

DESCRIPTION

Title:

INFORMATION PROCESSING METHOD AND INFORMATION PROCESSING DEVICE

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BACKGROUND

Technical Field

[0001] The disclosure relates to an information processing method and an information processing device.

10 Related Art

[0002] Conventionally, in production process management, a technology for aligning time series data of measurement values such as temperature and pressure measured in production equipment with time series data during normal conditions is known for judging abnormalities in production equipment. For example, a technology is known that flexibly sets a permissible range of temporal deviations in sampling timing for each sampling value when aligning.

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Citation List

Patent Document

[0003] [Patent Document 1] Japanese Patent Laid-open No. 5492622

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SUMMARY

Technical Problem

[0004] However, in the above conventional technology, in a process consisting of multiple steps, when using an alignment method based on elapsed time from the process start point,

there is a tendency for the distribution to become wider as the process progresses to later steps. Therefore, in cases where it is desired to detect deviations in the required time of steps positioned later in the process as abnormalities, even if the required time for that step deviates from the normal data, which is the time series data during normal conditions, it might be judged to be within the range of normal data. In this case, there is a risk that deviations in the required time for that step cannot be detected as abnormal.

[0005] The disclosure aims to solve such issues and has an objective of enabling more accurate alignment.

Solution to Problem

[0006] An information processing method according to the disclosure includes: an acquisition step that acquires target data, which is time series data including sampling values for each sampling timing, and standard time series data that serves as a criterion for judging whether the target data is normal or not; a generation step that, for each of the sampling values of the standard time series data, decides a sampling timing corresponding to the sampling value as a relative sampling timing, which is a sampling timing measured from a predetermined starting point, and generating distribution data indicating a distribution range of the relative sampling timing; and a decision step that decides a warping path based on the target data and the standard time series data such that it is included within the distribution range of the relative sampling timing decided based on the distribution data.

[0007] In the above information processing method, all the sampling values of the target data and the standard time series data are compared with each other, and a warping path that minimizes a distance between the target data and the standard time series data is decided as an optimal warping path.

[0008] In the above information processing method, the warping path is decided by

restricting a path of the warping path to be within the distribution range of the relative sampling timing decided based on the distribution data.

[0009] The above information processing method further includes a calculation step that calculates a distance between the target data and the standard time series data by accumulating values on a path of the warping path.

[0010] The above information processing method further includes a judgment step that judges the target data is abnormal in a case where the distance calculated by the calculation step is equal to or greater than a predetermined threshold.

[0011] In the above information processing method, the distribution data is a range of variation in values represented by a difference between the relative sampling timing and a sampling timing of the target data.

Effects

[0012] According to the above information processing method, it is possible to achieve more accurate alignment because: target data, which is time series data including sampling values for each sampling timing, and standard time series data that serves as a criterion for judging whether the target data is normal or not are acquired; for each of the sampling values of the standard time series data, a sampling timing corresponding to the sampling value is decided as a relative sampling timing, which is a sampling timing measured from a predetermined starting point; distribution data indicating a distribution range of the relative sampling timing is generated; and a warping path based on the target data and the standard time series data is decided such that it is included within the distribution range of the relative sampling timing decided based on the distribution data.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. 1 is a conceptual diagram showing an overview of an embodiment.

FIG. 2 is a diagram showing an example of the configuration of an information processing system according to an embodiment.

FIG. 3 is a diagram showing an example of a dataset information memory part
5 according to an embodiment.

FIG. 4 is a diagram showing an example of a threshold information memory part according to an embodiment.

FIG. 5 is a conceptual diagram showing generation processing according to an embodiment.

10 FIG. 6 is a flowchart showing an example of the flow of decision processing executed by an information processing device according to an embodiment.

FIG. 7 is a flowchart showing an example of the flow of judgment processing executed by an information processing device according to an embodiment.

15 DESCRIPTION OF THE EMBODIMENTS

[0014] Next, embodiments will be described with reference to the drawings. In the following description, common components in each embodiment are given the same reference numerals, and repetitive explanations are omitted.

[0015]

20 [Embodiment]

[1. Overview of Embodiment]

In the production process management site, it is necessary to detect abnormalities in production equipment early to ensure stable operation of the production equipment. Conventionally, in production process management, a technique is known for aligning time

series data (time series data of a monitoring target for monitoring abnormalities) of measurement values such as temperature and pressure measured in production equipment with time series data during normal conditions so as to judge abnormalities in production equipment. For example, a technique is known for flexibly setting a permissible range of temporal deviations in sampling timing for each sampling value when aligning. In this case, Dynamic Time Warping (DTW) is used for alignment.

[0016] However, in conventional technology, there was a risk that abnormalities in measurement values measured by production equipment could not be detected in a process consisting of multiple steps. Generally, plant operation data may consist of multiple steps.

In this case, process data refers to, for example, data of batch process in a plant, which is the data of various in the plant.

[0017] For example, a process consists of step 1 for loading raw materials, step 2 for preprocessing the raw materials, step 3 for reacting the preprocessed raw materials, step 4 for ending the process, step 5 for removing products from the equipment, and step 6 for shutting down the plant. In this way, the process targeted in this disclosure assumes a process with clear start and end.

[0018] In such cases, the required time until the process ends may change due to the entire process or each step. For example, even among normal data, there may be data that is long or short in the time axis direction, and jitters may occur in the time axis direction.

Therefore, it was necessary to perform synchronization processing in the time axis direction.

[0019] However, in the alignment method using elapsed time from the process start point, there is a tendency for the distribution to become wider as the process progressed towards the later steps. The reason for this tendency is thought to be that the distribution of elapsed time from the process start point in steps positioned later in the process includes not only

the variation in the required time for that step but also the variations of all the steps that have been passed through up to that point. Therefore, when trying to detect deviations in the required time of steps positioned later in the process as abnormalities, even if the required time for that step deviates from the normal data, it might be judged to be within the range of normal data in the distribution that includes the variations in required time of the previous steps that have been passed through up to that point. As a result, there were cases where deviations in the required time for that step could not be detected as abnormalities.

[0020] Here, the deviation in the required time for steps will be described with reference to FIG. 1. FIG. 1 is a conceptual diagram showing an overview of the embodiment. In the example of FIG. 1, FIG. FI1 shows time series data where the horizontal axis represents time and the vertical axis represents sensor values (an example of sampling values). Moreover, FIG. FI1 is a diagram overlaying multiple time series data. For example, in FIG. FI1, the dotted line represents normal data, and the solid line represents target data OD1. The normal data referred to here is, for example, time series data of normal sensor values acquired from a plant.

[0021] In this case, the process consists of step ST1, step ST2, step ST3, step ST4, and step ST5. Here, as shown in FIG. 1, it may be seen that a variation FL1 in step ST5 is larger compared to other steps. Thus, when trying to judge whether the required time in each step ST1 to ST5 is normal or abnormal, or when trying to judge whether the required time for the entire process is normal or abnormal, there is a problem that the variation in required time becomes larger in later steps (corresponding to step ST5 in the example of FIG. 1, for example).

[0022] When applying conventional technology to such time series data, even in cases where the sampling timing of the target data deviates from the variation in the time axis

direction of the normal data, there is a possibility that the sampling timing of the standard time series data and the sampling timing of the target data would synchronize when performing alignment using DTW. Moreover, sampling timing refers to actual time, elapsed time from the process start, or indices indicating time, etc.

5 **[0023]** Therefore, in this disclosure, to address the above issue, a relative sampling timing, which is a sampling timing measured from a predetermined starting point is introduced. For example, this disclosure provides a solution that generates distribution data based on the relative sampling timing. For instance, in this disclosure, among the sampling timings of the time series data, a point selected from any data point is set as the starting point of the
10 relative sampling timing. Moreover, this disclosure decides the range of difference between the current sampling timing and such starting point as a synchronizable range. Subsequently, this disclosure performs alignment based on the synchronizable range.

[0024] In the following, an example where the starting point of the relative sampling timing is a sampling timing that is a predetermined value before the current sampling timing.

15 **[0025]**

[2. Configuration of the Information Processing System]

Using FIG. 2, we will describe an example of the configuration of an information processing system 1. FIG. 2 is a diagram showing an example of the configuration of the information processing system 1 according to the embodiment. In the example of FIG. 2,
20 the information processing system 1 includes a data server 10 and an information processing device 100. The data server 10 and the information processing device 100 are communicably connected via a network N, either wired or wirelessly. Moreover, the information processing system 1 shown in FIG. 2 may include multiple data servers 10 or multiple information processing devices 100.

[0026] The data server 10 is an information processing device that acquires various data and provides it to the information processing device 100, and is realized, for example, by a server device or a cloud system. For instance, the data server 10 stores target data newly acquired from a plant. For example, the target data is time series data that includes
5 sampling values for each sampling timing. In this case, the data server 10 may store information related to the step corresponding to the sampling timing of the target data in association with the target data.

[0027] Moreover, the data server 10 stores standard time series data. Here, the standard time series data is data generated based on normal data, which represents time series data
10 of normal sensor values acquired from the plant. For example, the standard time series data serves as a criterion for judging whether the target data newly acquired from the plant is normal or not.

[0028] The standard time series data is data generated from the average values of each of multiple normal data.

15 To give a more specific example, the value (time axis value) of the sampling timing of the standard time series data is the average of the value of the sampling timing of the first normal data and the value of the sampling timing of the second normal data. Furthermore, the sensor value of the standard time series data is the average of the sensor value of the first normal data and the sensor value of the second normal data.

20 **[0029]** Moreover, in the above example, the value of the sampling timing of the standard time series data is not limited to being the average of the value of the sampling timing of the first normal data and the value of the sampling timing of the second normal data. For example, instead of the average value, it may be a weighted average or the like.

[0030] The information processing device 100 is an information processing device

capable of communicating with various devices via the network N, and is realized, for example, by a server device, a cloud system, or the like. For instance, the information processing device 100 is communicably connected to other various devices via the network N.

5 **[0031]** For example, the information processing device 100 acquires the target data and the standard time series data from the data server 10. Subsequently, the information processing device 100 generates distribution data indicating the distribution range of the relative sampling timing, which is the sampling timing measured from a predetermined starting point. Then, the information processing device 100 decides a warping path based
10 on the target data and the standard time series data such that it is included within the distribution range of the relative sampling timing decided based on the distribution data generated.

[0032] In other words, the information processing device 100 decides the range of the difference between the current sampling timing and the starting point of the relative
15 sampling timing as a synchronizable range, and performs alignment based on this synchronizable range. As a result, the information processing device 100 can achieve more accurate alignment.

[0033]

[3. Configuration of the Information Processing Device]

20 Next, an example of the functional configuration of the information processing device 100 will be described. As shown in FIG. 2, the information processing device 100 according to the embodiment includes a communication part 110, a memory part 120, and a control part 130.

[0034]

(Regarding the Communication Part 110)

The communication part 110 is realized, for example, by a NIC (Network Interface Card) or the like. The communication part 110 is connected to the network N either by wire or wirelessly, and performs sending and receiving of information with other various devices.

[0035]

(Regarding the Memory Part 120)

The memory part 120 is realized, for example, by semiconductor memory elements such as RAM (Random Access Memory), flash memory, or storage devices such as hard disks or optical disks. For example, the memory part 120 includes a dataset memory part 121 and a threshold information memory part 122.

[0036]

(Regarding the dataset memory part 121)

The dataset memory part 121 stores various data. Here, FIG. 3 shows an example of the dataset memory part 121 according to the embodiment. In the example shown in FIG. 3, the dataset memory part 121 includes items such as “dataset ID (Identifier)”, “standard time series data ID”, “sampling timing”, “sensor value”, “target data ID”, “sampling timing”, “sensor value”, “relative distribution data ID”, and “relative distribution data”.

[0037] The “dataset ID” is an identifier that identifies a group of data called a dataset.

The “standard time series data ID” is an identifier that identifies the standard time series data associated with the “dataset ID”. The “sampling timing” is information related to the sampling timing of the standard time series data associated with the “standard time series data ID”. For example, the sampling timing of the standard time series data is the

time measured with the process start point as 0. The “sensor value” is information related to the sensor value of the standard time series data associated with the “standard time series data ID”.

[0038] The “target data ID” is an identifier that identifies the target data associated with the “dataset ID”. The “sampling timing” is information related to the sampling timing of the target data associated with the “target data ID”. For example, the sampling timing of the target data is the time measured with the process start point as 0. The “sensor value” is information related to the sensor value of the target data associated with the “target data ID”.

[0039] The “distribution data ID” is an identifier that identifies the distribution data associated with the “dataset ID”. The “distribution data” is information related to the distribution data associated with the “distribution data ID”. For example, the distribution data is a range of variation in values represented by the difference between the relative sampling timing and the sampling timing of the normal data.

[0040] For example, in FIG. 3, “D1” identified by the dataset ID has a standard time series data ID of “SD1”, a sampling timing of “ST1”, and a sensor value of “SS1”. Moreover, it has a target data ID of “OD1”, a sampling timing of “DT1”, and a sensor value of “DS1”. Furthermore, it has a distribution data ID of “AD1” and distribution data of “ADD1”.

[0041] Moreover, in the example shown in FIG. 3, the sampling timing or the like is expressed with abstract symbols such as “ST1”. However, the sampling timing or the like may be specific numerical values, specific character strings, or file formats that include various information indicating sampling timing or the like.

[0042]

(Regarding the threshold information memory part 122)

The threshold information memory part 122 stores information related to predetermined thresholds. Here, FIG. 4 shows an example of the threshold information memory part 122 according to the embodiment. In the example shown in FIG. 4, the threshold information memory part 122 has items such as “threshold ID” and “threshold information”.

[0043] The “threshold ID” is an identifier that identifies the threshold information. The “threshold information” is information related to the threshold associated with the “threshold ID”. For example, the information related to the threshold indicates a predetermined threshold. For instance, the predetermined threshold is a value estimated from time series data during abnormal conditions and may be any arbitrary value. Moreover, the predetermined threshold may be set in consideration of the distance between the time series data during abnormal conditions and the standard time series data. In this case, the predetermined threshold is a lower limit value of the calculated distance.

[0044] For example, in FIG. 4, “T1” identified by the threshold ID has threshold information of “TH1”. Moreover, in the example shown in FIG. 4, the threshold information or the like is expressed with abstract symbols such as “TH1”. However, the threshold information or the like may be specific numerical values, specific character strings, or file formats that include various information indicating the threshold information or the like.

[0045]

(Regarding the control part 130)

The control part 130 is a controller that is realized, for example, it is realized by a CPU (Central Processing Unit) or MPU (Micro Processing Unit), executing various programs stored in the memory device inside the Information Processing Device 100 with

RAM as a work area. Moreover, the control part 130 is a controller that may be realized by integrated circuits such as ASIC (Application Specific Integrated Circuit) or FPGA (Field Programmable Gate Array).

[0046] As shown in FIG. 2, the control part 130 includes an acquisition part 131, a generation part 132, a calculation part 133, a decision part 134, and a judgment part 135, and realizes or executes the functions and operations of information processing as described below. Moreover, the internal configuration of the control part 130 is not limited to the configuration shown in FIG. 2, and may have other configurations as long as it is capable of performing the information processing to be described later. Furthermore, the connection relationships between each processing part possessed by the control part 130 are not limited to the connection relationships shown in FIG. 2, and may have other connection relationships.

[0047]

(Regarding the acquisition part 131)

The acquisition part 131 acquires various information. Specifically, the acquisition part 131 acquires target data, which is time series data including sampling values for each sampling timing, and standard time series data, which serves as a criterion for judging whether such time series data is normal or not.

[0048] For example, the acquisition part 131 acquires the target data and the standard time series data from the data server 10. Then, the acquisition part 131 stores the acquired target data and standard time series data in the dataset memory part 121.

[0049]

(Regarding the generation part 132)

The generation part 132 generates various information. Specifically, the

generation part 132 decides, for each sampling value of the standard time series data, the sampling timing corresponding to the sampling value as a relative sampling timing, which is the sampling timing measured from a predetermined starting point. In this case, the generation part 132 decides the starting point of the relative sampling timing for each
5 sampling timing of the standard time series data.

[0050] For example, the generation part 132 decides, as the starting point of the relative sampling timing, a sampling timing that is a predetermined value before the current sampling timing.

[0051] Subsequently, the generation part 132 generates distribution data indicating the
10 distribution range of the decided relative sampling timing. Then, the generation part 132 stores the generated distribution data in the dataset memory part 121.

[0052] Subsequently, the generation part 132 decides a range for associating the sampling timings based on the distribution data. For example, the generation part 132 decides the distribution range of the relative sampling timing indicated by the distribution data as the
15 range for associating sampling timings.

[0053] Here, the generation processing of distribution data will be described using FIG. 5. FIG. 5 is a conceptual diagram showing the generation processing according to the embodiment. In the example of FIG. 5, table TA1 shows the sampling timings of the standard time series data and the sampling timings of normal data 1 to N (for example, N is
20 an arbitrary integer) on which the standard time series data is based.

[0054] Here, in table TA1, when the sampling timing of the standard time series data is “1”, the sampling timing of normal data 1 is “1”, the sampling timing of normal data 2 is “1”, and the sampling timing of normal data N is “1”.

[0055] Moreover, in table TA1, when the sampling timing of the standard time series data

is “20”, the sampling timing of normal data 1 is “17”, the sampling timing of normal data 2 is “22”, and the sampling timing of normal data N is “19”.

[0056] Moreover, in table TA1, when the sampling timing of the standard time series data is “35”, the sampling timing of normal data 1 is “28”, the sampling timing of normal data 2 is “33”, and the sampling timing of normal data N is “38”.

[0057] Here, it is assumed that the starting point of the relative sampling timing is the sampling timing “20” of the standard time series data. In this case, the relative sampling timing is expressed by the difference between the current sampling timing and the sampling timing that serves as the starting point. In the example of FIG. 5, the relative sampling timing is expressed by the difference between the sampling timing “35” of the standard time series data and the sampling timing “20” of the standard time series data.

[0058] Subsequently, distribution data of relative sampling timings corresponding to the sampling timings of the standard time series data is generated. First, the differences in each sampling timing of the normal data corresponding to the relative sampling timing are calculated. In the example of FIG. 5, the difference between the sampling timing “17” of normal data 1 corresponding to the starting point sampling timing and the sampling timing “28” of normal data 1 corresponding to the current sampling timing is “+11”.

[0059] Moreover, the difference between the sampling timing “22” of normal data 2 corresponding to the starting point sampling timing and the sampling timing “33” of normal data 2 corresponding to the current sampling timing is “+11”.

[0060] Moreover, the difference between the sampling timing “19” of normal data N corresponding to the starting point sampling timing and the sampling timing “38” of normal data N corresponding to the current sampling timing is “+19”.

[0061] Next, the generation part 132 generates distribution data from the differences in

each sampling timing in the normal data. In the example of FIG. 5, the generation part 132 generates the distribution data for normal data 1 to N as “+11 to +19”. In this manner, the generation part 132 generates the distribution data “+11 to +19” of the relative sampling timing corresponding to the sampling timing “35” of the standard time series data. Then, the generation part 132 stores the generated distribution data “+11 to +19” in the dataset memory part 121.

[0062] Moreover, the distribution data may include, for example, the minimum value of the sampling timing and the maximum value of the sampling timing. Moreover, the distribution data may indicate the standard deviation of the sampling timing.

[0063]

(Regarding the calculation part 133)

The calculation part 133 calculates a distance matrix based on the target data and the standard time series data. In this case, in the distance matrix, rows correspond to the standard time series data, and columns correspond to the target data. For example, as an example of the absolute difference between the sensor values of the target data and the sensor values of the standard time series data, the calculation part 133 calculates the absolute difference for all combinations of all sensor values of the target data and all sensor values of the standard time series data. In this manner, the calculation part 133 calculates the distance matrix based on the target data and the standard time series data. Then, the calculation part 133 stores the calculated distance matrix in the memory part 120.

[0064] Furthermore, the calculation part 133 calculates the distance between the target data and the standard time series data by accumulating the values on the path of the warping path. For example, in an example where the warping path is decided in advance, the calculation part 133 calculates the distance between the target data and the standard time

series data using the values on the path of the warping path. For instance, the calculation part 133 refers to the distance matrix stored in the memory part 120, accumulates the absolute differences of each matrix element forming the warping path, and calculates the distance between the standard time series data and the target data. The matrix elements mentioned here correspond to the matrix elements of the distance matrix based on the target data and the standard time series data. Then, the calculation part 133 stores the calculated distance in the memory part 120.

[0065]

(Regarding the decision part 134)

The decision part 134 decides a warping path based on the target data and the standard time series data such that it is included within the distribution range of the relative sampling timing decided based on the distribution data.

[0066] For example, the decision part 134 compares all sampling values of the target data and the standard time series data with each other, and decides a warping path that minimizes the distance between the target data and the standard time series data. In this case, the decision part 134 decides the warping path by restricting the path of the warping path within the distribution range of the relative sampling timing decided based on the distribution data stored in the dataset memory part 121. Taking FIG. 5 as an example, the decision part 134 decides the warping path by restricting the path of the warping path within the range of “+11 to +19” of the distribution data generated by the generation part 132 in FIG. 5.

[0067] To provide a more specific example, the decision part 134 refers to the distance matrix calculated by the calculation part 133 and stored in the memory part 120, and decides to exclude matrix elements included in the warping path located outside the distribution range of the relative sampling timing from the path of the warping path.

[0068] For example, it is assumed that that one matrix element included in the warping path is located outside the distribution range of the relative sampling timing. In this case, the decision part 134 changes the one matrix element included in the warping path to a matrix element in the same column but a different row, which is included in the warping path located within the distribution range of the relative sampling timing. In this manner, the decision part 134 decides a warping path restricted within the distribution range of the relative sampling timing.

[0069]

(Regarding the judgment part 135)

The judgment part 135 judges that the target data is abnormal in the case where the distance calculated by the calculation part 133 is equal to or greater than a predetermined threshold. For example, the judgment part 135 judges that the target data is abnormal in the case where the distance calculated by the calculation part 133 and stored in the memory part 120 is equal to or greater than a predetermined threshold stored in the threshold information memory part 122. On the other hand, the judgment part 135 judges that the target data is normal in the case where the distance stored in the memory part 120 is below the predetermined threshold stored in the threshold information memory part 122.

[0070]

[4. Processing Procedure (1)]

Next, using FIG. 6, the procedure of the decision processing executed by the information processing device 100 according to the embodiment will be described. FIG. 6 is a flowchart showing an example of the flow of decision processing executed by the information processing device 100 according to the embodiment.

[0071] For example, it is assumed that the standard time series data and the target data are

acquired from the data server 10 in advance. Moreover, it is assumed that the alignment has already been performed for all points of each of the standard time series data and the normal data.

[0072] In such a case, as shown in FIG. 6, the information processing device 100 substitutes 1 to a sampling timing t (Step S101). Subsequently, the acquisition part 131 acquires information related to the sampling timing of the target data from the dataset memory part 121 (Step S102).

[0073] Then, the generation part 132 selects a starting point of the relative sampling timing from among the sampling timings of the target data (Step S103). For example, the generation part 132 decides a sampling timing that is a predetermined value before the current sampling timing as the starting point of the relative sampling timing.

[0074] Subsequently, the acquisition part 131 acquires the sampling timing corresponding to the starting point of the relative sampling timing from among the standard time series data (Step S104). For example, the acquisition part 131 acquires the sampling timing of the standard time series data associated with the relative sampling timing of the target data.

[0075] Then, the generation part 132 generates distribution data based on the relative sampling timing (Step S105). For example, the generation part 132 generates distribution data indicating the distribution range of the relative sampling timing.

[0076] Subsequently, the generation part 132 decides the range for associating sampling timings based on the distribution data (Step S106). For example, the generation part 132 decides the distribution range of the relative sampling timing indicated by the distribution data as the range for associating sampling timings.

[0077] Then, the decision part 134 decides whether to associate the target data based on the range for association (Step S107). For example, the decision part 134 compares all

sampling values of the target data and the standard time series data with each other, and decides the warping path that minimizes the distance between the target data and the standard time series data as an optimal warping path. In this case, the decision part 134 decides the warping path by restricting the path of the warping path within the distribution
5 range of the relative sampling timing decided based on the distribution data stored in the dataset memory part 121. In other words, the decision part 134 performs DTW in the distribution range to search for the optimal points.

[0078] To provide a more specific example, the decision part 134 refers to the distance matrix stored in the memory part 120 and decides to exclude matrix elements included in
10 the warping path located outside the distribution range of the relative sampling timing from the path of the warping path.

[0079] For example, it is assumed that that one matrix element included in the warping path is located outside the distribution range of the relative sampling timing. In this case, the decision part 134 changes the one matrix element included in the warping path to a
15 matrix element in the same column but a different row, which is included in the warping path located within the distribution range of the relative sampling timing. In this manner, the decision part 134 decides the warping path restricted within the distribution range of the relative sampling timing.

[0080] Subsequently, the information processing device 100 substitutes $t+1$ to the
20 sampling timing t (Step S108). Then, the information processing device 100 judges whether t is greater than a predetermined value (Step S109). For example, the predetermined value is a value indicating data length of the target data.

[0081] Specifically, in the case where the information processing device 100 judges that t is smaller than the predetermined value (Step S109; No), the process returns to Step S102.

On the other hand, in the case where the information processing device 100 judges that t is greater than the predetermined value (Step S109; Yes), the information processing ends.

[0082] Moreover, in the above example, in Step S101, an example where the information processing device 100 substitutes 1 to the sampling timing t is described, but it is not limited thereto and may be executed by various components (for example, the acquisition part 131, etc.) possessed by the information processing device 100. Moreover, in Step S108 an example where the information processing device 100 substitutes $t+1$ to the sampling timing t is described, but it is not limited thereto and may be executed by various components possessed by the information processing device 100. Furthermore, in Step S109, an example where the information processing device 100 judges whether t is greater than a predetermined value is described, but it is not limited thereto and may be executed by various components possessed by the information processing device 100.

[0083] Moreover, the above example describes information processing that repeats until t reaches a predetermined value, but it is not limited thereto. For example, the above information processing may be implemented only for some sampling timings of the target data.

[0084]

[5. Processing Procedure (2)]

Next, using FIG. 7, the procedure of the judgment processing executed by the information processing device 100 according to the embodiment will be described. FIG. 7 is a flowchart showing an example of the flow of judgment processing executed by the information processing device 100 according to the embodiment.

[0085] As shown in FIG. 7, the calculation part 133 calculates the distance between the target data and the standard time series data (Step S201). For example, the calculation part

133 calculates the distance between the target data and the standard time series data by accumulating the absolute differences on the path of the warping path between the target data and the standard time series data.

[0086] Subsequently, the judgment part 135 judges whether the distance calculated by the calculation part 133 is equal to or greater than a predetermined threshold or not (Step S202). Specifically, in the case where the distance is equal to or greater than the predetermined threshold (Step S202; Yes), the judgment part 135 judges that the target data is abnormal (Step S203).

[0087] On the other hand, in the case where the distance is below the predetermined threshold (Step S202; No), the judgment part 135 judges that the target data is normal (Step S204).

[0088]

[6. Effects]

As described above, the information processing device 100 according to the embodiment acquires the target data and the standard time series data. Subsequently, the information processing device 100 decides, for each sampling value of the standard time series data, the sampling timing corresponding to the sampling value as a relative sampling timing. Then, the information processing device 100 generates distribution data indicating the distribution range of the relative sampling timings. Subsequently, the information processing device 100 decides a warping path based on the target data and the standard time series data such that it is included within the distribution range of the relative sampling timing decided based on the distribution data.

[0089] For example, by using the relative sampling timing, the information processing device 100 is capable of correctly evaluating the variation in required time for each step

independently of the position on the time axis. Moreover, when performing alignment using DTW, the generated distribution data serves as a restriction condition. Moreover, when aligning the target data with the standard time series data, the points of the target data are linked to appropriate points based on the distribution data among the points of the standard time series data. As a result, the information processing device 100 can execute appropriate synchronization processing in accordance with the distribution of normal data. In this manner, the information processing device 100 enables more accurate alignment.

[0090] Furthermore, the information processing device 100 decides a sampling timing that is a predetermined value before the current sampling timing as the starting point of the relative sampling timing, and decides the relative sampling timing, and can thus avoid the influence of variations in required time for steps prior to the step that includes sampling.

[0091]

[7. Modification Example]

The information processing device 100 described above may be implemented in various different forms other than the above embodiment. Therefore, in the following, other embodiments of the information processing device 100 will be described.

[0092]

[7-1. Sampling Value]

In the above embodiment, an example where the sampling value is a sensor value was described, but it is not limited thereto. For example, the sampling value may be any value indicating measurement values such as temperature or pressure measured in the production equipment.

[0093]

[7-2. Starting Point of Relative sampling timing]

In the above embodiment, an example where the starting point of the relative sampling timing is a sampling timing that is a predetermined value before the current sampling timing was described, but it is not limited thereto.

[0094] For example, the starting point of the relative sampling timing may be a sampling timing corresponding to a time acquired from actual operation history data. For instance, such a starting point may be a sampling timing corresponding to a time recorded as a signal of process operation. To give a more specific example, the information processing device 100 may decide the first sampling timing having the same value as the sampling value at the sampling timing in the identification information indicating the step acquired in the process, as the starting point of the relative sampling timing.

[0095] Moreover, the starting point of the relative sampling timing may be estimated by machine learning. For example, the information processing device 100 may identify points where the trajectory of the data changes significantly in the time series data, based on conventional technology related to machine learning. Moreover, the information processing device 100 may decide a point closest to the sampling timing among the identified points as the starting point of the relative sampling timing. It is desirable that the starting point of the relative sampling timing be a point close to the starting point of the step that includes sampling.

[0096]

[7-3. Information Processing Device]

Furthermore, the information processing device 100 may be an information processing device that monitors the target data. For example, the information processing device 100 may judge whether time series data including sampling values such as temperature and pressure acquired from the data server 10 is normal or not. For instance,

the judgment part 135 judges that the target data is abnormal in the case where the distance calculated by the calculation part 133 is equal to or greater than a predetermined threshold stored in the threshold information memory part 122. On the other hand, the judgment part 135 judges that the target data is normal in the case where the distance calculated by the calculation part 133 is below the predetermined threshold stored in the threshold information memory part 122.

[0097] Moreover, the judgment processing executed by the information processing device 100 may judge whether the target data is normal or not in the case where the degree of agreement between the aligned target data and the aligned normal data is below a predetermined threshold.

[0098] For example, the calculation part 133 calculates the degree of agreement between the aligned target data and the aligned normal data. Moreover, regarding the calculation processing, various conventional technologies for calculating the degree of agreement between data may be adopted.

[0099] Then, the judgment part 135 may judge that the target data is abnormal in the case where the degree of agreement calculated by the calculation part 133 is below a predetermined threshold. On the other hand, the judgment part 135 may judge that the target data is normal in the case where the degree of agreement calculated by the calculation part 133 is equal to or greater than the predetermined threshold.

[0100]

[7-4. Relative sampling timing]

Furthermore, the information processing device 100 may combine the sampling timing and the relative sampling timing, such as a product set, as a new relative sampling timing.

[0101]

[8. Others]

Moreover, among the various processes described in the above embodiments and modification examples, all or part of the processes explained as being performed automatically may also be performed manually, or all or part of the processes explained as being performed manually may also be performed automatically by known methods. In addition, the processing procedures, specific names, and information including various data and parameters shown in the above document or drawings may be changed arbitrarily unless otherwise specified. For example, the various information shown in each drawing is not limited to the information illustrated.

[0102] Furthermore, each component of the various devices shown in the drawings is conceptually functional and does not necessarily need to be physically constructed as illustrated. In other words, the specific forms of distribution and integration of each device are not limited to those shown in the drawings, and all or part of them may be functionally or physically distributed or integrated in any unit according to various loads and usage conditions.

[0103] Furthermore, the above embodiments and modification examples may be appropriately combined within a range that does not cause contradiction in the processing content.

[0104] In addition, the “part (section, module, unit)” described above may be reinterpreted as “means” or “circuit”. For example, the decision part may be reinterpreted as a decision means or a decision circuit.

[0105] While several embodiments of this disclosure have been described in detail based on the drawings, but these are examples, and this disclosure may be implemented in other

forms with various modifications and improvements applied based on the knowledge of those skilled in the art, including the aspects described in the disclosure of invention section.

[Reference Signs List]

[0106]

5	N	Network
	1	Information processing system
	10	Data server
	100	Information processing device
	110	Communication part
10	120	Memory part
	121	Dataset Memory part
	122	Threshold information memory part
	130	Control part
	131	Acquisition part
15	132	Generation part
	133	Calculation part
	134	Decision part
	135	Judgment part

CLAIMS

Claim 1: An information processing method, comprising:

an acquisition step that acquires target data, which is time series data including sampling values for each sampling timing, and standard time series data that serves as a criterion for judging whether the target data is normal or not;

a generation step that, for each of the sampling values of the standard time series data, decides a sampling timing corresponding to the sampling value as a relative sampling timing, which is a sampling timing measured from a predetermined starting point, and generates distribution data indicating a distribution range of the relative sampling timing;

and

a decision step that decides a warping path based on the target data and the standard time series data such that it is included within the distribution range of the relative sampling timing decided based on the distribution data.

Claim 2: The information processing method according to claim 1,

wherein the decision step

compares all the sampling values of the target data and the standard time series data with each other, and decides a warping path that minimizes a distance between the target data and the standard time series data as the warping path.

Claim 3: The information processing method according to claim 2,

wherein the decision step

decides the warping path by restricting a path of the warping path within the distribution range of the relative sampling timing decided based on the distribution data.

Claim 4: The information processing method described in claim 2,
wherein the information processing method further comprises a calculation step
that calculates a distance between the target data and the standard time series data by
5 accumulating values on a path of the warping path.

Claim 5: The information processing method described in claim 4,
wherein the information processing method further comprises a judgment step
that judges the target data to be abnormal in a case where the distance calculated by the
10 calculation step is equal to or greater than a predetermined threshold.

Claim 6: The information processing method according to claim 1,
wherein the distribution data is a range of variation in values represented by a
difference between the relative sampling timing and a sampling timing of normal data,
15 which is time series data during normal condition.

Claim 7: An information processing device, comprising:
an acquisition part that acquires target data, which is time series data including
sampling values for each sampling timing, and standard time series data that serves as a
20 criterion for judging whether the target data is normal or not;
a generation part that, for each of the sampling values of the standard time series
data, decides a sampling timing corresponding to the sampling value as a relative sampling
timing, which is a sampling timing measured from a predetermined starting point, and
generates distribution data indicating a distribution range of the relative sampling timing;

a decision part that decides a warping path based on the target data and the standard time series data such that it is included within the distribution range of the relative sampling timing decided based on the distribution data.