

DESCRIPTION

Title of Invention:

DATA PROCESSING APPARATUS, DATA PROCESSING METHOD, AND 5 PROGRAM

Technical Field

[0001] The present invention relates to a technique for managing the measurement result of a measuring instrument (also called a sensor).

Background Art

10 [0002] With relation to a measured data management apparatus which tallies measured data measured by a measuring instrument, from various viewpoints such as the location, belongingness, or intended purpose of the measuring instrument, a method is disclosed which sets a virtual measurement point to which no measuring instrument is actually disposed, as opposed to an actual measurement point to which the measuring
15 instrument is actually disposed (for example, Patent Literature 1).

The actual measurement point corresponds to the measured data measured by an existing measuring instrument. The virtual measurement point corresponds to imaginary measured data calculated using the sum, proportional distribution, or the like of the measured data of actual measurement points.

20 A method is also disclosed which obtains measured data of a virtual measurement point by proportionally distributing the measured data of an actual measurement point according to the management classification such as the time course basis, the building basis, the location basis, the measurement type basis, or the application basis (for example, Patent Literature 2).

25 **Citation List**

Patent Literature

[0003] Patent Literature 1: JP 4640212

Patent Literature 2: JP 2006-185318

Summary of Invention

5 Technical Problem

[0004] The measured data have characteristics in that they arrive continuously along with the lapse of time, and that measured data which are measured in the same time zone are often closely related to each other.

Hence, when the measured data are to be stored in the table of a database, it is
10 convenient for use if an individual measured value is associated with the corresponding column of the table and the measured values of the same measurement time are collectively stored in one record.

[0005] With the recent technical background of a higher performance and lower price of a measuring instrument, a wider network band, a lower storage price per unit capacity,
15 and the like, it has become possible to collect measured data at shorter collection cycles from a larger number of measuring instruments and to accumulate and store the collected measured data.

Needs from the users of the measured data for utilization of the measured data increase.

20 For example, there are a need for determining a policy for increasing the effect of the energy conservation measures by collecting and analyzing the power consumption amount, a need for preventive maintenance for preventing a failure of a machine or facility by collecting and analyzing the status data of the machine or facility, and the like.

25 The measured data to be managed by a single system of a measured data

management apparatus has been increasing with the above background.

[0006] In a general database management system, the number of columns that can be defined in a single table is approximately 1,000 at maximum.

Hence, when the types of measured data produced by the measuring
5 instrument far outnumber the upper limit of the number of columns and such measured data are to be managed, the table needs to be divided in the direction of columns and the measured data needs to be distributed over a plurality of tables and stored in the plurality of tables.

If the measured data are distributed among the plurality of tables, when
10 tallying is to be conducted utilizing a virtual measurement point as in the prior art, or an analysis is to be conducted utilizing a plurality of types of measured data, the measured data may be read from the plurality of tables.

This leads to a problem that more time is required for tallying and analysis as compared to when the measured data is read from a single table.

15 Basically, along with the increase in number of tables from which the measured data is read, the time required for tallying and analysis also increases.

In the case where the measured data is read from the plurality of tables, sometimes a post-process such as an additional tallying process may become necessary on the user application side. This leads to a problem of a higher application
20 development workload.

[0007] The present invention is mainly aimed at solving the above problems, and has as its main objective to determine the storing destination tables of measured values when there are many measuring instruments and the measured values are distributed over a plurality of tables and stored in the plurality of tables, such that tallying and
25 analysis can be conducted efficiently.

Solution to Problem

[0008] A data processing apparatus according to the present invention manages tree structure data associated with measuring instruments, and includes:

5 a data dividing part to divide the tree structure data into a plurality of pieces of subtree data such that the number of measuring instruments associated with each piece of subtree data is equal to or smaller than the number of table-storable instruments, being an upper-limit number of measuring instruments whose measured value is storable in a measured value table;

10 a status determining part to determine whether or not the subtree data obtained through division by the data dividing part is in a definite status; and

a table assigning part to assign the measured value table which is to store a measured value from a measuring instrument associated with the subtree data, to the subtree data determined by the status determining part as being in the definite status,

15 wherein if a measuring instrument associated with one piece of subtree data is not associated with any other subtree data and if the number of measuring instruments associated with the one piece of subtree data is equal to or smaller than the number of table-storable instruments, the status determining part determines that the one piece of subtree data is in a first definite status,

20 wherein if at least one measuring instrument out of a measuring instrument associated with one piece of subtree data is redundantly associated with another piece of subtree data and if a total number with redundancy removed of the number of measuring instruments associated with the one piece of subtree data and the number of measuring instruments associated with the another piece of subtree data is equal to or smaller than the number of table-storable instruments, the status determining part determines that the
25 one piece of subtree data and the another piece of subtree data are in a second definite

status, and

wherein the status determining part causes the data dividing part to divide subtree data determined as being neither in the first definite status nor the second definite status, further into a plurality of pieces of subtree data.

5 **Advantageous Effects of Invention**

[0009] According to the present invention, subtree data is divided while determination is made as to whether the subtree data is in the first definite status or in the second definite status. Therefore, the measured values to be simultaneously utilized for both tallying and analysis can be correlated to the same measured value table as much as possible. As a result, tallying and analysis can be performed efficiently.

Brief Description of Drawings

[0010] Fig. 1 is a diagram illustrating a configuration example of a measured data management apparatus according to Embodiment 1.

Fig. 2 is a diagram illustrating a configuration example of a measured data management system according to Embodiment 1.

Fig. 3 is a diagram illustrating a configuration example of a measured data management system according to Embodiment 1.

Fig. 4 is a diagram illustrating a format example of measured data according to Embodiment 1.

Fig. 5 is a diagram illustrating an example of a measured value table according to Embodiment 1.

Fig. 6 is a diagram illustrating an example of configuration information according to Embodiment 1.

Fig. 7 is a diagram illustrating an example of configuration information according to Embodiment 1.

Fig. 8 is a diagram illustrating an example of configuration information according to Embodiment 1.

Fig. 9 is a diagram illustrating a relation between configuration information trees, virtual measurement point information, actual measurement points, and a
5 measured value table according to Embodiment 1.

Fig. 10 is a diagram illustrating an example of a configuration information table according to Embodiment 1.

Fig. 11 is a diagram illustrating an example of a group name table and an example of a level name table according to Embodiment 1.

10 Fig. 12 is a diagram illustrating an example of a virtual measurement point definition table according to Embodiment 1.

Fig. 13 is a diagram illustrating an example of measured value table design information according to Embodiment 1.

Fig. 14 is a diagram illustrating an example of a substitute measurement point
15 definition table according to Embodiment 1.

Fig. 15 is a flowchart illustrating a creating procedure of the measured value table design information according to Embodiment 1.

Fig. 16 is a flowchart illustrating a creating procedure of the measured value table design information according to Embodiment 1.

20 Fig. 17 is a diagram illustrating an example of a measurement point management information table according to Embodiment 1.

Fig. 18 is a diagram illustrating an example of a sub-configuration information tree management table according to Embodiment 1.

Fig. 19 is a flowchart illustrating a procedure of dividing a sub-configuration
25 information tree into a subtree according to Embodiment 1.

Fig. 20 is a diagram illustrating an operation preparation stage of the measured data management apparatus according to Embodiment 1.

Fig. 21 is a diagram illustrating a collection and accumulation stage for the measured data of the measured data management apparatus according to Embodiment 1.

5 Fig. 22 is a diagram illustrating a read and tallying stage for the measured data of the measured data management apparatus according to Embodiment 1.

Fig. 23 is a diagram illustrating an example of a first definite status according to Embodiment 1.

10 Fig. 24 is a diagram illustrating an example of a second definite status according to Embodiment 1.

Fig. 25 is a diagram illustrating an example of a third definite status according to Embodiment 1.

Fig. 26 is a diagram illustrating an example of a configuration information tree according to Embodiment 1.

15 Fig. 27 is a diagram illustrating an example of a configuration information table according to Embodiment 1.

Fig. 28 is a diagram illustrating an example of the configuration information tree according to Embodiment 1.

20 Fig. 29 is a diagram illustrating an example of the configuration information table according to Embodiment 1.

Fig. 30 is a diagram illustrating a relation between the configuration information trees and actual measurement points according to Embodiment 1.

Fig. 31 is a diagram illustrating an example of a virtual measurement point definition table according to Embodiment 1.

25 Fig. 32 is a diagram illustrating an example of the virtual measurement point

definition table according to Embodiment 1.

Fig. 33 is a diagram illustrating an example of a temporary configuration information table according to Embodiment 1.

Fig. 34 is a diagram illustrating an example of the temporary configuration information table according to Embodiment 1.

Fig. 35 is a diagram illustrating an example a measurement point management information table according to Embodiment 1.

Fig. 36 is a diagram illustrating an example of a sub-configuration information tree table according to Embodiment 1.

Fig. 37 is a diagram illustrating an update example of the temporary configuration information table according to Embodiment 1.

Fig. 38 is a diagram illustrating an update example of the measurement point management information table according to Embodiment 1.

Fig. 39 is a diagram illustrating an update example of the sub-configuration information tree table according to Embodiment 1.

Fig. 40 is a diagram illustrating an update example of the temporary configuration information table according to Embodiment 1.

Fig. 41 is a diagram illustrating an update example of the measurement point management information table according to Embodiment 1.

Fig. 42 is a diagram illustrating an update example of the sub-configuration information tree table according to Embodiment 1.

Fig. 43 is a diagram illustrating an update example of the sub-configuration information tree table according to Embodiment 1.

Fig. 44 is a diagram illustrating a hardware configuration example of the measured data management apparatus according to Embodiment 1.

Fig. 45 is a diagram illustrating an update example of the virtual measurement point definition table according to Embodiment 1.

Fig. 46 is a diagram illustrating an update example of the virtual measurement point definition table according to Embodiment 1.

5 Fig. 47 is a diagram illustrating an update example of the measurement point management information table according to Embodiment 1.

Fig. 48 is a diagram illustrating a derivation procedure of substitute measurement point definition according to Embodiment 1.

Description of Embodiments

10 [0011] Embodiment 1.

In Embodiment 1, a measured data management apparatus will be described which, when the number of measuring instruments is large and the types of measured data far outnumber the maximum number of columns of one table of a database management system, can inhibit an increase in execution time at executing tallying and
15 an increase in execution time at executing analysis, by correlating the measured data simultaneously utilized for tallying and analysis to the same table as much as possible, and can reduce the application development load of the user.

[0012] A measured data management apparatus 100 according to this embodiment has a configuration as exemplified in Fig. 1.

20 The constituent elements of the measured data management apparatus 100 illustrated in Fig. 1 will be described later in detail.

The measured data management apparatus 100 is an example of a data processing apparatus.

[0013] The measured data management apparatus 100 according to this embodiment
25 constitutes a measured data management system 200 together with measuring

instruments 201, hub devices 210, and an operation terminal 220, as illustrated in Figs. 2 and 3.

The measuring instruments 201, hub devices 210, and operation terminal 220 illustrated in Figs. 2 and 3 will be described later in detail.

5 [0014] Prior to describing in detail the configuration and operation of the measured data management apparatus 100 according to this embodiment, the outline of the operation of the measured data management apparatus will be described first.

[0015] The operation of the measured data management apparatus 100 is divided into the following three types of processes.

10 (1) Preparation for Operation

(2) Collection and Accumulation of Measured Data

(3) Read and Tallying of Measured Data

[0016] (1) Preparation for Operation

In the stage of the preparation for operation, prior to the start of actual
15 operation such as collection and accumulation, and read and tallying of sensor data, the following processes are executed as preparation (Fig. 20).

Using a virtual measurement point information input/output part 111, the user sets a virtual measurement point definition table 141 to the measured data management apparatus 100 (S11).

20 Using a configuration information input/output part 112, the user sets a configuration information table 142 to the measured data management apparatus 100 (S12).

Based on the virtual measurement point definition table 141 and the configuration information table 142, a measured value table designing part 121 creates
25 measured value table design information 143 (S13).

At this time, the measured value table designing part 121 describes information on substitute measurement points to the virtual measurement point definition table 141 as required.

The substitute measurement points will be described later.

5 In this step S13, the correlation between the actual measurement points and the columns of measured value tables 144 is determined.

Based on the measured value table design information 143, a measured value table defining part 122 creates (CREATE) the measured value tables (S14).

In this embodiment, the process of S13 will be mainly described.

10 [0017] (2) Collection and Accumulation of Measured Data

When the regular operation is started, measured data are collected from the measuring instruments corresponding to the actual measurement points. The measured values are accumulated in the measured value tables 144.

15 More specifically, the following processes are executed in collection and accumulation of the measured data (Fig. 21).

In each measuring instrument 201, data are measured repeatedly (periodically in most cases) (S21).

The measured data are collected by the measured data management apparatus 100 via the hub devices 210.

20 The collected measured data are written to a measured data collecting/accumulating part 131 of the measured data management apparatus 100 (S22).

25 Based on the measured value table design information 143, the measured data collecting/accumulating part 131 determines the measured value table 144 and columns as a destination where the measured data are to be stored, and writes the measured

values of the measured data to the corresponding columns (S23).

If a substitute measurement point associated with an actual measurement point ID of the measured data is defined, the measured data is written to the corresponding column.

5 The substitute measurement point will be described later.

[0018] (3) Read and Tallying of Measured Data

When the regular operation is started and the measured values of the measured data are accumulated in the measured value tables 144, the measured data are read and tallied as required. The user of the measured data management apparatus 100 utilizes
10 the measured data.

More specifically, the following process is executed in read and tallying of the measured data (Fig. 22).

The user designates the virtual measurement point name and the measurement time period for the measured data, and requests the measured data management
15 apparatus 100, via the operation terminal 220, to read the measured data (S31).

A virtual measured data computing part 132 acquires the list of actual measurement points which enables the user to obtain desired measured data, from the designated virtual measurement point name, based on the virtual measurement point definition table 141 (S32).

20 At this time, if a substitute measurement point is defined for a certain virtual measurement point and if the measured data of this virtual measurement point and the measured data of another actual measurement point are assigned with the same table, the virtual measured data computing part 132 reads the measured data from a column corresponding to the substitute measurement point (S32).

25 Then, the virtual measured data computing part 132 outputs the measured data

calculated according to the virtual measurement point definition, to the operation terminal 220 (S33).

[0019] Note that the measured value table designing part 121 is an example of a data dividing part, a status determining part, a table assigning part, and a substitute measurement point setting part.

The measured data collecting/accumulating part 131 is an example of a measurement point calculation part.

[0020] More detailed description will now be made on: (1) Preparation for Operation (S13 of Fig. 20).

10 [0021] The measured data management apparatus 100 according to this embodiment manages a configuration information tree 700 and a configuration information tree 710, each being tree structure data, as illustrated in Fig. 9.

The measured data management apparatus 100 also manages the measured value tables 144.

15 The measured values measured by the plurality of measuring instruments 201 are stored in the measured value tables 144.

Each of the configuration information tree 700 and the configuration information tree 710 has a hierarchical structure constituted of a plurality of nodes.

Each node serves as a unit of measured value tallying.

20 A calculation formula for calculation of tallying is defined in each node. The calculation formula includes 0 or more actual measurement points and 0 or more virtual measurement points.

An actual measurement point is an identifier associated with a measured value of the measured value table 144 directly. A virtual measurement point is an identifier associated with an actual measurement point directly, or indirectly via another virtual

25

measurement point.

Namely, each node is associated with a measuring instrument via an actual measurement point and a virtual measurement point.

In Fig. 9, 721, 722, and 723 represent virtual measurement points, and 731,
5 732, and 733 represent actual measurement points.

The number of columns of the measured value table 144, that is, the number of measuring instruments (the number of table-storable instruments) whose measured values can be stored in the measured value table 144 is finite. There is a case where the number of actual measurement points (that is, the number of measuring instruments)
10 exceeds the number of columns of the measured value table 144.

If the number of actual measurement points exceeds the number of columns of the measured value table 144, a plurality of measured value tables 144 need be used.

The measured data management apparatus 100 according to this embodiment determines to which measured value table 144 out of the plurality of measured value
15 tables 144 the measured value is to be stored.

[0022] In the measured data management apparatus 100 according to this embodiment, the measured value table designing part 121 divides each of the configuration information tree 700 and configuration information tree 710 into a plurality of sub-configuration information trees (also called subtree data or subtrees) such that the
20 number of measuring instruments associated with the sub-configuration information tree is equal to or smaller than the number of columns of the measured value table 214.

For example, regarding the configuration information tree 700, the measured value table designing part 121 divides it into a sub-configuration information tree constituted of only a node 701, a sub-configuration information tree having a node 702a
25 as a root node, and a sub-configuration information tree having 702b as a root node.

If the number of measuring instruments associated with the sub-configuration information tree having the node 702a is equal to or smaller than the number of columns of the measured value table 214, this sub-configuration information tree will not be further divided.

5 If the number of measuring instruments associated with the sub-configuration information tree having the node 702b exceeds the number of columns of the measured value table 214, this sub-configuration information tree is divided into, for example, a subtree constituted of only the node 702b, a sub-configuration information tree having a node 703a as a root node, and a sub-configuration information tree having a node 703b
10 as a root node.

When the number of measuring instruments associated with every single sub-configuration information tree becomes equal to or smaller than the number of columns of the measured value table 214, the measured value table designing part 121 determines whether or not each sub-configuration information tree is in a definite status
15 or not.

The measured value table designing part 121 assigns to a sub-configuration information tree in the definite status, a measured value table which is to store measured values from the measuring instruments associated with this sub-configuration information tree.

20 Regarding a sub-configuration information tree that is not in the definite status, the measured value table designing part 121 divides it further into a plurality of sub-configuration information trees.

[0023] There are two types of definite status in this embodiment.

If measuring instruments associated with one subtree are not associated with
25 any other subtree and if the number of measuring instruments associated with this one

subtree is equal to or smaller than the number of columns of the measured value table, the measured value table designing part 121 determines that this one subtree is in the first definite status.

If at least one measuring instrument out of the measuring instruments
 5 associated with one subtree is redundantly associated with another subtree and if a total number (unique total number) with redundancy removed of the number of measuring instruments associated with this one subtree and the number of measuring instruments associated with this another subtree is equal to or smaller than the number of columns of the measured value table, the measured value table designing part 121 determines that
 10 this one subtree and another subtree are in the second definite status.

[0024] Subtrees 1101 and 1102 in Fig. 23 are in the first definite status.

Actual measurement points 1 to 5 associated with the subtree 1101 are associated with only the subtree 1101, and their number is equal to or smaller than 8 being the number of columns of the measured value table.

15 Likewise, actual measurement points 6 to 11 associated with the subtree 1102 are associated with only the subtree 1102, and their number is smaller than 8 being the number of columns of the measured value table.

Hence, the subtrees 1101 and 1102 in Fig. 23 are in the first definite status.

[0025] Subtrees 1111 and 1112 in Fig. 24 are in the second definite status.

20 Actual measurement points associate with the subtree 1111 are 1 to 6. Actual measurement points associated with the subtree 1112 are 2 to 7.

The actual measurement points 2 to 6 are associated with both the subtree 1111 and the subtree 1112. When counted without this redundancy, the total number of the number of actual measurement points associated with the subtree 1111 and the number
 25 of actual measurement points associated with the subtree 1112 is 7, namely the actual

measurement points 1 to 7.

The number of actual measurement points, being 7, is smaller than 8 being the number of columns of the measured value table.

Hence, the subtrees 1111 and 1112 in Fig. 24 are in the second definite status.

- 5 [0026] If the calculation formula of a root node (a node R in Fig. 23) includes a measurement point other than one actual measurement point (a case of including two or more actual measurement points; a case of including a combination of an actual measurement point and a virtual measurement point; or a case of including only a virtual measurement point), the measured value table designing part 121 according to
10 this embodiment associates a substitute measurement point with the root node.

A substitute measurement point is an identifier indicating that a calculation for tallying measured values need be performed before a tallying instruction is received from the user.

- If the calculation formula of the root node (the node R in Fig. 23) includes a
15 virtual measurement point (a case of including a combination of an actual measurement point and a virtual measurement point; and a case of including only a virtual measurement point), the measured value table designing part 121 creates, using an actual measurement point with which the virtual measurement point is associated directly or indirectly, a substitute calculation formula including only the actual
20 measurement point and capable of providing the same calculation result as with a calculation formula defined at the root node, and associates the substitute calculation formula with the substitute measurement point.

- Then, concerning the root node with which the substitute measurement point is associated, the measured data collecting/accumulating part 131 carries out calculation
25 for tallying the measured values in advance before a tallying instruction is received.

The measured data collecting/accumulating part 131 then associates the calculation result with the substitute measurement point.

In this manner, at the time the user makes a tallying instruction concerning the root node, the tallied value has already been calculated. Therefore, the tallied value
5 can be presented to the user with no delay.

[0027] Based on the above outline description, the configuration and operation of the measured data management apparatus 100 according to this embodiment will be described in detail.

[0028] Fig. 1 is a functional configuration diagram of the measured data management
10 apparatus 100 according to Embodiment 1.

The functional configuration of the measured data management apparatus 100 according to Embodiment 1 will be described with reference to Fig. 1.

[0029] The measured data management apparatus 100 is a computer device that manages various types of measured data.

15 With broad classification, the measured data management apparatus 100 includes a virtual measurement point managing part 110, a measured value table managing part 120, a measured data managing part 130, and a data storing part 140.

[0030] The virtual measurement point managing part 110 includes the virtual measurement point information input/output part 111 and the configuration information
20 input/output part 112.

The virtual measurement point information input/output part 111 accepts an input of virtual measurement point information from the user and stores the virtual measurement point information to the virtual measurement point definition table 141.

The configuration information input/output part 112 accepts an input of
25 configuration information from the user and stores the configuration information to the

configuration information table 142 of the data storing part 140.

Also, the virtual measurement point information input/output part 111 reads the virtual measurement point information from the virtual measurement point definition table 141 in response to a request from the user and outputs the virtual measurement point information that has been read.

Also, the configuration information input/output part 112 reads the configuration information from the configuration information table 142 in response to a request from the user and outputs the configuration information that has been read.

The virtual measurement point information, the configuration information, the virtual measurement point definition table 141, and the configuration information table 142 will be described later.

[0031] The measured value table managing part 120 includes the measured value table designing part 121 and the measured value table defining part 122.

The measured value table designing part 121 creates design information of the measured value tables 144, based on the information recorded in the virtual measurement point definition table 141 and configuration information table 142, and records the created design information as the measured value table design information 143.

The measured value table defining part 122 actually creates the measured value tables 144 based on the measured value table design information 143.

[0032] The measured data managing part 130 is constituted of the measured data collecting/accumulating part 131, the virtual measured data computing part 132, and a measured data output part 133.

The measured data collecting/accumulating part 131 accepts an input of the collected measured data from the various types of measuring instruments and stores the

accepted measured data to the measured value tables 144.

The virtual measured data computing part 132 calculates measured data of the virtual measurement points based on the virtual measurement point definition of the virtual measurement point definition table 141.

5 The measured data output part 133 reads the measured data from the measured value tables 144 in response to a measured data read request such as tallying from the user, and outputs the measured data that has been read, to the user.

[0033] The data storing part 140 stores various types of data of the virtual measurement point definition table 141, the configuration information table 142, the measured value table design information 143, the measured value tables 144, and the like.

[0034] The function parts of the measured data management apparatus 100 may be implemented in one computer device, or implemented separately in a plurality of computer devices connected via a network.

15 [0035] Figs. 2 and 3 are diagrams each illustrating a configuration example of the measured data management system 200 according to Embodiment 1.

The configuration examples of the measured data management system 200 according to Embodiment 1 will be described with reference to Figs. 2 and 3.

[0036] The measured data management system 200 illustrated in Fig. 2 includes, in addition to the measured data management apparatus 100, not less than one hub device 210 and not less than one operation terminal 220 both connected to the measured data management apparatus 100 via the network.

If the measured data management apparatus 100 includes the function (application executing part 221) of the operation terminal 220, the measured data management system 200 need not include any operation terminal 220.

[0037] The hub device 210 is a computer or communication device that transmits measured data including measured values (such as power consumption, voltage, water consumption, or temperature) to the measured data management apparatus 100.

The hub device 210 includes a measured data receiving part 211, a measured
5 data transmitting part 212, and a hub device storing part 219.

The measured data receiving part 211 receives the measured data including the measured values from the measuring instruments 201 (example: a power distributor, a voltmeter, a water meter, or a thermometer) which measure the measured values.

The measured data transmitting part 212 transmits the measured data received
10 by the measured data receiving part 211 to the measured data management apparatus 100.

The hub device storing part 219 stores data which are to be used in the hub device 210, such as the measured data received by the measured data receiving part 211.

[0038] The operation terminal 220 is a device (computer) that executes an application
15 program (to be referred to as application hereinafter) serving to conduct a process requested by the user, such as a measured value tallying process.

The operation terminal 220 includes an application executing part 221 which executes the application, and an operation terminal storing part 229 which stores data to be used by the operation terminal 220.

20 For example, the application executing part 221 of the operation terminal 220 operates in the following manner by executing the application.

The application executing part 221 requests the measured values from the measured data management apparatus 100, acquires the measured values from the measured data management apparatus 100, and executes a tallying process concerning
25 the acquired measured values.

[0039] The measured data collecting/accumulating part 131 (see Fig. 1) of the measured data management apparatus 100 collects the measured value including the measured values from the hub devices 210 connected to measured data management apparatus 100, and stores the collected measured data to the measured value tables 144.

5 [0040] The measured data management system 200 illustrated in Fig. 2 has a star configuration in which each hub device 210 is connected to the measured data management apparatus 100. Alternatively, the measured data management system 200 may have a tree configuration as illustrated in Fig. 3 in which the hub devices 210 are connected hierarchically, or a configuration in which the measured data management
10 apparatus 100 and the hub devices 210 are connected by another connecting form.

In the measured data management system 200 illustrated in Fig. 3, a hub device 210A collects measured data from subordinate hub devices 210B and 210C which are connected via the network, and transmits the collected measured data to the measured data management apparatus 100.

15 [0041] Fig. 4 is a diagram illustrating a basic structure of the measured data according to Embodiment 1.

Measured data 400 according to Embodiment 1 includes at least an actual measurement point ID 401, a measurement time 402, and a measured value 403.

The actual measurement point ID 401 is an identifier that allows unique
20 identification of the measuring instrument 201 or a location where the measuring instrument 201 is set.

The measuring instrument 201 or the location where the measuring instrument 201 is set will be referred to as "actual measurement point" hereinafter.

The actual measurement point ID will be expressed by a "\$x" format.

25 Note that "x" is an arbitrary integer value.

The measurement time 402 indicates the time and date the measured value is measured.

The measurement time 402 is set by each measuring instrument 201 or each hub device 210.

5 The measured value 403 indicates a measured value measured by the measuring instrument 201.

[0042] Fig. 5 is a diagram illustrating the measured value table 144 according to Embodiment 1.

Each record (row) of the measured value table 144 is constituted of a row
10 number 501, a measurement time 502, and a plurality of measured values 503A to 503E measured at the same time.

The row number 501 is a number that identifies the measured values measured at the time time.

The measurement time 502 corresponds to the measurement time 402 but may
15 include some difference.

The measurement time 402 may possibly include a difference depending on the time variance of the clock of the corresponding measuring instrument 201 or hub device 210.

In that case, it is necessary to conduct a process of rounding the measurement
20 time 402 within a permissible difference range and treating the rounded result as the measured data for the same measurement time 502.

For example, the permissible difference is set to 100 ms in advance. A plurality of pieces of measured data included in the measurement time 402 of "2013/4/1 18:00:00.000" to "2013/4/1 18:00:00.099" are gathered into one record as the measured
25 data for the measurement time 502 of "2013/4/1 18:00:00.000".

In this embodiment, the difference rounding method for the measurement time 402 is not an essential issue and its detail will accordingly be omitted.

The measured value 403 is stored in any one measured value 503.

The correlation is determined based on the measured value table design
5 information 143 to be described later.

[0043] This embodiment is premised to use configuration information having a hierarchical structure, in order to express the configuration of a target object being a target to which a virtual measurement point is set, .

This hierarchical structure can be expressed as a tree structure illustrated in Fig.
10 6, for example. Information having such a hierarchical structure will be referred to as a configuration information tree.

This hierarchical relation may also be referred to as a parent-child relation or a vertical relation.

There are a plurality of types (view points) of configuration information trees,
15 as illustrated in the examples of Figs. 6, 7, and 8.

[0044] Fig. 9 is a diagram explaining the relation between the configuration information trees 700 and 710, virtual measurement point information 720, actual measurement point information 730, and the measured value 503 stored in the measured value table 144.

20 The configuration information has a plurality of configuration information trees, like the configuration information trees 700 and 710.

The configuration information tree has a tree structure constituted of nodes called configuration information nodes.

The configuration information nodes include the regular nodes 702 and 703
25 each having a parent node and child nodes, the root node 701 having no parent node,

and leaf nodes 704 and 711 having no child node.

Each configuration information node is associated with one virtual measurement point (722, for example) in the virtual measurement point information 720.

5 There is a case where a plurality of configuration information nodes point one virtual measurement point 723, as the configuration information nodes 704 and 711 do. [0045] The virtual measurement point included in the virtual measurement point information 720 is associated with not less than one actual measurement point (731, for example) included in the actual measurement point information 730, or not less than
10 one virtual measurement point.

For example, the virtual measurement point 722 is associated with two actual measurement points that are the actual measurement points 731 and 732.

Like the virtual measurement point 721, the virtual measurement point may be associated with only a virtual measurement point (with the virtual measurement point
15 722 in this case); or like the virtual measurement point 723, the virtual measurement point may be associated with both of the actual measurement point 733 and a virtual measurement point.

In this manner, the virtual measurement point is an identifier directly associated with an actual measurement point, or indirectly via another virtual
20 measurement point.

[0046] Furthermore, the actual measurement point 731 included in the actual measurement point information 730 is associated with not less than one column of the measured value 503 of the measured value table 144.

In this manner, the actual measurement point is an identifier directly associated
25 with a measured value of the measuring instrument.

[0047] An example of the configuration information tree will be described with reference to Fig. 6.

The configuration information tree has a tree structure including nodes (round-corner quadrangles in Fig. 6) each representing the constituent element of a target object being a target to which a virtual measurement point is set, and edges (lines connecting the nodes) representing the hierarchical relations between the constituent elements.

The node (for example, "company" node in Fig. 6) located at the top of the tree structure is the root node, being the parent node at the highest rank.

10 The node (for example, "team 1" node in Fig. 6) located at the bottom of the tree structure is the leaf node, being the child node at the lowest rank.

[0048] Fig. 6 illustrates a configuration information tree representing the configuration of an "organization" as a target to which a virtual measurement point is set.

15 A "company" node 601 represents the company as a whole.

The "company" is constituted of a plurality of "divisions" such as "management division" 602, "O project division" 603, and "Δ project division" 604.

The "management division" 602 is constituted of a plurality of "departments" such as "human resources department" 605, "general affairs department" 606, and
20 "accounting department" 607.

The human resources department 605 is constituted of a plurality of "sections" such as "human resources section" 608 and "training section" 609.

Each node such as the "company" 601, "management division" 602, "human resources department" 605, or "human resources section" 608 is an example of the
25 virtual measurement point.

[0049] Fig. 7 illustrates an example of a configuration information tree representing the configuration of "arrangement" which is a target to which a virtual measurement point is set.

[0050] Fig. 8 illustrates an example of a configuration information tree representing the configuration of "instrument" which is a target to which a virtual measurement point is set.

[0051] Figs. 10 and 11 are diagrams illustrating the configuration information tables 142 according to Embodiment 1.

The configuration information tables 142 are an example of data that indicates configuration information representing a target object which is a target to which a virtual measurement point is set.

The configuration information tables 142 illustrated in Figs. 10 and 11 include configuration information concerning the configuration information trees illustrated in Figs. 6 to 8.

[0052] The configuration information table 142 includes records in which "node ID", "parent ID", "group ID", "level", "virtual measurement point ID", and "node name" are correlated to each other.

The "node ID" indicates an identifier that identifies a configuration information node.

The "parent ID" indicates an identifier that identifies a parent node having a parent-child relation with this configuration information node.

When the "parent ID" is "null", the corresponding node signifies a root node.

The "group ID" indicates an identifier that identifies a configuration information tree.

The "level" indicates the depth (level) of a layer where the corresponding

configuration information node is located.

Assume that the level of the root node is "1". As the node level lowers by 1 layer towards a lower rank, the numerical value of the node increments by 1.

The "virtual measurement point ID" indicates an identifier that identifies a
5 virtual measurement point correlated to the corresponding configuration information node.

The virtual measurement point ID will be expressed by "#x" hereinafter.

Note that "x" is an arbitrary integer value.

The "node name" indicates a node name expressing the content of the
10 corresponding configuration information node.

[0053] For example, the node ID of "company" node illustrated in Fig. 6 is "1", group ID is "1", level is "1", and virtual measurement point ID is "#1".

The node ID of "management division" node is "2", parent ID is "1" (that is, "company" node), group ID is "1", level is "2", and virtual measurement point ID is
15 "#2".

[0054] The configuration information table 142 is associated with a group name table 142A which defines group names indicating the contents of the configuration information tree, and a level name table 142B which defines level names indicating the contents of the layers of the configuration information tree (both tables 142A and 142B
20 illustrated in Fig. 11).

[0055] The group name table 142A includes records in each of which "node ID" and "group name" are correlated to each other.

For example, the configuration information tree illustrated in Fig. 6 is identified by group ID "1" and represents an "organization" in the company.

25 The tree structure illustrated in Fig. 7 is identified by group ID "2" and

represents the "arrangement (place)" in the company.

[0056] The level name table 142B includes records in each of which "group ID", "level", and "level name" are correlated to each other.

For example, in the tree structure illustrated in Fig. 6, the layer of level "1" represents the "company" as a whole, and the layer of level "2" represents the "division" in the company.

In the tree structure illustrated in Fig. 7, the layer of level "1" represents the "arrangement" as a whole, the layer of level "2" represents the "district" where sites in the company are located, and the layer of level "3" represents the "site" in the company.

[0057] Fig. 12 is a diagram illustrating the virtual measurement point definition table 141 according to Embodiment 1.

The virtual measurement point definition table 141 is an example of data that defines the virtual measurement points in correlation with the actual measurement points.

The virtual measurement point definition table 141 includes records in each of which "virtual measurement point ID" 901, "virtual measurement point name" 902, "virtual measurement point definition" 903, and "substitute measurement point flag" 904 are correlated to each other.

The "virtual measurement point ID" 901 indicates an identifier that identifies a virtual measurement point.

The "virtual measurement point ID" 901 corresponds to the virtual measurement point ID 805 of the configuration information table 142.

The "virtual measurement point name" 902 indicates a virtual measurement point name that represents the content of the virtual measurement point.

The virtual measurement point names need not be identical to the node names.

The "virtual measurement point definition" 903 indicates the definition of the virtual measurement point in correlation to the actual measurement point or another virtual measurement point.

The "substitute measurement point flag" 904 indicates a flag representing whether or not the virtual measurement point includes a substitute measurement point.
 5 [0058] For example, virtual measurement point "#1" is associated with "power at whole company" signifying the power consumption of the whole company.

In particular, in a large organization such as the whole company, there is no measuring instrument to measure its power consumption directly. The "whole
 10 company" is a virtual measurement point that is not provided in reality.

Hence, the power consumption at virtual measurement point "#1" is equal to the sum of the power consumption at virtual measurement point "#2" (power at management division) of a subordinate organization, the power consumption at "#10" (power at O project division) of a subordinate organization, and the power consumption
 15 at "#20" (power at Δ project division) of a subordinate organization.

Namely, virtual measurement point "#1" is defined by a definition formula " $\#2 + \#10 + \#20$ ".

[0059] Virtual measurement point "#201" is associated with "power transformer facility of Tokyo 1st building" which controls the power consumption of the entire
 20 building of "Tokyo 1st building".

The power consumption of virtual measurement point "#201" is equal to the power consumption measured at actual measurement point "\$1" representing the power transformer facility of Tokyo 1st building.

[0060] Virtual measurement point "#1" is defined by substitute measurement point
 25 "%1" in addition to the definition formula " $\#2 + \#10 + \#20$ ".

A substitute measurement point is a measurement point for which a column is defined, in addition to the original virtual measurement point definition formula or actual measurement point, in the measured value table 144. The column is where the measured value of the corresponding virtual measurement point is read out.

5 More specifically, if the substitute measurement point is defined, the measurement value can be read directly from a corresponding column of the measured value table 144, in the same manner as the actual measurement point.

Whether or not a substitute measurement point is defined for the virtual measurement point definition, is set in the substitute measurement point flag 904 as
10 well.

The substitute measurement point will be described in detail later.

The substitute measurement point ID being the identifier of the substitute measurement point will be expressed by "%x" hereinafter.

Note that "x" is an arbitrary integer value.

15 Fig. 12 describes substitute measurement points "%1", "%2", "%3", and "%4". The substitute measurement points are set by the measured value table designing part 121 at S13 (Fig. 20) in the operation stage. Hence, the substitute measurement points "%1", "%2", "%3", and "%4" are described in the measured value table 144 after the process of S13.

20 [0061] Fig. 13 is a diagram indicating the measured value table design information 143 according to Embodiment 1.

The measured value table design information 143 is an example of data that defines the correlation between an actual measurement point or substitute measurement point and the measured value table 144.

25 The measured value table design information 143 includes records in which

"measurement point ID" 1001, "DB server name" 1002, "database name" 1003, "table name" 1004, "column name" 1005, and "data type" 1006 are correlated to each other.

The "measurement point ID" 1001 indicates an actual measurement point ID or a substitute measurement point ID.

5 The "DB server name" 1002 indicates the name of a server in which the database management system where the measured value table 144 is defined exists.

The "database name" 1003 indicates the name of a database where the measured value table 144 is defined.

10 The "table name" 1004 indicates the actual table name of the measured value table 144.

Note that the "DB server name" 1002, the "database name" 1003, and the "table name" 1004 are examples. It suffices as far as information that can uniquely specify the table of the measured value table 144 correlated to the actual measurement point or substitute measurement point is set.

15 The "column name" 1005 indicates the name of a column on the measured value table 144 which stores the measured value of the actual measurement point or substitute measurement point.

The "data type" 1006 indicates the data type of the measured value.

[0062] Fig. 14 is a diagram illustrating a substitute measurement point definition table 143A accompanying the measured value table design information 143 according to Embodiment 1.

20

The substitute measurement point definition table 143A includes records in which "substitute measurement point ID" 1011 and "substitute measurement point definition" 1012 are correlated to each other.

25 The "substitute measurement point ID" 1011 indicates substitute measurement

point ID.

The "substitute measurement point definition" 1012 indicates a substitute measurement point definition for calculating the measured data of the substitute measurement point.

- 5 The substitute measurement point definition is constituted of the measured data of a single actual measurement point, or of an arithmetic expression of the measured data of the actual measurement point and substitute measurement point.

- The substitute measurement point definition will be described later in detail.
 [0063] When a large number of measuring instruments are utilized in a large building
 10 or organization, sometimes the number of actual measurement points associated with one configuration information tree is much larger than the upper limit of the number of columns of one measured value table 144.

- In this case, a countermeasure may be conceived in which the table is divided in the direction of columns and the measured data of the actual measurement points are
 15 distributed into a plurality of tables and managed.

 At this time, as a method for determining a table as a storing destination of the measured data of each actual measurement point, a method may be conceived in which focus is placed on one certain configuration information tree and the table is divided according to units of its subtrees.

- 20 For example, the focus is placed on the configuration information of the "arrangement", and the configuration information tree is divided into subtrees each corresponding to a different "site". Then, the table is divided into a table that stores measured data associated with "Tokyo Site", a table that stores measured data associated with "Kanagawa Site", and a table that stores measured data associated with
 25 "Saitama Site".

In this case, if the range of tallying and analysis of the measured values is limited within the site, the problem of a decrease in efficiency of the process of tallying and analysis does not occur.

If tallying and analysis are carried out in accordance with the configuration information other than "arrangement", sometimes the efficiency of the process of tallying and analysis may decrease.

[0064] Sometimes one virtual measurement point or one actual measurement point may be associated with a plurality of configuration information trees, as illustrated in Fig. 9.

In an actual case, most virtual measurement points and most actual measurement points may be each associated with a plurality of configuration information trees.

Assume that departments belonging to the "O project division" are placed in different sites throughout the nation. In this case, in order to tally and analyze the measured data concerning the "O project division", the measured values need be read from the plurality of measured value tables 144.

Assume a virtual measurement point corresponding to a high-rank node of the configuration information tree. For example, regarding "company" or "Kanto district" in a case where the measured value table 144 is divided with the focus on the configuration information of the "arrangement", when the measured data is calculated by the virtual measurement point definition formula, the measured values need always be read from the plurality of measured value tables 144.

A situation like this in which measured data necessary for tallying and analysis is distributed over the plurality of measured value tables 144 will be called fragmentation of measured data.

[0065] The measured value table designing part 121 creates design information of the measured value table 144 that may inhibit fragmentation of the measured data.

[0066] As a premise, assume that the virtual measurement point information and the configuration information are created in advance and are respectively stored in the

5 virtual measurement point definition table 141 and the configuration information table 142.

Since the substitute measurement point is defined by the measured value table designing part 121, at this time point, the substitute measurement points have not been defined in the virtual measurement point definition.

10 Assume that the "measurement point ID" 1001 and "data type" 1006 of the actual measurement point have been set in the measured value table design information 143.

[0067] Definition is made as follows.

C: in one table of the measured value table 144, the number of columns that
15 can store measured data

Tree size: the number of all nodes included in the tree

Nut size: the number of unique actual measurement points and substitute measurement points associated with the tree

[0068] The operation (operation of S13 illustrated in Fig. 20) of the measured value
20 table designing part 121 according to Embodiment 1 will be described with reference to Figs. 15 and 16.

Figs. 15 and 16 are flowcharts illustrating the sequence of the creating process of the measured value table design information 143 in the measured value table designing part 121 according to Embodiment 1.

25 [0069] (Step S1101) The measured value table designing part 121 creates a temporary

configuration information table, being a copy of the configuration information table 142, in a working storage device.

The measured value table designing part 121 creates and initializes a measurement point management information table and a sub-configuration information tree management table.

These tables may be created in a temporary storage device provided especially to the measured value table designing part 121, or in a temporary storage device on the measured data management apparatus 100.

[0070] The configuration information table is used for managing the status of the sub-configuration information tree.

[0071] Fig. 17 is a diagram illustrating an example of a measurement point management information table 1200 created in step S1101.

The measurement point management information table 1200 includes records in each of which "measurement point ID" 1201, "own node ID" 1202, "root node ID" 1203, "column name" 1204, and "substitute measurement point definition" 1205 are correlated to each other.

The "measurement point ID" 1201 indicates actual measurement point ID or substitute measurement point ID.

The "own node ID" 1202 indicates the nodes ID of all nodes associated with virtual measurement points that have virtual measurement point definitions directly including the actual measurement points ID designated by the "measurement point ID" 1201.

For example, in the virtual measurement point definition table 141 of Fig. 12, the virtual measurement point definition 903 for virtual measurement point ID "#201" is "\$1", and thus directly includes actual measurement point ID.

In this case, "201" is extracted as node ID 801 associated with virtual measurement point ID "#201", from the configuration information table 142, and is set in the "own node ID" 1202.

Meanwhile, in the virtual measurement point definition table 141 of Fig. 12,
 5 virtual measurement point definition 903 for virtual measurement point ID "#1" is entirely constituted of the arithmetic expression of the measured data of the virtual measurement point, and accordingly does not directly include actual measurement point ID.

The "root node ID" 1203 in the measurement point management information
 10 table 1200 of Fig. 17 indicates the root node ID of a sub-configuration information tree with which the actual measurement point or substitute measurement point designated by the "measurement point ID" 1201 is associated.

If an actual measurement point or a substitute measurement point is associated with a plurality of sub-configuration information trees, the node IDs of the root nodes of
 15 all the sub-configuration information trees with which the actual measurement point or the substitute measurement point is associated are set in the root node ID.

If all the sub-configuration information trees with which the actual measurement point or substitute measurement point is associated have a size 1 (one node), or if the actual measurement point or the substitute measurement point is not
 20 associated with any sub-configuration information tree, then "null" is set.

The "column name" 1204 indicates the name of column, on the measured value table 144, which stores the measured data designated by the "measurement point ID" 1201.

The "substitute measurement point definition" 1205 indicates a definition
 25 formula for calculating the measured data of the substitute measurement point.

The definition formula of the substitute measurement point definition is constituted of the measured data of a single actual measurement point, or an arithmetic expression of the measured data of the actual measurement point and the substitute measurement point.

- 5 [0072] Fig. 18 is a diagram illustrating a sub-configuration information tree management table 1210 created in step S1101.

The sub-configuration information tree management table 1210 includes records in each of which "sub-configuration information tree ID" 1211, "root node ID" 1212, "sub-configuration information tree group ID" 1213, "definite flag" 1214, "DB
10 server name" 1215, "database name" 1216, and "table name" 1217 are correlated to each other.

The "sub-configuration information tree ID" 1211 indicates an identifier to uniquely identify the sub-configuration information tree.

The "root node ID" 1212 indicates the node ID of the root node of the
15 sub-configuration information tree identified by the sub-configuration information tree ID.

The "sub-configuration information tree group ID" 1213 indicates an identifier to uniquely identify the set (sub-configuration information tree group) of associated sub-configuration information trees.

20 The same "sub-configuration information tree group ID" is set to the plurality of sub-configuration information trees determined to be in the second definite status.

The "definite flag" 1214 indicates whether or not the sub-configuration information tree identified by the "sub-configuration information tree ID" 1211 is definite.

25 The "DB server name" 1215, "database name" 1216, and "table name" 1217

indicate the DB server name, the database name, and the table name, respectively, of the measured value table 144.

The "DB server name" 1215, "database name" 1216, and "table name" 1217 are information to uniquely identify the table where the measured data of the actual measurement point or substitute measurement point associated with the sub-configuration information tree identified by the "sub-configuration information tree ID" 1211 is stored, and are the same as the "DB server name" 1002, "database name" 1003, and "table name" 1004, respectively.

[0073] "A sub-configuration information tree T1 is definite" means that the

sub-configuration information tree is either in "the first definite status" or "the second definite status" described below.

A sub-configuration information tree that does not correspond to neither "the first definite status" nor "the second definite status" will be referred to as a "non-definite sub-configuration information tree".

[0074] (First Definite Status)

The nut size of the sub-configuration information tree T1 is equal to or smaller than C and none of the associated actual measurement points or substitute measurement points associated with the sub-configuration information tree T1 is associated with another sub-configuration information tree T2.

In the measurement point management information table 1200, the root nodes ID of all the associated actual measurement points or substitute measurement points are only the root node of the sub-configuration information tree T1.

[0075] (Second Definite Status)]

Even if all the actual measurement points or substitute measurement points

associated with the sub-configuration information tree T1 having a nut size equal to or

smaller than C are associated with another sub-configuration information tree T2, the unique (redundancy removed) number of actual measurement points associated with the sub-configuration information trees T1 and T2 is equal to or smaller than C.

If an actual measurement point N1 associated with a certain sub-configuration information tree T1 is also associated with another sub-configuration information tree T2 and if an another actual measurement point N2 associated with the sub-configuration information tree T2 is further associated with still another sub-configuration information tree T3, the unique number of all the actual measurement points or substitute measurement points associated with the sub-configuration information tree T1, T2, or T3 is measured. If the measured unique number is equal to or smaller than C, then this signifies second definite status.

[0076] First, the measured value table designing part 121 sets each of all the actual measurement point IDs sequentially to the measurement points ID 1201 of the records in the measurement point management information table 1200.

Then, for each actual measurement point ID, the measured value table designing part 121 extracts an associated configuration information tree, and sets the node ID of the root node of the associated configuration information tree to the root node ID 1203.

For this purpose, the measured value table designing part 121 searches the virtual measurement point definition 903 in the virtual measurement point definition table 141 and extracts all virtual measurement point IDs 901 that match the virtual measurement point definitions including the corresponding actual measurement point ID.

Then, the measured value table designing part 121 extracts all group IDs 803 with which the virtual measurement point IDs are associated, from the configuration

information table 142.

Finally, the measured value table designing part 121 extracts the node ID of the root node out of the node IDs belonging to the extracted group IDs, and sets the extracted node ID to the root node ID 1203 in the measurement point management
5 information table 1200.

[0077] In order to obtain the size of a certain tree, in the temporary configuration information table, for each node, the number of nodes whose parent ID is the node ID of a currently targeted node may be counted sequentially, starting with a node corresponding to the root node of this tree, recursively.

10 In order to obtain the nut size of a certain tree, the number of times the root node ID of this tree appears in the root node ID 1203 in the measurement point management information table 1200 may be counted.

[0078] Likewise, first, the measured value table designing part 121 defines an identifier (= sub-configuration information tree ID) for identifying each configuration
15 information tree uniquely, and sets the defined sub-configuration information tree ID to the sub-configuration information tree ID 1211 of each record in the sub-configuration information tree management table 1210.

As the sub-configuration information tree ID of this time, the group ID 803 in the configuration information table 142 may be used.

20 [0079] (Step S1102) The measured value table designing part 121 divides the configuration information tree into subtrees such that every sub-configuration information tree has a nut size equal to or smaller than C.

The following procedure is an example of this step.

(1) The measured value table designing part 121 selects one sub-configuration
25 information tree T having a nut size exceeding C, out of all the sub-configuration

information trees.

(2) The measured value table designing part 121 divides the selected sub-configuration information tree T into a root node and subtrees having the child nodes of the root node, as their new root nodes.

5 Then, the measured value table designing part 121 updates the measurement point management information table 1200 and the sub-configuration information tree management table 1210.

This procedure will be described later in detail.

(3) The measured value table designing part 121 repeats the operations (1) to
10 (2) until there is no more sub-configuration information tree left which has a nut size exceeding C.

[0080] (Step S1103) The measured value table designing part 121 selects a largest-size sub-configuration information tree T1 out of the non-definite sub-configuration information trees.

15 [0081] (Step S1104) The measured value table designing part 121 selects a largest-size sub-configuration information tree T2 out of other sub-configuration information trees associated with the the actual measurement point or substitute measurement point N1 associated with the sub-configuration information tree T1 selected in step S1103.

20 [0082] (Step S1105) The measured value table designing part 121 compares the number of child nodes of the root node between the sub-configuration information trees T1 and T2, and selects a sub-configuration information tree T' having a larger number of child nodes.

 Then, the measured value table designing part 121 divides the
25 sub-configuration information tree T' into the the root node R and sub-configuration

information trees having the child nodes of the root node, as their new parents.

In dividing the selected sub-configuration information tree T', the same procedure as that of (2) of step S1102 is applied.

[0083] (Step S1106) The measured value table designing part 121 checks whether or
 5 not the virtual measurement point definition of the root node R of step S1105 includes
 an actual measurement point directly.

More specifically, the measured value table designing part 121 extracts virtual
 measurement point ID 805 associated with the node ID of the root node R, from the
 configuration information table 142.

10 Then, the measured value table designing part 121 extracts the virtual
 measurement point definition 903 of the virtual measurement point ID from the virtual
 measurement point definition table 141, and checks whether or not the virtual
 measurement point definition 903 includes an actual measurement point directly.

As the result of the check, if an actual measurement point is included directly
 15 (YES), the process advances to step S1109.

If an actual measurement point is not included directly (NO), the process
 advances to step S1107.

"An actual measurement point is included directly" means that the virtual
 measurement point definition 903 is defined by one actual measurement point.

20 If the virtual measurement point definition 903 is defined by a plurality of
 actual measurement points, or by only a virtual measurement point, or by a combination
 of an actual measurement point and a virtual measurement point, then it is determined
 that an actual measurement point is not included directly (NO).

[0084] (Step S1107) The measured value table designing part 121 assigns a substitute
 25 measurement point ID anew to the root node R of the step S1105, and adds the assigned

substitute measurement point ID to the measurement point management information table 1200.

The measured value table designing part 121 adds a new record to the measurement point management information table 1200. The measured value table
 5 designing part 121 sets the substitute measurement point ID newly assigned as the "measurement point ID" 1201, to the "own node ID" 1202, and sets the node ID of the root node R, to the "root node ID" 1203.

The "column name" 1204 will be set later.

To the "substitute measurement point definition" 1205, a definition formula for
 10 calculating the measured data of a corresponding substitute measurement point is set.
 [0085] In order to set a definition formula to the "substitute measurement point definition" 1205, the measured value table designing part 121 extracts the virtual measurement point ID associated with the node ID of this root node R from the virtual measurement point ID 805 in the configuration information table 142, and extracts the
 15 virtual measurement point definition of a corresponding virtual measurement point from the virtual measurement point definition 903 in the virtual measurement point definition table 141.

Furthermore, the measured value table designing part 121 recursively expands the definition formula of the extracted "virtual measurement point definition" 903 until
 20 the definition formula no longer includes any virtual measurement point ID, and then sets the result of expansion to the "substitute measurement point definition" 1205.

[0086] At this time, if the expanded "substitute measurement point definition" 1205 is so complicated that the calculation load of the measured data is high, or if the measured data of the substitute measurement point cannot be calculated from only the measured
 25 data of the same measurement time, the measured value table designing part 121 need

not define a substitute measurement point.

[0087] (Step S1108) The measured value table designing part 121 adds information on the substitute measurement point to the virtual measurement point definition table 141.

The measured value table designing part 121 specifies the virtual measurement point definition 903 associated with the node ID of the root node R, in the same manner as in the procedure in above step S1107, and adds the substitute measurement point ID assigned to the root node R, to the virtual measurement point definition 903.

[0088] (step S1109) The measured value table designing part 121 adds the root node R to the sub-configuration information tree management tree, as a size-1 sub-configuration information tree.

The measured value table designing part 121 creates a record corresponding to the root node R. The measured value table designing part 121 assigns a sub-configuration information tree ID to this record anew, and sets the newly assigned sub-configuration information tree ID to the "sub-configuration information tree ID" 1211.

Also, the measured value table designing part 121 sets the node ID of the root node R to the "root node ID" 1212.

Furthermore, the measured value table designing part 121 assigns group ID to the sub-configuration information tree anew, and sets the newly assigned group ID to the "sub-configuration information tree group ID" 1213.

[0089] (Step S1110) The measured value table designing part 121 checks the sub-configuration information tree management table 1210 to see whether or not all sub-configuration information trees are definite (whether a "definite flag" 1214 is set).

If all the sub-configuration information trees are definite (if the "definite flag" 1214 is set; YES), the process advances to step S1111.

If a non-definite sub-configuration information tree exists (NO), the process returns to step S1103.

[0090] (Step S1111) When all the sub-configuration information trees are definite, the measured value table designing part 121 sets the DB server name 1215, the database name 1216, the table name 1217, and the column name 1204.

First, the measured value table designing part 121 sets the same "DB server name" 1215, the same "database name" 1216, and the same "table name" 1217 to records in which the same "sub-configuration information tree group ID" 1213 is set, in the sub-configuration information tree management table 1210.

10 To a record in which different "sub-configuration information tree group ID" 1213 is set, the measured value table designing part 121 sets such values that at least one of "DB server name" 1215, "database name" 1216, and "table name" 1217 is different.

Subsequently, the measured value table designing part 121 extracts the root nodes ID of sub-configuration information trees belonging to the same sub-configuration information tree group from "root node ID" 1212, and assigns to the "root node ID" 1203 of the measurement point management information table 1200, "column name" 1204 unique to a measurement point for which the extracted root node ID has been set.

20 [0091] (Step S1112) The measured value table designing part 121 updates the measured value table design information 143 and the substitute measurement point definition table 143A based on information in measurement point management information table 1200 and sub-configuration information tree management table 1210.

More specifically, the setting operation is carried out as follows.

25 "Measurement point ID" 1201 of measurement point management information

table 1200 → "measurement point ID" 1001 of measured value table design information 143

"DB server name" 1215 of sub-configuration information tree management

table 1210 → "DB server name" 1002 of measured value table design information 143

5 "Database name" 1216 of sub-configuration information tree management

table 1210 → "database name" 1003 of measured value table design information 143

"Table name" 1217 of sub-configuration information tree management table

1210 → "table name" 1004 of measured value table design information 143

"Column name" 1204 of measurement point management information table

10 1200 → "column name" 1005 of measured value table design information 143

Substitute measurement point ID in "measurement point ID" 1201 of measurement point management information table 1200 → "substitute measurement point ID" 1011 of substitute measurement point definition table 143A

"Substitute measurement point definition" 1205 of measurement point

15 management information table 1200 → "substitute measurement point definition" 1012 of substitute measurement point definition table 143A

Note that the "data type" 1006 of a substitute measurement point in the measured value table design information 143 can be set based on the "data type" 1006 of an actual measurement point associated with this substitute measurement point.

20 [0092] In step S1112, the correlation between the "measurement point ID" 1001 of the measured value table design information 143 and the "DB server name" 1215 and "database name" 1216 of the sub-configuration information tree management table 1210 can be determined by using the "root node ID" 1203 of the measurement point management information table 1200 and the "root node ID" 1212 of the
25 sub-configuration information tree management table 1210, as the key.

[0093] In step S1111, the "DB server name" 1215, the "database name" 1216, the "table name" 1217, and the "column name" 1204 are assigned. It may be possible that the measured value table designing part 121 sets only the "measurement point ID" 1201, "own node ID" 1202, "root node ID" 1203 and "substitute measurement point definition" 1205 of the measurement point management information table 1200, and the "sub-configuration information tree ID" 1211, "root node ID" 1212, "sub-configuration information tree group ID" 1213, and "definite flag" 1214 of the sub-configuration information tree management table 1210. The user may set the remaining "DB server name" 1215, "database name" 1216, "table name" 1217, and "column name" 1204.

10 [0094] (Step S1113) The measured value table designing part 121 records the updated measured value table design information 143 and substitute measurement point definition table 143A to the data storing part 140, and ends the process.

[0095] The larger the size of the sub-configuration information tree, the higher the probability that the actual measurement point or substitute measurement point associated with the sub-configuration information tree is associated with another sub-configuration information tree.

Therefore, in above steps S1103 and S1104, the measured value table designing part 121 selects a tree having a large-size sub-configuration information tree preferentially, and divides it.

20 In above steps S1103 and S1104, the sub-configuration information tree T may be selected not based on the tree size but based on the nut size.

A sub-configuration information tree having a root node with largest-number child nodes may be selected.

The larger the number of child nodes of the root node, the smaller the size of sub-configuration information trees into which the configuration information tree is

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divided by one division into sub-configuration information trees. Thus, an effect of reducing the number of steps required until all the sub-configuration information trees become definite can be expected.

A threshold value may be set in advance for the tree size or nut size, or for the number of child nodes of the root node. A sub-configuration information tree that is found the first among sub-configuration information trees exceeding this threshold value may be selected.

Thus, an effect of reducing the time required for searching a candidate sub-configuration information tree that is to be divided can be expected.

[0096] In step S1105, the sub-configuration information tree may be selected not based on the number of child nodes of the root node but with reference to the tree size or nut size.

A threshold value may be set in advance for the number of child nodes of the root node, tree size, or nut size. A sub-configuration information tree that is found the first among sub-configuration information trees exceeding this threshold value may be selected.

[0097] Fig. 19 is a flowchart illustrating the sequence of a process of dividing a sub-configuration information tree into subtrees according to Embodiment 1.

Namely, Fig. 19 illustrates the procedure of step S1102(2) in detail.

[0098] (Step S1301) The sub-configuration information tree T to be divided is designated.

[0099] (Step S1302) The measured value table designing part 121 extracts in the temporary configuration information table all records each having the node ID of the root node R of the sub-configuration information tree T as "parent ID" 802.

The nodes of such records will be referred to as nodes Ri.

The measured value table designing part 121 sets "null" to the "parent ID" 802 of each corresponding record.

[0100] (Step S1303) The measured value table designing part 121 extracts a record having the node ID of the root node R of the sub-configuration information tree T as the "root node ID" 1203 in the measurement point management information table 1200, and updates this root node ID. At the same time, the measured value table designing part 121 updates "level" 804 of all nodes included in the sub-configuration information tree T in the configuration information table 142.

[0101] An example of the update procedure, in step S1303, of the "root node ID" 1203 of the measurement point management information table 1200 will be described.

First, the measured value table designing part 121 selects one node ID of the record of a node R_i extracted in step S1302.

The measured value table designing part 121 searches the configuration information table 142 for the nodes ID of the child nodes sequentially, starting with the selected node ID, and subtracts 1 from the "level" 804 of the record that hits. Also, when the node ID contained in the "own node ID" 1202 in the measurement point management information table 1200 is detected, the measured value table designing part 121 sets the selected node ID to the "root ID" of this record in the measurement point management information table 1200 in place of the original ID.

The measured value table designing part 121 repeats this operation for the node IDs of all the records extracted in step S1302.

[0102] (Step S1304) The measured value table designing part 121 adds information on a sub-configuration information tree T_i obtained through division by the operation of steps 132 to S1303, to the sub-configuration information tree management table 1210.

The measured value table designing part 121 creates a record corresponding to

each sub-configuration information tree T_i . The measured value table designing part 121 assigns sub-configuration information tree ID to the record anew, and sets the newly assigned sub-configuration information tree ID to the "sub-configuration information tree ID" 1211.

5 The measured value table designing part 121 also sets the node ID of the root node R_i of the sub-configuration information tree T_i to the "root node ID" 1212. Furthermore, measured value table designing part 121 assigns the group ID of the sub-configuration information tree anew and sets the assigned group ID to the "sub-configuration information tree group ID" 1213.

10 [0103] (Step S1305) The measured value table designing part 121 checks if there is a definite sub-configuration information tree. If there is a definite sub-configuration information tree, the measured value table designing part 121 sets "definite flag" 1214 corresponding to the sub-configuration information tree in the sub-configuration information tree management table 1210.

15 If a plurality of definite sub-configuration information trees are associated with the same actual measurement point or substitute measurement point, the measured value table designing part 121 assigns and sets the same sub-configuration information tree group ID to the "sub-configuration information tree group ID" 1213 of these sub-configuration information trees.

20 Even with definite sub-configuration information trees belonging to different sub-configuration information tree groups, if the unique number of actual measurement points or substitute measurement points associated with the definite sub-configuration information trees is equal to or smaller than C , the measured value table designing part 121 may set the same sub-configuration information tree group ID again.

25 [0104] In step S1305, another condition (third definite status), under which it is

determined that a sub-configuration information tree is definite, will be described.

Even when not less than one actual measurement point P is associated with a plurality of non-definite sub-configuration information trees, the plurality of non-definite sub-configuration information trees can be made definite by treating the
 5 actual measurement point P as an independent measurement point and assigning a different substitute measurement point ID to the actual measurement point P.

More specifically, the measured value table designing part 121 stores the measured data of the actual measurement point P to the plurality of measured value tables 144.

10 If there are many such actual measurement points P, many pieces of measured data will be stored doubly or triply, wasting the storage capacity.

In view of this, the measured value table designing part 121 sets the permissible number in redundancy of measurement points, as a threshold value in advance. If the number of actual measurement points associated with the plurality of
 15 non-definite sub-configuration information trees does not exceed the threshold value, the measured value table designing part 121 adds a record to the measurement point management information table 1200, assigns a substitute measurement point ID anew to the actual measurement point P, and sets the newly assigned actual measurement point P to the "measurement point ID" 1201.

20 Simultaneously, the measured value table designing part 121 sets the original actual measurement point ID to the "substitute measurement point definition" 1205 of the record.

The measured value table designing part 121 lets the sub-configuration information trees associated to the actual measurement point P be definite as they are.

25 By assigning a different substitute measurement point ID to the actual

measurement point P, the sub-configuration information trees associated with this actual measurement point P can be treated as independent sub-configuration information trees. If these sub-configuration information trees satisfy the first or second definite status, the sub-configuration information trees can be made definite.

- 5 [0105] In the example illustrated in Fig. 25, the subtree data 1101 is associated with actual measurement points 1 to 6, and the subtree data 1102 is associated with actual measurement points 6 to 11.

The measurement point 6 is associated with both the subtree data 1101 and the subtree data 1102.

- 10 In the example of Fig. 25, the number of columns of one measured value table is 8, and the number of actual measurement points associated with the subtree 1101 and subtree 1102 is 11. This does not fall under the second definite status illustrated in Fig. 24.

- 15 In the example of Fig. 25, since the number of actual measurement points associated with the plurality of subtree data does not exceed the threshold value, each of the subtree data 1101 and subtree data 1102 is determined to be in the third definite status.

The actual measurement point 6 is assigned to both the measured value table of the subtree data 1101 and the measured value table of the subtree data 1102.

- 20 The user can decide the threshold value for the number of actual measurement points arbitrarily.

[0106] An operation example of the measured value table designing part 121 will be described through a practical example.

- 25 [0107] Figs. 26 and 28 respectively illustrate a configuration information tree 1131 and a configuration information tree 1132 which are used in the following description.

Group ID = 1 is set for the configuration information tree 1131. Group ID = 2 is set for the configuration information tree 1132.

In Figs. 26 and 28, a node surrounded by double outlines is a node associated with an actual measurement point directly.

5 Fig. 27 illustrates a configuration information table (corresponding to the configuration information table 142 of Fig. 10) of the configuration information tree 1131 of Fig. 26. Fig. 29 illustrates a configuration information table of the configuration information tree 1132 of Fig. 28.

The configuration information tree 1131 and the configuration information tree 10 1132 are associated with actual measurement points \$1 to \$15, as illustrated in Fig. 30.

Fig. 31 illustrates a virtual measurement point definition table (corresponding to the virtual measurement point definition table 141 of Fig. 12) of the configuration information tree 1131. Fig. 32 illustrates a virtual measurement point definition table of the configuration information tree 1132.

15 Fig. 33 illustrates a temporary configuration information table of the configuration information tree 1131. Fig. 34 illustrates a temporary configuration information table of the configuration information tree 1132.

Fig. 35 illustrates a measurement point management information table (corresponding to the measurement point management information table 1200 of Fig. 20 17) of the configuration information tree 1131 and configuration information tree 1132.

Fig. 36 illustrates a sub-configuration information tree table (corresponding to the sub-configuration information tree management table 1210 of Fig. 18) before the measured value table designing part 121 starts dividing the configuration information tree 1131 and configuration information tree 1132.

25 In the following description, assume that the nut size $C = 8$, namely, the

number of actual measurement points (measuring instruments) whose measured values can be stored in the measured value table 144 is 8.

[0108] As indicated by S1102 of Fig. 15, the measured value table designing part 121 divides the configuration information tree 1131 and the configuration information tree 1132 such that each subtree has a nut size $C = 8$ or less.

[0109] More specifically, the measured value table designing part 121 selects the configuration information tree 1131 (S1301 of Fig. 19), for example, and extracts nodes "A02" and "A03" that are the child nodes of a root node "A01" (S1302).

The measured value table designing part 121 then subtracts 1 from the "level" of each of nodes "A02" to "A39" of the temporary configuration information table (Fig. 33) of the configuration information tree 1131 (S1303).

Consequently, the temporary configuration information table of the configuration information tree 1131 is updated as in Fig. 37.

Also, the measured value table designing part 121 updates the root node ID of a record in the measurement point management information table (Fig. 35) where "1" (ID of the root node "A01") has been described in the root node ID field (S1303).

Consequently, the measurement point management information table is updated as in Fig. 38.

[0110] Subsequently, the measured value table designing part 121 adds information on subtrees each having the node "A02" as the root node and information on subtrees each having the node "A03" as the root node to the sub-configuration information tree table (Fig. 36) (S1304).

At this time point, neither the subtrees each having the node "A02" as the root node nor the subtrees each having the node "A03" as the root node are definite.

Since the actual measurement points directly associated with the subtrees each

having the node "A02" as the root node are the actual measurement points 1 to 7, the nut size is 7. However, the actual measurement points 1 to 7 are associated with the configuration information tree 1132 as well.

Hence, the subtrees each having the node "A02" as the root node are not in the first definite status.

The configuration information tree 1132 has not been divided yet at this time point. As the configuration information tree 1132 associated with the actual measurement points 1 to 7 is associated with the actual measurement points 8 to 15 as well, the configuration information tree 1132 is not in the second definite status, either.

The configuration information tree 1132 is not in the third definite status either.

Since the actual measurement points directly associated with the subtrees each having the node "A03" as the root node are the actual measurement points 8 to 14, the nut size is 7. However, the actual measurement points 8 to 14 are associated with the configuration information tree 1132 as well.

Hence, the subtrees each having the node "A03" as the root node are not in the first definite status.

The configuration information tree 1132 has not been divided yet at this time point. As the configuration information tree 1132 associated with the actual measurement points 8 to 14 is associated with the actual measurement points 1 to 7 and 15 as well, the configuration information tree 1132 is not in the second definite status either.

The configuration information tree 1132 is not in the third definite status either.

Hence, the sub-configuration information tree table is updated as in Fig. 39.

In the sub-configuration information tree table in Fig. 39, the definite flag is "1" for the subtree constituted of only the root node "A01". For any other subtree, the definite flag is "0".

[0111] Subsequently, the measured value table designing part 121 selects the

5 configuration information tree 1132 (S1301 in Fig. 19) and extracts nodes "B11" to "B13" that are the child nodes of a root node "B01" (S1302).

The measured value table designing part 121 then subtracts 1 from the "level" of each of nodes "B11" to "B44" of the temporary configuration information table (Fig. 34) of the configuration information tree 1132 (S1303).

10 Consequently, the temporary configuration information table of the configuration information tree 1132 is updated as in Fig. 40.

Also, the measured value table designing part 121 updates the root node ID of a record in the measurement point management information table (Fig. 38) where "101" (ID of the root node "B01") has been described in the root node ID field (S1303).

15 Consequently, the measurement point management information table is updated as in Fig. 41.

[0112] Subsequently, the measured value table designing part 121 adds information on subtrees each having the node "B11" as the root node, information on subtrees each having the node "B12" as the root node, and information on subtrees each having the node "B13" as the root node, to the sub-configuration information tree table (Fig. 39) (S1304).

At this time point, all the subtrees are definite.

The unique number of actual measurement points associated with the subtrees each having the node "A02" as the root node and with the subtrees each having the node "B11" as the root node is 7. Therefore, the subtrees each having the node "A02" as the

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root node and the subtrees each having the node "B11" as the root node fall under the second definite status.

The unique number of actual measurement points associated with the subtrees each having the node "A03" as the root node, with the subtrees each having "B12" as the root node, and with the subtrees each having the node "B13" as the root node, is 8. Therefore, the subtrees each having the node "A03" as the root node, the subtrees each having the node "B12" as the root node, and the subtrees each having the node "B13" as the root node fall under the second definite status.

Hence, the sub-configuration information tree table is updated as in Fig. 42.

In the sub-configuration information tree table of Fig. 42, the definite flag is "1" for all subtrees.

[0113] Then, the measured value table designing part 121 updates the field of the "sub-configuration information tree group ID" of the sub-configuration information tree table.

More specifically, the measured value table designing part 121 updates the field of the "sub-configuration information tree group ID", as indicated in Fig. 43.

[0114] Then, the measured value table designing part 121 carries out S1103 to S1105 of Fig. 15. Since all the subtrees are definite in this example, the processes of S1103 to S1105 are omitted.

The measured value table designing part 121 determines whether the virtual measurement point definition of the root node includes an actual measurement point directly (S1106).

Referring to the virtual measurement point definition tables of Figs. 31 and 32, for any one of "A01", "A02", "A03", "B01", "B11", "B12", and "B13" each being a root node, the virtual measurement point definition does not include an actual measurement

point directly (NO in S1106).

Hence, the measured value table designing part 121 adds information on the substitute measurement point to the virtual measurement point definition table (S1108), for each of "A01", "A02", "A03", "B01", "B11", "B12", and "B13".

5 In this example, since information on all the subtrees have already been registered in the sub-configuration information tree management table, the process of S1109 is omitted.

Since all the subtrees are definite (YES in S1110), the measured value table designing part 121 carries out the processes of S1111 to S1113.

10 The processes of S1111 to S1113 have been described with reference to Fig. 16, and a description thereof will accordingly be omitted.

At the completion of the process of S1113, the virtual measurement point definition table has been updated as illustrated in Figs. 45 and 46, and the measurement point management information table has been updated as illustrated in Fig. 47.

15 In the virtual measurement point definition table of Fig. 45, for virtual measurement point ID: #1, a substitute measurement point "%1" is added to the virtual measurement point definition, and the individual substitute measurement point flag is "1".

For virtual measurement point IDs: #2 and #3, substitute measurement points
20 "%2" and "%3" are respectively added to the virtual measurement point definitions, and the individual substitute measurement point flag is "1".

Similarly, in the virtual measurement point definition table of Fig. 46 as well, for virtual measurement point IDs: #101, #111, #112, and #113, substitute measurement points "%4", "%5", "%6", and "%7" are respectively added to the virtual measurement
25 point definitions, and the individual substitute measurement point flag is "1".

In the measurement point management table of Fig. 47, records for measurement point IDs: %1 to %7 are added.

The substitute measurement point definition in the measurement point management information table is derived in accordance with, for example, the
 5 procedure illustrated in Fig. 48.

Fig. 48 indicates the deriving procedure of the substitute measurement point for the substitute measurement point of %1.

As illustrated in Fig. 45, the substitute measurement point of %1 corresponds to the virtual measurement point of #1. From the virtual measurement point definition,
 10 $\#1 = \#2 + \#3$, $\#2 = \#11 + \#12 + \#13$, and $\#3 = \#14 + \#15 + \#16$ are obtained.

Hence, for the substitute measurement point of %1, $\#1 = (\#11 + \#12 + \#13) + (\#14 + \#15 + \#16)$ is obtained.

Thereafter, when each virtual measurement point is expanded in accordance with the virtual measurement point definition, a substitute measurement point definition
 15 as indicated on the last line of Fig. 48 is obtained.

[0115] In this embodiment, a measured data management apparatus as follows has been described hereinabove.

(a) The measured data management apparatus includes a measured data collecting/accumulating part which accepts input of a plurality of pieces of measured
 20 data measured by a measuring instrument, and a storage device to store the measured data, and stores the inputted measured data to one of a plurality of measured value tables defined in the storage device.

(b) The measuring instrument is associated with configuration information having a plurality of layers (tree structure).

25 (c) The measured data management apparatus is provided with a virtual measurement

point definition to calculate measured data of a virtual measurement point depending on a hierarchical relation of the above configuration information, and includes a measured data output part which calculates and outputs measured data of the virtual measurement point based on virtual measurement point definition and the measured data which is
5 stored in the measured data table.

(d) The measured data management apparatus includes a measured value table designing part which divides the configuration information into subtrees based on the above configuration information and the virtual measurement point definition.

(e) The measured value table designing part further associates the measured data which
10 is associated with one or a plurality of subtrees of the configuration information, with the measured value table, and records correlation information as measured value table design information.

(f) The measured value table designing part includes a measured value table defining part which defines a plurality of tables in the storage device based on the measured
15 value table design information.

(g) The measured data collecting/accumulating part determines a measured value table where the measured data is to be stored, based on the identifier of the measured data and the measured value table design information.

[0116] In this embodiment, a measured value table designing part has been described
20 which divides the configuration information into subtrees recursively such that the number of types of the measured data associated with the subtrees of the configuration information falls within the range of the specifications of a database management system used for storing the measured data.

[0117] In this embodiment, the measured value table designing part has been
25 described which, when one or the plurality of pieces of measured data are associated

with a plurality of pieces of configuration information, selects one piece of the associated configuration information associated, and divides the selected configuration information into subtrees repeatedly until the number of pieces of measured data associated with one or a plurality of pieces of subtrees falls within the range of the specifications.

[0118] In this embodiment, the measured value table designing part as follows has been described.

(a) When dividing the configuration information into the subtrees, the measured value table designing part divides the configuration information into a root node of a tree structure, and subtrees each having a child node of the root node, as a new root.

(b) The measured value table designing part assigns the identifier of a substitute measurement point to the original root node anew, and stores the identifier and a calculation formula to calculate the measured data of a virtual measurement point which corresponds to the root node, to the measured data table design information.

[0119] In this embodiment, the measured value table designing part has been described which, when one or a plurality of pieces of measured data are associated with the subtrees of the plurality of pieces of configuration information, assigns the identifiers of a plurality of substitute measurement points to the measured data, and stores the identifiers, and an identifier of the measuring instrument or a calculation formula each for obtaining the original measured data, to the measured value table design information.

[0120] Finally, a hardware configuration example of the measured data management apparatus 100 indicated in this embodiment will be described with reference to Fig. 44.

The measured data management apparatus 100 is a computer and can implement each element of the measured data management apparatus 100 by a program.

As the hardware configuration of the measured data management apparatus 100, a computation device 1901, an external storage device 1902, a main storage device 1903, a communication device 1904, and an input/output device 1905 are connected to a bus.

5 [0121] The computation device 1901 is a CPU (Central Processing Unit) which executes the program.

The external storage device 1902 is, for example, a ROM (Read Only Memory), a flash memory, or a hard disk device.

The main storage device 1903 is a RAM (Random Access Memory).

10 The communication device 1904 is, for example, an NIC (Network Interface Card).

The input/output device 1905 is, for example, a mouse, a keyboard, or a display device.

[0122] Programs are usually stored in the external storage device 1902. The
15 programs as loaded in the main storage device 1903 are sequentially read and executed by the computation device 1901.

The programs are those that implement functions explained as "parts" (data storing part excluded; the same applies hereinafter) in Fig. 1.

Furthermore, the external storage device 1902 also stores an operating system
20 (OS). At least part of the OS is loaded in the main storage device 1903. The computation device 1901, while executing the OS, executes the programs implementing the functions of the "parts" indicated in Fig. 1.

Information, data, signal values, and variable values representing the results of the processes described in the explanation of this embodiment as "determine", "decide",
25 "extract", "divide", "detect", "set", "register", "select", "create", "add", "update",

"receive", "output", and the like are stored, in the form of files, in the main storage device 1903.

An encryption key or decryption key, random values, and parameters may be stored, in the form of files, in the main storage device 1903.

5 [0123] The configuration of Fig. 44 merely presents an example of the hardware configuration of the measured data management apparatus 100. The hardware configuration of the measured data management apparatus 100 is not limited to that illustrated in Fig. 44, but can be another configuration.

[0124] A data processing method according to the present invention can be realized by
10 the procedure indicated in this embodiment.

Reference Signs List

[0125] 100: measured data management apparatus; 110: virtual measurement point managing part; 111: virtual measurement point information input/output part; 112: configuration information input/output part; 120: measured value table managing part;
15 121: measured value table designing part; 122: measured value table defining part; 130: measured data managing part; 131: measured data collecting/accumulating part; 132: virtual measured data computing part; 133: measured data output part; 140: data storing part; 141: virtual measurement point definition table; 142: configuration information table; 143: measured value table design information; 144: measured value table; 200:
20 measured data management system; 201: measuring instrument; 210: hub device; 211: measured data receiving part; 212: measured data transmitting part; 219: hub device storing part; 220: operation terminal; 221: application executing part; 229: operation terminal storing part; 400: measured data; 1200: measurement point management information table; 1210: sub-configuration information tree management table

Claims

[Claim 1] A data processing apparatus which manages tree structure data associated with measuring instruments, comprising:

5 a data dividing part to divide the tree structure data into a plurality of pieces of subtree data such that the number of measuring instruments associated with each piece of subtree data is equal to or smaller than the number of table-storable instruments, being an upper-limit number of measuring instruments whose measured value is storable in a measured value table;

10 a status determining part to determine whether or not the subtree data obtained through division by the data dividing part is in a definite status; and

a table assigning part to assign the measured value table which is to store a measured value from a measuring instrument associated with the subtree data, to the subtree data determined by the status determining part as being in the definite status,

15 wherein if a measuring instrument associated with one piece of subtree data is not associated with any other subtree data and if the number of measuring instruments associated with the one piece of subtree data is equal to or smaller than the number of table-storable instruments, the status determining part determines that the one piece of subtree data is in a first definite status,

20 wherein if at least one measuring instrument out of a measuring instrument associated with one piece of subtree data is redundantly associated with another piece of subtree data and if a total number with redundancy removed of the number of measuring instruments associated with the one piece of subtree data and the number of measuring instruments associated with the another piece of subtree data is equal to or smaller than the number of table-storable instruments, the status determining part determines that the one piece of subtree data and the another piece of subtree data are in a second definite

status, and

wherein the status determining part causes the data dividing part to divide subtree data determined as being neither in the first definite status nor the second definite status, further into a plurality of pieces of subtree data.

5 [Claim 2] The data processing apparatus according to claim 1,

wherein, if at least one measuring instrument out of the measuring instruments associated with one piece of subtree data is redundantly associated with another piece of subtree data, if a total number with redundancy removed of the number of measuring instruments associated redundantly with the one piece of subtree data and the number of measuring instruments associated with the another piece of subtree data exceeds the number of table-storable instruments, if the number of measuring instruments associated with the one piece of subtree data and the another piece of subtree data is equal to or smaller than a predetermined number, and if the one piece of subtree data and the another piece of subtree data are able to be determined as being in the first or second definite status, the status determining part determines that the one piece of subtree data and the another piece of subtree data are in a third definite status, and

wherein the status determining part causes the data dividing part to divide the subtree data determined as being neither in the first definite status, the second definite status, nor the third definite status, further into a plurality of pieces of subtree data.

20 [Claim 3] The data processing apparatus according to claim 1,

wherein the data processing apparatus manages tree structure data including a plurality of nodes,

wherein the data dividing part divides into subtree data constituted of only a root node and two or more pieces of subtree data each having a child node of the root node as a new root node, as the plurality of pieces of subtree data, and

wherein the status determining part causes the data dividing part to divide subtree data not in a definite status except for the subtree data constituted of only the root node, further into a plurality of pieces of subtree data until all subtree data except for the subtree data constituted of only the root node, fall under the definite status.

5 [Claim 4] The data processing apparatus according to claim 3,

 wherein the data processing apparatus manages tree structure data including a plurality of nodes serving as a unit of tallying for measured values, where a calculation formula for tallying the measured values is defined for each of the nodes, the calculation formula including at least either one of an actual measurement point being an identifier
10 associated with the measured value of the measuring instrument directly, and a virtual measurement point being an identifier associated with the actual measurement point directly or indirectly,

 wherein the data processing apparatus further comprises a substitute measurement point setting part to

15 determine whether or not a measurement point included in a calculation formula for the root node of subtree data obtained through division by the data dividing part is only one actual measurement point, and

 if the measurement point included in the calculation formula for the root node is not only one actual measurement point, associate a substitute measurement point
20 being an identifier to the root node, the indicator indicating that calculation for tallying the measured values need be carried out in advance prior to a tallying instruction is made.

[Claim 5] The data processing apparatus according to claim 4, wherein the substitute measurement point setting part,

25 if the calculation formula for the root node includes a virtual measurement

point, creates, using an actual measurement point associated with the virtual measurement point directly or indirectly, a substitute calculation formula including only the actual measurement point and being capable of providing the same calculation result as with the calculation formula for the root node, and

5 associates the substitute calculation formula with the substitute measurement point.

[Claim 6] The data processing apparatus according to claim 4, further comprising

 a substitute measurement point calculating part that carries out calculation for
10 tallying the measured values in advance prior to the tallying instruction is made concerning the root node with which the substitute measurement point is associated, and associates a calculation result with the substitute measurement point.

[Claim 7] The data processing apparatus according to claim 1, wherein the table assigning part

15 assigns one measured value table to one piece of subtree data which is determined by the status determining part as being in the first definite status, and
 assigns one measured value table to the plurality of pieces of subtree data which are determined by the status determining part as being in the second definite status.

20 [Claim 8] The data processing apparatus according to claim 2, wherein the table assigning part

 assigns one measured value table to each of the plurality of pieces of subtree data which is determined by the status determining part as being in the third definite status, and

25 causes the measured value from the measuring instrument associated

redundantly with the plurality of pieces of subtree data, to be stored in the measured value tables for each piece of subtree data.

[Claim 9] A data processing method conducted by a computer that manages tree structure data associated with measuring instruments, the data processing method

5 comprising:

a data dividing process of dividing, by the computer, the tree structure data into a plurality of pieces of subtree data such that the number of measuring instruments associated with each piece of subtree data is equal to or smaller than the number of table-storable instruments, being an upper-limit number of measuring instruments

10 whose measured value is storable in a measured value table;

a status determining process of determining, by the computer, whether or not the subtree data obtained through division in the data dividing process is in a definite status; and

a table assigning process of assigning, by the computer, the measured value
15 table which is to store a measured value from a measuring instrument associated with the subtree data, to the subtree data determined in the status determining process as being in the definite status,

wherein in the status determining process,

if a measuring instrument associated with one piece of subtree data is not
20 associated with any other subtree data and if the number of measuring instruments associated with the one piece of subtree data is equal to or smaller than the number of table-storable instruments, the computer determines that the one piece of subtree data is in a first definite status, and

if at least one measuring instrument out of a measuring instrument associated
25 with one piece of subtree data is redundantly associated with another piece of subtree

data and if a total number with redundancy removed of the number of measuring instruments associated with the one piece of subtree data and the number of measuring instruments associated with the another piece of subtree data is equal to or smaller than the number of table-storable instruments, the computer determines that the one piece of subtree data and the another piece of subtree data are in a second definite status, and

wherein in the data dividing process,

the computer divides subtree data determined as being neither in the first definite status nor the second definite status in the status determining process, further into a plurality of pieces of subtree data.

[Claim 10] A program which causes a computer that manages tree structure data associated with measuring instruments, to execute:

a data dividing process of dividing the tree structure data into a plurality of pieces of subtree data such that the number of measuring instruments associated with each piece of subtree data is equal to or smaller than the number of table-storable instruments, being an upper-limit number of measuring instruments whose measured value is storable in a measured value table;

a status determining process of determining whether or not the subtree data obtained through division in the data dividing process is in a definite status; and

a table assigning process of assigning the measured value table which is to store a measured value from a measuring instrument associated with the subtree data, to the subtree data determined in the status determining process as being in the definite status,

wherein in the status determining process,

if a measuring instrument associated with one piece of subtree data is not associated with any other subtree data and if the number of measuring instruments

associated with the one piece of subtree data is equal to or smaller than the number of table-storable instruments, the program causes the computer to determine that the one piece of subtree data is in a first definite status, and

5 if at least one measuring instrument out of a measuring instrument associated
with one piece of subtree data is redundantly associated with another piece of subtree
data and if a total number with redundancy removed of the number of measuring
instruments associated with the one piece of subtree data and the number of measuring
instruments associated with the another piece of subtree data is equal to or smaller than
the number of table-storable instruments, the program causes the computer to determine
10 that the one piece of subtree data and the another piece of subtree data are in a second
definite status, and

 wherein in the data dividing process,

 the program causes the computer to divide subtree data determined as being
neither in the first definite status nor the second definite status in the status determining
15 process, further into a plurality of pieces of subtree data.