, the prediction processing unit 42 converts the transition of the state anomaly in the period from the current time back to the predetermined period ago, acquired by the history information acquisition unit 40, into information on the directed graph network indicating the transition in the form of a directed graph network.

[0117] The prediction processing unit 42 predicts a node connected to an end node of the directed graph network obtained by the conversion, on the basis of a result of comparison between the information on the directed graph network obtained by the conversion and the information on the directed graph network included in the state transition history information. The prediction processing unit 42 outputs information including information on the predicted node to the information generation unit 32A as the first prediction information.

[0118] The information generation unit 32A generates anomaly information including the first prediction information and the second prediction information. The anomaly information generated by the information generation unit 32A is outputted from the information output unit 19 to the input/output device 20. On the basis of the anomaly information outputted from the information output unit 19,

the input/output device 20 displays a state transition image on the display unit (not illustrated), the state transition image including the information indicating the transition of the state anomaly, the information indicating the change in state of the related signal, the first prediction information, the second prediction information, and so on.

[0119] FIG. 10 is a diagram illustrating an example of the state transition image displayed on the input/output device according to the second embodiment. As illustrated in FIG. 10, a state transition image 60A displayed on the input/output device 20 is different from the state transition image 60 illustrated in FIG. 4 in that the state transition image 60A includes first prediction information 64 and second prediction information 65a, 65b, and 65c in addition to the state anomaly transition information 61 and the signal state information 62.

[0120] The first prediction information 64 illustrated in FIG. 10 is information on a similar state transition pattern that is a past state transition pattern including a state transition pattern that matches or is similar to a pattern of transition of a state anomaly in the period from the current time back to a predetermined period ago.

[0121] In the example illustrated in FIG. 10, the first prediction information 64 is information on a state

transition pattern in which the state D, the state E, the state A, the state B, and the state C transition in time series, by which it is indicated that there is a possibility of transition to the state C next. Note that the first prediction information 64 may include the information on the directed graph network including the information on the node predicted by the prediction processing unit 42 instead of or in addition to the example illustrated in FIG. 10.

[0122] The pieces of second prediction information 65a, 65b, and 65c are trend graphs of the related signals in a period in which the past state transition pattern indicated by the first prediction information 64 appears. The second prediction information 65a indicates a past state of the signal S003, the second prediction information 65b indicates a past state of the signal S001, and the second prediction information 65c indicates a past state of the signal S002. By virtue of these pieces of second prediction information 65a, 65b, and 65c, the change in trend of the related signal in the past can be presented to the user, and a possibility that the related signals change according to the second prediction information 65a, 65b, and 65c after the anomaly state of the state B can be presented to the user.

[0123] As described above, in the plant monitoring

support system 100A, the similar past state anomaly transition, the changes in the trends of the related signals in the past, the predicted state anomaly transition, and the like can be presented to the user of the plant monitoring support system 100A as reference information.

[0124] Next, processing performed by the plant monitoring support system 100A will be described using a flowchart. FIG. 11 is a flowchart illustrating an example of state transition determination processing performed by the plant monitoring support system according to the second embodiment. Processing of steps S40 to S42 illustrated in FIG. 11 is the same as the processing of steps S30 to S32 illustrated in FIG. 7, and so its description is omitted.

[0125] As illustrated in FIG. 11, the anomaly information generation unit 18A of the plant monitoring support system 100A generates the state transition pattern information, and causes the state transition history information storage unit 21 to store therein the generated state transition pattern information (step S43). In step S43, the anomaly information generation unit 18A causes the state transition history information storage unit 21 to store the state transition pattern information by adding the generated state transition pattern information to the state transition history information stored in the state

transition history information storage unit 21.

[0126] Next, the state transition prediction unit 22 of the plant monitoring support system 100A generates the first prediction information including the information on the past state transition pattern on the basis of the state transition history information stored in the state transition history information storage unit 21 and the information on the transition of the state anomaly determined by the state anomaly determination unit 15 (step S44). The state transition prediction unit 22 further generates the second prediction information including the information on one or more related signals in the period in which the past state transition pattern indicated by the first prediction information appears (step S45).

[0127] The information output unit 19 of the plant monitoring support system 100A outputs the anomaly information generated by the anomaly information generation unit 18A (step S46). Such anomaly information includes the state anomaly transition information 61, the signal state information 62, the first prediction information, and the second prediction information. When finishing the processing of step S46, the plant monitoring support system 100A ends the processing illustrated in FIG. 11.

[0128] An example of a hardware configuration of the plant monitoring support system 100A according to the

second embodiment is the same as the hardware configuration of the plant monitoring support system 100 illustrated in FIG. 8. The state transition history information storage unit 21 is implemented by the memory 102. The processor 101 can implement the functions of the anomaly information generation unit 18A and the state transition prediction unit 22 by reading and executing the programs stored in the memory 102.

[0129] As described above, the plant monitoring support system 100A includes the history information acquisition unit 40 and the similar information extraction unit 41. The history information acquisition unit 40 acquires the transition history information that is the information on the transition of the state anomaly that has occurred in the plant 1 in the past. The similar information extraction unit 41 extracts, from the transition history information acquired by the history information acquisition unit 40, the information on the state anomaly transition pattern that is a pattern of a transition of the past state anomaly including a transition of the state anomaly that matches or is similar to the transition of the state anomaly determined by the state anomaly determination unit 15. The anomaly information generation unit 18A generates the information including the information on the state anomaly transition pattern as the anomaly information on

the basis of the result of extraction obtained by the similar information extraction unit 41. As a result, in the plant monitoring support system 100A, the similar past state anomaly transition can be presented to the user of the plant monitoring support system 100A as the reference information. It is noted that the transition history information is an example of the state transition history information.

[0130] Moreover, the similar information extraction unit 41 extracts past signal state information indicating a signal state indicated by the measurement information during the period of occurrence of the state anomaly transition pattern among the measurement information collected by the information collection unit 10. The anomaly information generation unit 18A generates information including the past signal state information as the anomaly information on the basis of the result of extraction obtained by the similar information extraction unit 41. As a result, in the plant monitoring support system 100A, the change in trend of one or more related signals in the past can be presented to the user of the plant monitoring support system 100A as useful reference information.

[0131] Moreover, the plant monitoring support system 100A includes the history information acquisition unit 40

and the prediction processing unit 42. The history information acquisition unit 40 acquires the transition history information that is the information on the transition of the state anomaly that has occurred in the plant 1 in the past. The prediction processing unit 42 predicts a state anomaly that occurs in the plant 1 on the basis of the transition history information acquired by the history information acquisition unit 40 and the determination result obtained by the state anomaly determination unit 15. The anomaly information generation unit 18A generates the information including the information that indicates the result of prediction obtained by the prediction processing unit 42 as the anomaly information. As a result, in the plant monitoring support system 100A, the information on the transition of the state anomaly predicted can be presented to the user of the plant monitoring support system 100A as useful reference information.

[0132] Moreover, the transition history information includes information on a first directed graph network in which the transition of the state anomaly determined in the past by the state anomaly determination unit 15 is indicated in the form of a directed graph network. On the basis of a result of comparison between one set of information on a second directed graph network indicating

information on the transition of the state anomaly determined by the state anomaly determination unit 15 in the form of a directed graph network and the other set of information on the first directed graph network, the prediction processing unit 42 predicts a node connected to a dead end node of the second directed graph network, and generates information including information on the predicted node as the anomaly information. As a result, in the plant monitoring support system 100A, the information on the transition of the state anomaly predicted can be presented to the user of the plant monitoring support system 100A as useful reference information.

[0133] Third Embodiment.

A plant monitoring support system according to a third embodiment is different from the plant monitoring support system 100A according to the second embodiment in that the former system further includes a function of being able to automatically update information on a condition for determining a state anomaly of the plant. Hereinafter, components having functions similar to those in the second embodiment will be denoted by the same reference signs as those used in the second embodiment and so their description is omitted, and thus differences from the plant monitoring support system 100A of the second embodiment will be mainly described.

[0134] FIG. 12 is a diagram illustrating an example of a configuration of a plant monitoring support system according to the third embodiment. A plant monitoring support system 100B illustrated in FIG. 12 is different from the plant monitoring support system 100A according to the second embodiment in that the system 100B further includes a determination condition update unit 23.

[0135] On the basis of the measurement information stored in the measurement information storage unit 11, the determination condition update unit 23 compares a current distribution that is a distribution of the measured values included in the measurement information in a period from the current time back to a predetermined period ago, with a past distribution that is a distribution of the measured values included in the measurement information in a past period. When the current distribution has changed from the past distribution, the determination condition update unit 23 automatically corrects the determination condition information included in the state determination information stored in the state determination information storage unit 12 on the basis of the degree of change in the current distribution with respect to the past distribution.

[0136] When the plant 1 needs to operate with reducing the output of one of or some of the facilities to 50% of the rated value for a reason of construction work or the

like being performed, an operation with 50% output is continued while the measurement information from the measurement device 2 is newly stored in the measurement information storage unit 11 under a condition of the operation with 50% output.

[0137] When the measurement information for a sufficient period is newly stored in the measurement information storage unit 11 with the plant 1 operating with 50% output, the determination condition update unit 23 generates determination condition information including a new determination expression and/or the like on the basis of a distribution of measured values included in the measurement information for the period in which the operation with 50% output is performed, and causes the state determination information storage unit 12 to overwrite the state determination information 50 stored in the state determination information storage unit 12 with the generated determination condition information and store the resultant information therein. As a result, the determination condition information in the state determination information storage unit 12 is automatically corrected on the basis of the degree of change in the current distribution with respect to the past distribution.

[0138] Moreover, on the basis of the measurement information stored in the measurement information storage

unit 11, the determination condition update unit 23 can delete, from the state determination information storage unit 12, information on the determination condition using the measured value in the measurement information outputted from the measurement device 2 that performs measurement related to the function whose operation has been stopped in the facility, for example.

[0139] In addition, when a control setting value is switched by a control operation on the input/output device 20, the determination condition update unit 23 can add information on the determination condition corresponding to the control setting value after the switching to the state determination information storage unit 12 and/or can delete information on the determination condition corresponding to the control setting value before the switching from the state determination information storage unit 12. Note that in this case, the relationship between the control setting value and the information on the determination condition is stored in the state determination information storage unit 12. The control setting value is information for setting the details of control on a control target in the plant 1.

[0140] The plant 1 is composed of a plurality of facilities, and these facilities are designed on the assumption of long-term operation. However, deterioration or the like of the facilities will occur with the lapse of

time, and for this reason there is a case where a change in a manner of operation of the plant 1 is demanded in dependence upon a managerial, management, environmental, or social requirement or the other requirements. In such a case, a determination condition different from the conventional ones may be required, or the conventional determination condition may be unnecessary.

[0141] In the circumstances, the determination condition update unit 23 automatically creates or updates the determination condition for determining the state anomaly of the plant 1 on the basis of a distribution range of the measured values included in the measurement information, the switching of the control setting value, or the like. By so doing, the plant monitoring support system 100B can automatically follow update of the facilities in the plant 1, change in operation manner of the plant 1, or the like. Therefore, the user of the plant monitoring support system 100B can satisfactorily support monitoring of a state in which two or more state anomalies influence each other in the plant 1 without forcing an operator to perform works such as works changing the determination condition.

[0142] Next, processing performed by the plant monitoring support system 100B will be described using a flowchart. FIG. 13 is a flowchart illustrating an example of processing performed by the plant monitoring support

system according to the third embodiment. Processing of steps S50 to S55 illustrated in FIG. 13 is the same as the processing of steps S10 to S15 illustrated in FIG. 5, and so its description is omitted.

[0143] As illustrated in FIG. 13, the determination condition update unit 23 of the plant monitoring support system 100B determines whether or not a condition update timing has come (step S56). The condition update timing is, for example, a timing that comes in a preset cycle, a timing at which the control setting value is switched, or the like.

[0144] If determining that the condition update timing has come (Yes in step S56), the determination condition update unit 23 executes condition update processing (step S57). The condition update processing in step S57 corresponds to processing of steps S60 to S63 illustrated in FIG. 14, and will be described in more detail later.

[0145] When finishing the processing of step S57 or if determining that the condition update timing has not come (No in step S56), the plant monitoring support system 100B ends the processing illustrated in FIG. 13.

[0146] FIG. 14 is a flowchart illustrating an example of the condition update processing performed by the plant monitoring support system according to the third embodiment. As illustrated in FIG. 14, the determination

condition update unit 23 of the plant monitoring support system 100B acquires the measurement information (step S60).

[0147] The determination condition update unit 23 calculates a distribution of the measured values included in the measurement information acquired in step S60 (step S61). In the processing of step S61, the determination condition update unit 23 calculates the current distribution that is a distribution of the measured values included in the measurement information in the period from the current time back to a predetermined period ago, and the past distribution that is a distribution of the measured values included in the measurement information in the past period.

[0148] The determination condition update unit 23 determines whether or not the determination condition needs to be changed on the basis of the degree of change in the current distribution with respect to the past distribution (step S62). If determining that the determination condition needs to be changed (Yes in step S62), the determination condition update unit 23 updates the determination condition information stored in the state determination information storage unit 12 (step S63).

[0149] When finishing the processing of step S63 or if it is determined that the determination condition does not

need to be changed (No in step S62), the plant monitoring support system 100B ends the processing illustrated in FIG. 14.

[0150] An example of a hardware configuration of the plant monitoring support system 100B according to the third embodiment is the same as the hardware configuration of the plant monitoring support system 100 illustrated in FIG. 8. The processor 101 can implement the function of the determination condition update unit 23 by reading and executing a program stored in the memory 102.

[0151] As described above, the plant monitoring support system 100B according to the third embodiment includes the determination condition update unit 23. The determination condition update unit 23 changes the determination condition information on the basis of the change in distribution of the measured values included in the measurement information collected by the information collection unit 10. As a result, in the plant monitoring support system 100B, the user of the plant monitoring support system 100B can satisfactorily support monitoring of a state in which two or more state anomalies influence each other in the plant 1 without imposing an additional burden such as a work of changing the determination condition on the operator.

[0152] Fourth Embodiment.

A plant monitoring support system according to a fourth embodiment is different from the plant monitoring support system 100B according to the third embodiment in that the former system further includes a function of automatically updating a related signal on the basis of an operation on an input/output device. Hereinafter, components having functions similar to those in the third embodiment will be denoted by the same reference signs as those used in the third embodiment and their description is omitted, and thus differences from the plant monitoring support system 100B of the third embodiment will be mainly described.

[0153] FIG. 15 is a diagram illustrating an example of a configuration of a plant monitoring support system according to the fourth embodiment. A plant monitoring support system 100C illustrated in FIG. 15 is different from the plant monitoring support system 100B according to the third embodiment in that the system 100C includes an anomaly information generation unit 18C instead of the anomaly information generation unit 18A, and in that the system 100C further includes a selection history information storage unit 24, a selection information acquisition unit 25, and a related signal update unit 26.

[0154] The anomaly information generation unit 18C is different from the anomaly information generation unit 18A

according to the third embodiment in that the unit 18C includes an information generation unit 32C instead of the information generation unit 32A. The information generation unit 32C generates anomaly information including related signal candidate information that includes one or more related signal candidates. The information output unit 19 outputs the anomaly information generated by the information generation unit 32C to the input/output device 20.

[0155] On the basis of the anomaly information outputted from the anomaly information generation unit 18C, the input/output device 20 displays a state transition image including information indicating the transition of a state anomaly, information indicating a change in the state of the related signal, first prediction information, second prediction information, the related signal candidate information, and the like on a display unit (not illustrated).

[0156] FIG. 16 is a diagram illustrating an example of the state transition image displayed on the input/output device according to the fourth embodiment. As illustrated in FIG. 16, a state transition image 60C displayed on the input/output device 20 is different from the state transition image 60A illustrated in FIG. 10 in that the state transition image 60C includes related signal

candidate information 66 in addition to the state anomaly transition information 61, the signal state information 62, the first prediction information 64, and the second prediction information 65a, 65b, and 65c.

[0157] The related signal candidate information 66 illustrated in FIG. 16 includes, for each candidate of the related signal, a selection box for selecting the candidate of the related signal such as the signal S001, the signal S002, the signal S003, the signal S004, the signal S005, a signal S006, a signal S007, and a signal S008 as the related signal.

[0158] In the example illustrated in FIG. 16, since the trend graphs of the signal S001, the signal S002, and the signal S003 are included in the signal state information 62 with the signal S001, the signal S002, and the signal S003 being determined as the related signals, the selection boxes for the signal S001, the signal S002, and the signal S003 are checked.

[0159] On the other hand, since the signal S004, the signal S005, the signal S006, the signal S007, and the signal S008 are not determined as the related signals, the selection boxes for the signal S004, the signal S005, the signal S006, the signal S007, and the signal S008 are not checked.

[0160] A user of the plant monitoring support system

100C operates an input unit (not illustrated) of the input/output device 20 thereby making it possible to check the selection box for a signal to be newly set as the related signal and uncheck the selection box for a signal to be excluded from the related signal.

[0161] The input/output device 20 causes the selection history information storage unit 24 to store, as selection information, the operation on each selection box performed by the user of the plant monitoring support system 100C. The selection information includes information on the signal whose selection box is newly checked and information on the signal whose selection box is unchecked.

[0162] For example, when the user unchecks the selection box for the signal S001 and checks the selection box for the signal S005, the input/output device 20 causes the selection history information storage unit 24 to store therein the selection information including deselection information of the signal S001 and additional selection information of the signal S005.

[0163] The selection information acquisition unit 25 acquires the selection information from the selection history information storage unit 24. The related signal update unit 26 changes the related signal information included in the determination condition information stored in the state determination information storage unit 12 on

the basis of the update content of the related signal included in the selection information acquired by the selection information acquisition unit 25.

[0164] Control logics are individually incorporated in the facilities included in the plant 1, respectively, and the entire plant 1 is controlled by the control logics operating in association with each other. In a case where inspection or tuning is performed in each facility or in a case where part(s) replacement is performed in the facility, the strength of the influence or the range of the influence of each control logic changes so that some influence may also occur in a relation between facilities that has not been initially considered.

[0165] As described above, the user of the plant monitoring support system 100C can select the signal to be observed by manual setting and, for example, can observe some minute change that does not satisfy the determination condition. Moreover, in the plant monitoring support system 100C, the related signal can be changed without changing the determination condition.

[0166] Next, processing performed by the plant monitoring support system 100C will be described using a flowchart. FIG. 17 is a flowchart illustrating an example of related signal update processing performed by the plant monitoring support system according to the fourth

embodiment.

[0167] As illustrated in FIG. 17, the input/output device 20 of the plant monitoring support system 100C determines whether or not a signal is selected (step S70). In the processing of step S70, the input/output device 20 determines that a signal is being selected when an operation on the selection box is performed by the user of the plant monitoring support system 100C.

[0168] If determining that a signal is selected (Yes in step S70), the input/output device 20 causes the selection history information storage unit 24 to store therein information indicating the content of the operation on the selection box as the selection information (step S71).

[0169] When the processing of step S71 is finished or if the input/output device 20 determines that a signal is not being selected (No in step S70), the related signal update unit 26 of the plant monitoring support system 100C determines whether or not a related signal update timing has come (step S72). The related signal update timing is, for example, a timing that comes in a preset cycle, a timing at which the selection information is stored in the selection history information storage unit 24, or some other timing.

[0170] If it is determined that the related signal update timing has come (Yes in step S72), the selection

information acquisition unit 25 of the plant monitoring support system 100C acquires the selection information from the selection history information storage unit 24 (step S73). The related signal update unit 26 determines whether or not the related signal information stored in the state determination information storage unit 12 needs to be updated on the basis of the selection information acquired by the selection information acquisition unit 25 (step S74).

[0171] If determining that the related signal information needs to be updated (Yes in step S74), the related signal update unit 26 updates the related signal information stored in the state determination information storage unit 12 on the basis of the selection information acquired by the selection information acquisition unit 25 (step S75).

[0172] When the processing of step S75 is finished, if it is determined that the related signal update timing has not come (No in step S72), or if it is determined that the related signal information does not need to be updated (No in step S74), the plant monitoring support system 100C ends the processing illustrated in FIG. 17.

[0173] An example of a hardware configuration of the plant monitoring support system 100C according to the fourth embodiment is the same as the hardware configuration

of the plant monitoring support system 100 illustrated in FIG. 8. The selection history information storage unit 24 is implemented by the memory 102. The processor 101 can implement the functions of the anomaly information generation unit 18C, the selection information acquisition unit 25, and the related signal update unit 26 by reading and executing programs stored in the memory 102.

[0174] As described above, the plant monitoring support system 100C according to the fourth embodiment is provided with the related signal update unit 26. When the related signal is updated with the signal state information being displayed on the display unit (not illustrated) of the input/output device 20, the related signal update unit 26 updates the related signal information included in the determination condition information on the basis of the update content of the related signal. As a result, in the plant monitoring support system 100C, the related signal can be changed without changing the determination condition.

[0175] Fifth Embodiment.

A plant monitoring support system according to a fifth embodiment is different from the plant monitoring support system 100C according to the fourth embodiment in that the former system further includes a function of presenting information on a recommended candidate of a control

operation for the plant 1. Hereinafter, components having functions similar to those in the fourth embodiment will be denoted by the same reference signs as those used in the fourth embodiment and so their description is omitted, and thus differences from the plant monitoring support system 100C of the fourth embodiment will be mainly described.

[0176] FIG. 18 is a diagram illustrating an example of a configuration of a plant monitoring support system according to the fifth embodiment. A plant monitoring support system 100D illustrated in FIG. 18 is different from the plant monitoring support system 100C according to the fourth embodiment in that the system 100D further includes a control history information storage unit 27, a control history information acquisition unit 28, and a recommended control information generation unit 29.

[0177] The control history information storage unit 27 stores therein control history information that is information on the content of a control operation on the plant 1 at the time of occurrence of a state anomaly in the past. The control operation is, for example, an operation on an input unit (not illustrated) of the input/output device 20. In a case where the control operation for the plant 1 at the time of occurrence of a state anomaly in the past is an operation by which a control setting value for controlling the facility of the plant 1 is changed, the

input/output device 20 causes the control history information storage unit 27 to store therein information indicating the content of change in the control setting value as the control history information.

[0178] The input/output device 20 can also cause the control history information storage unit 27 to store, as the control history information, information in which information on the content of the control operation for the plant 1 at the time of occurrence of a state transition pattern that is a pattern of transition of the state anomaly having occurred in the past, is associated with the state transition pattern.

[0179] The input/output device 20 can also cause the control history information storage unit 27 to store, as the control history information, information in which information on the content of a control operation whose repetition frequency for a state anomaly having occurred in the past or for a state transition pattern having occurred in the past is higher than or equal to a threshold, among the control operations for the plant 1, is associated with the state anomaly or the state transition pattern.

[0180] The control history information acquisition unit 28 acquires the control history information stored in the control history information storage unit 27. The recommended control information generation unit 29

generates recommended control information including information on the recommended candidate of the control operation for the plant 1 on the basis of the control history information acquired by the control history information acquisition unit 28 and the determination result obtained by the state anomaly determination unit 15.

[0181] On the basis of the recommended control information generated by the recommended control information generation unit 29, the information output unit 19 causes a display unit (not illustrated) of the input/output device 20 to display a state transition image including the information on the recommended candidate of the control operation for the plant 1.

[0182] FIG. 19 is a diagram illustrating an example of the state transition image displayed on the input/output device according to the fifth embodiment. As illustrated in FIG. 19, a state transition image 60D displayed on the input/output device 20 is different from the state transition image 60C illustrated in FIG. 16 in that the state transition image 60D includes recommended control information 67 in addition to the state anomaly transition information 61, the signal state information 62, the first prediction information 64, the second prediction information 65a, 65b, and 65c, and the related signal candidate information 66.

[0183] The recommended control information 67 illustrated in FIG. 19 is information indicating, as a recommended control operation, an operation of changing the set value of the signal S105 for controlling the facility of the plant 1 from "100" to "120". As a result, a user of the plant monitoring support system 100D can grasp how a control operation has been performed in the past from the recommended control operation for the transition of the state anomaly indicated by the state anomaly transition information 61, and can easily control the facility of the plant 1 with reference to the recommended control operation.

[0184] Next, processing performed by the plant monitoring support system 100D will be described using a flowchart. FIG. 20 is a flowchart illustrating an example of processing performed by the plant monitoring support system according to the fifth embodiment. Processing of steps S80 to S87 illustrated in FIG. 20 is the same as the processing of steps S50 to S57 illustrated in FIG. 13, and so its description is omitted.

[0185] As illustrated in FIG. 20, the input/output device 20 of the plant monitoring support system 100D determines whether or not a control operation has been performed (step S88). If determining that the control operation has been performed (Yes in step S88), the

input/output device 20 causes the control history information storage unit 27 to store information in which the information on the control operation is associated with the state anomaly or the state transition pattern as the control history information (step S89).

[0186] When finishing the processing of step S89 or if it is determined that the control operation has not been performed (No in step S88), the plant monitoring support system 100D ends the processing illustrated in FIG. 20.

[0187] Next, state transition determination processing performed by the plant monitoring support system 100D will be described using a flowchart. FIG. 21 is a flowchart illustrating an example of the state transition determination processing performed by the plant monitoring support system according to the fifth embodiment.

Processing of steps S90 to S95 illustrated in FIG. 21 is the same as the processing of steps S40 to S45 illustrated in FIG. 11, and so its description is omitted.

[0188] As illustrated in FIG. 21, the control history information acquisition unit 28 of the plant monitoring support system 100D acquires the control history information stored in the control history information storage unit 27 (step S96). The recommended control information generation unit 29 of the plant monitoring support system 100D generates the recommended control

information including the information on the recommended candidate of the control operation for the plant 1 on the basis of the control history information acquired by the control history information acquisition unit 28 (step S97).

[0189] The information output unit 19 of the plant monitoring support system 100D outputs anomaly information including the state anomaly transition information, the signal state information, the first prediction information, the second prediction information, and the recommended control information (step S98). When finishing the processing of step S98, the plant monitoring support system 100D ends the processing illustrated in FIG. 21.

[0190] An example of a hardware configuration of the plant monitoring support system 100D according to the fifth embodiment is the same as the hardware configuration of the plant monitoring support system 100 illustrated in FIG. 8. The control history information storage unit 27 is implemented by the memory 102. The processor 101 can implement the functions of the control history information acquisition unit 28 and the recommended control information generation unit 29 by reading and executing the programs stored in the memory 102.

[0191] As described above, the plant monitoring support system 100D according to the fifth embodiment is provided with the control history information storage unit 27 and

the recommended control information generation unit 29. The control history information storage unit 27 stores control history information that is information on the content of a control operation on the plant 1 at the time of occurrence of a state anomaly in the past. The recommended control information generation unit 29 generates the recommended control information including the information on the recommended candidate of the control operation for the plant 1 on the basis of the control history information stored in the control history information storage unit 27 and the determination result obtained by the state anomaly determination unit 15. The information output unit 19 outputs the recommended control information. With this configuration, a user of the plant monitoring support system 100D can easily grasp how a control operation has been performed by an operator on the transition of the state anomaly having occurred in the past from the recommended control operation, for the transition of the state anomalies indicated by the state anomaly transition information 61, and can easily control the facility of the plant 1 with reference to the recommended control operation.

[0192] The configurations illustrated in the above embodiments merely illustrate examples, and each of them can be combined with other publicly known techniques while

the embodiments are combined together or are not combined and can be partially omitted and/or modified without departing from the scope of the present disclosure.

[0193] The present disclosure has an advantageous effect of supporting monitoring of the state in which two or more state anomalies influence each other in the plant.

What is claimed is:

1. A plant monitoring support system comprising:

an information collection unit to collect measurement information outputted by a measurement device provided in a plant;

a state determination information acquisition unit to acquire state determination information including determination condition information in which information on a condition for determining a state anomaly of the plant is included for each type of the state anomaly;

a state anomaly determination unit to determine a type and a period of occurrence of the state anomaly having occurred in the plant, on the basis of the measurement information collected by the information collection unit and the state determination information acquired by the state determination information acquisition unit;

an anomaly information generation unit to generate anomaly information including state anomaly transition information that indicates a transition of the state anomaly having occurred in the plant, on the basis of a determination result obtained by the state anomaly determination unit; and

an information output unit to output the anomaly information generated by the anomaly information generation

unit.

2. The plant monitoring support system according to claim 1, wherein

the state determination information further includes related signal information that is information on a related signal that is a signal related to the state anomaly, and

the anomaly information generation unit generates, as the anomaly information, information including signal state information in which the type and the period of occurrence of the state anomaly determined by the state anomaly determination unit are associated with the related signal, on the basis of the determination result obtained by the state anomaly determination unit, the measurement information, and the state determination information.

3. The plant monitoring support system according to claim 2, wherein

the state determination information further includes priority information indicating a priority of the state anomaly, and

the anomaly information generation unit determines the related signal that is to be included in the signal state information on the basis of the determination result obtained by the state anomaly determination unit and the

state determination information.

4. The plant monitoring support system according to claim 3, wherein

the anomaly information generation unit determines the ranking of the related signal that is to be included in the signal state information on the basis of the determination result obtained by the state anomaly determination unit and the state determination information, and generates, as the signal state information, information in which the related signal is arranged in the ranking determined.

5. The plant monitoring support system according to any one of claims 2 to 4, further comprising

a related signal update unit to update the related signal information included in the determination condition information on the basis of an update content of the related signal when the related signal is updated in a state in which the signal state information is displayed on a display unit.

6. The plant monitoring support system according to any one of claims 1 to 5, further comprising:

a history information acquisition unit to acquire transition history information that is information on a

transition of the state anomaly having occurred in the plant in the past; and

a similar information extraction unit to extract, from among the transition history information acquired by the history information acquisition unit, information on a state anomaly transition pattern that is a pattern of a transition of a state anomaly in the past including a transition of a state anomaly matching or similar to the transition of the state anomaly determined by the state anomaly determination unit, wherein

the anomaly information generation unit generates, as the anomaly information, information including information on the state anomaly transition pattern on the basis of an extraction result obtained by the similar information extraction unit.

7. The plant monitoring support system according to claim 6, wherein

the similar information extraction unit extracts, from among the measurement information collected by the information collection unit, past signal state information indicating a signal state indicated by the measurement information in a period of occurrence of the state anomaly transition pattern, and

the anomaly information generation unit generates, as

the anomaly information, information including the past signal state information on the basis of an extraction result obtained by the similar information extraction unit.

8. The plant monitoring support system according to any one of claims 1 to 5, further comprising:

a history information acquisition unit to acquire transition history information that is information on a transition of the state anomaly having occurred in the plant in the past; and

a prediction processing unit to predict a state anomaly that occurs in the plant, on the basis of the transition history information acquired by the history information acquisition unit and the determination result obtained by the state anomaly determination unit, wherein

the anomaly information generation unit generates, as the anomaly information, information including information indicating a prediction result obtained by the prediction processing unit.

9. The plant monitoring support system according to claim 8, wherein

the transition history information includes information on a first directed graph network indicating a transition of the state anomaly determined in the past by

the state anomaly determination unit in a form of a directed graph network, and

the prediction processing unit predicts a node to be connected to an end node of a second directed graph network on the basis of a result of comparison between information on the second directed graph network and information on the first directed graph network, and generates, as the anomaly information, information including information on the node predicted, the second directed graph network indicating a transition of the state anomaly determined by the state anomaly determination unit in a form of a directed graph network.

10. The plant monitoring support system according to any one of claims 1 to 9, further comprising

a determination condition update unit to update the determination condition information on the basis of a change in a distribution of measured values included in the measurement information collected by the information collection unit.

11. The plant monitoring support system according to any one of claims 1 to 10, further comprising:

a control history information storage unit to store control history information that is information on a

content of a control operation for the plant at the time of occurrence of the state anomaly in the past; and

a recommended control information generation unit to generate recommended control information including information on a recommended candidate of the control operation for the plant, on the basis of the control history information stored in the control history information storage unit and the determination result obtained by the state anomaly determination unit, wherein the information output unit outputs the recommended control information.

12. A plant monitoring support method implemented by a computer, the method comprising:

a first step of collecting measurement information outputted by a measurement device provided in a plant;

a second step of acquiring state determination information including determination condition information in which information on a condition for determining a state anomaly of the plant is included for each type of the state anomaly;

a third step of determining a type and a period of occurrence of the state anomaly having occurred in the plant, on the basis of the measurement information collected by the first step and the state determination

information acquired by the second step;

a fourth step of generating anomaly information including state anomaly transition information that indicates a transition of the state anomaly having occurred in the plant, on the basis of a determination result obtained by the third step; and

a fifth step of outputting the anomaly information generated by the fourth step.

13. A storage medium in which a plant monitoring support program is stored, the program causing a computer to execute:

a first step of collecting measurement information outputted by a measurement device provided in a plant;

a second step of acquiring state determination information including determination condition information in which information on a condition for determining a state anomaly of the plant is included for each type of the state anomaly;

a third step of determining a type and a period of occurrence of the state anomaly having occurred in the plant, on the basis of the measurement information collected by the first step and the state determination information acquired by the second step;

a fourth step of generating anomaly information

including state anomaly transition information that indicates a transition of the state anomaly having occurred in the plant on the basis of a determination result obtained by the third step; and

a fifth step of outputting the anomaly information generated by the fourth step.