

ABNORMALITY DETERMINATION APPARATUS

Background

5 The present invention relates to an abnormality determination apparatus.

In a system to manage processes in a factory and the like, process data and the like are periodically collected from devices disposed in a plant to manage the processes. In such a system, in preparation for
10 unexpected failures such as server down and disk crash, a redundant configuration like a duplication of servers is adopted, thus increasing the reliability of the system. Examples of typical redundant methods include a parallel redundant method and a standby redundant method.
15 Japanese Patent Application Laid-open No. 2011-258125 discloses a process data collection device that adopts the standby redundant method.

Summary

For example, in plant facilities, devices are
20 replaced and added. In a redundant system, before and after the replacement, addition, and the like of the devices, device configurations and connection relationships in a main series and a subordinate series need to be matched. Additionally, in the case where the
25 main series is switched to the subordinate series because of a breakdown or the like of the main series, the operation needs to be normally taken over before and after the switching. Japanese Patent Application Laid-open No. 2011-258125 does not disclose a method of
30 confirming whether the main series and the subordinate series normally operate.

In view of such circumstances, it is desirable to provide an abnormality determination apparatus capable of confirming whether a main series and a subordinate series normally operate.

5 According to an embodiment of the present invention, there is provided an abnormality determination apparatus including: a first storage unit configured to store collecting node data including management target data received from a redundant first collection node, the
10 first collection node being configured to collect the management target data from a management target device; a second storage unit configured to store collecting node data including management target data received from a redundant second collection node, the second collection
15 node being configured to collect the management target data from the management target device; a third storage unit configured to accumulate and store the management target data collected by one of the first collection node and the second collection node; a first comparison unit
20 configured to compare the collecting node data stored in the first storage unit with the collecting node data stored in the second storage unit; a first determination unit configured to determine whether there is an abnormality or not based on whether a difference between
25 the pieces of collecting node data compared by the first comparison unit falls outside a preset first allowable range or not; an interchange unit configured to interchange a main series and a subordinate series of a redundant system in a case where the first determination
30 unit determines that there is no abnormality, the main series and the subordinate series being respectively set

for the first collection node and the second collection node; a second comparison unit configured to compare the management target data received from a main-series collection node out of the first collection node and the second collection node after the interchange by the interchange unit, with the management target data stored in the third storage unit; and a second determination unit configured to determine whether there is an abnormality or not based on whether a difference between the pieces of management target data compared by the second comparison unit falls outside a preset second allowable range or not.

The abnormality determination apparatus may further include a transmission unit configured to transmit an activation instruction that instructs the other subordinate-series collection node to start collecting the management target data, in a case where the redundant system adopts a standby redundant method, in which the first comparison unit may be configured to perform comparison using the pieces of collecting node data received from the first collection node and the second collection node, after the subordinate-series collection node is activated according to the activation instruction.

According to the present invention, it is possible to provide an abnormality determination apparatus capable of confirming whether a main series and a subordinate series normally operate.

Brief Description of Drawings

Fig. 1 is a diagram exemplifying a configuration of a redundant system including a data recording server as an abnormality determination apparatus according to an

embodiment;

Fig. 2 is a flowchart for describing an operation when the data recording server shown in Fig. 1 executes abnormality determination processing; and

5 Fig. 3 is a flowchart for describing an operation when the data recording server shown in Fig. 1 executes the abnormality determination processing.

Detailed Description of Embodiments

Hereinafter, an embodiment of the present invention
10 will be described with reference to the drawings. An embodiment that will be described later is merely an example and does not exclude various modifications or applications of the technology that are not clearly specified hereinafter. In other words, the present
15 invention can be variously modified and performed without departing from the gist thereof.

Fig. 1 is a diagram exemplifying a schematic configuration of a redundant system including a data recording server as an abnormality determination
20 apparatus according to an embodiment of the present invention. As shown in Fig. 1, the redundant system includes a data recording server (abnormality determination apparatus) 1 and redundant data collecting servers (first collection node and second collection
25 node) 2A and 2B. In the case where the data collecting servers 2A and 2B do not need to be particularly distinguished from each other, the data collecting servers 2A and 2B are hereinafter referred to as data collecting server(s) 2.

30 The data collecting server 2 collects data to be managed, such as process data, from a device to be

managed. The device to be managed is disposed in a plant.

The data to be managed is hereinafter referred to as "management target data". The device to be managed is hereinafter referred to as "management target device".

5 The data collecting server 2 then transmits the management target data to the data recording server 1.

Examples of the management target device include a device provided with a highway addressable remote transducer (HART) communication function and a device compatible with foundation (registered trademark) fieldbus (FF) technology. Specifically, various sensor devices that detect a flow rate, a pressure, a temperature, and the like, valve positioners that control various valves such as a flow rate control valve and a pressure control valve, and various actuators that operate pumps, fans, and the like can be used as the management target devices. Examples of the management target data include measured data of a flow rate, a pressure, a temperature, and the like and control data such as valve openings.

20 The data collecting servers 2A and 2B may adopt any of a parallel redundant method and a standby redundant method as a redundant method. In the case where the parallel redundant method is adopted, one of the data collecting servers 2A and 2B is set as a master-series (main-series) collection server and the other one is set as a slave-series (subordinate-series) collection server in the parallel redundant method.

30 In the case where the standby redundant method is adopted, one of the data collecting servers 2A and 2B is set as an active-series (main-series) collection server

and the other one is set as a standby-series
(subordinate-series) collection server in the standby
redundant method.

As shown in Fig. 1, the data collecting servers 2
5 functionally include data collecting units 21A and 21B
and data transmitting units 22A and 22B, for example. In
the case where the data collecting units 21A and 21B do
not need to be particularly distinguished from each other
and the data transmitting units 22A and 22B do not need
10 to be particularly distinguished from each other, the
data collecting units 21A and 21B and the data
transmitting units 22A and 22B are hereinafter referred
to as data collecting unit(s) 21 and data transmitting
unit(s) 22.

15 The data collecting unit 21 collects management
target data from a management target device according to
a data collection schedule.

The data transmitting unit 22 transmits activation
status information in the data collecting server 2 and
20 the management target data collected by the data
collecting unit 21 in each cycle in which processing of
transmitting collected data to the data recording server
1 starts.

In the case where the redundant method is the
25 standby redundant method, the data transmitting unit 22
transmits the activation status information and the
management target data to the data recording server 1 and
the other data collecting server 2. On the other hand,
in the case where the redundant method is the parallel
30 redundant method, the data transmitting unit 22 transmits
the activation status information and the management

target data only to the data recording server 1.

The data recording server 1 shown in Fig. 1 is an apparatus that receives pieces of management target data from the redundant data collecting servers 2 and accumulates and stores the management target data received from the main-series data collecting server. The data recording server 1 has a function of executing abnormality determination processing in the case where an abnormality determination instruction is input according to an operating instruction by an administrator. In the abnormality determination processing, whether the main series and the subordinate series normally operate or not is determined. This function of executing the abnormality determination processing will be described in detail below.

The data recording server 1 functionally includes, for example, a first comparison unit 11, a transmission unit 12, a first determination unit 13, an interchange unit 14, a second comparison unit 15, and a second determination unit 16. Additionally, the data recording server 1 includes a first storage unit 17, a second storage unit 18, and a third storage unit 19 as memories that store various types of data.

The first storage unit 17 stores collecting server data (collecting node data) that includes the management target data received from the data collecting server 2A. The second storage unit 18 stores collecting server data that includes the management target data received from the data collecting server 2B.

Here, the management target data includes, for example, identification information with which a

management target device is identified, a measured value that is measured by the management target device, a measurement date and time of the measured value (timestamp), and quality information indicating the quality (for example, good, bad, and the like) of the measured value.

Additionally, the collecting server data includes, in addition to the management target data described above, for example, collection definition information and activation status information. The collection definition information defines a collection destination, a collection target, a collection cycle, a collection method (synchronous/asynchronous with a collection schedule), and the like. The activation status information indicates whether to execute data collection processing.

The third storage unit 19 accumulates and stores the management target data collected in any of the data collecting servers 2A and 2B. Specifically, in the case where the parallel redundant method is adopted as the redundant method, management target data collected by the data collecting server 2, which is set to be a master series (main series) out of the data collecting servers 2A and 2B, is accumulated and stored. On the other hand, in the case where the standby redundant method is adopted, management target data collected by the data collecting server 2, which is set to be an active series (main series) out of the data collecting servers 2A and 2B, is accumulated and stored. Consequently, the management target data stored in the third storage unit 19 can be managed as history data.

The first comparison unit 11 compares the collecting server data stored in the first storage unit 17 with the collecting server data stored in the second storage unit 18.

5 Here, in the case where the standby redundant method is adopted as the redundant method, during operation, the standby-series (subordinate-series) data collecting server is stopped. Therefore, before an abnormality determination is executed (before the first comparison
10 unit 11 performs comparison), the transmission unit 12 transmits an activation instruction to the standby-series data collecting server according to an operating instruction by the administrator. The activation instruction instructs the standby-series data collecting
15 server to start collecting the management target data. Consequently, the standby-series data collecting server is activated to start collecting the management target data. In this case, the first comparison unit 11 compares the pieces of collecting server data received
20 from both of the data collecting servers 2A and 2B, after the standby-series data collecting server is activated.

 Hereinafter, description will be given on the details of the comparison processing by the first comparison unit 11.

25 (1-1) Case where the comparison target is the measurement date and time included in the management target data: calculated is a difference ratio of the measurement date and time stored in the first storage unit 17 to the measurement date and time stored in the
30 second storage unit 18, thus comparing the comparison targets.

(1-2) Case where the comparison target is the measured value included in the management target data: calculated is a difference ratio of the measured value stored in the first storage unit 17 to the measured value stored in the second storage unit 18, thus comparing the comparison targets.

(1-3) Case where the comparison target is the quality information included in the management target data: the quality information stored in the first storage unit 17 and the quality information stored in the second storage unit 18 are compared, thus comparing the comparison targets.

(1-4) Case where the comparison target is the collection definition information included in the collecting server data: the collection definition information stored in the first storage unit 17 and the collection definition information stored in the second storage unit 18 are compared, thus comparing the comparison targets.

(1-5) Case where the comparison target is the activation status information included in the collecting server data: the activation status information stored in the first storage unit 17 and the activation status information stored in the second storage unit 18 are compared, thus comparing the comparison targets.

The first determination unit 13 determines whether there is an abnormality or not based on a comparison result of the first comparison unit 11. This determination will be described in detail below.

In the cases of (1-1) and (1-2) described above, the first determination unit 13 determines whether there is

an abnormality or not based on whether the difference ratio between the comparison targets falls outside a preset allowable range (first allowable range) or not, the difference ratio being calculated by the first comparison unit 11. In other words, in the case where the difference ratio falls outside the allowable range, the first determination unit 13 determines that there is an abnormality, and in the case where the difference ratio falls within the allowable range, the first determination unit 13 determines that there is no abnormality.

In the cases of (1-3) to (1-5) described above, the first determination unit 13 determines whether there is an abnormality or not based on whether there is a difference between the comparison targets compared by the first comparison unit 11. In other words, in the case where there is a difference between the comparison targets, the first determination unit 13 determines that there is an abnormality, and in the case where there is no difference between the comparison targets, the first determination unit 13 determines that there is no abnormality.

In the case where the first determination unit 13 determines that there is no abnormality, the interchange unit 14 interchanges the main series and the subordinate series of the redundant system, the main series and the subordinate series being set for the data collecting servers 2A and 2B, respectively. For exemplary purposes, in the case where the parallel redundant method is adopted as the redundant method, and the data collecting server 2A is set to be a master series (main series) and

the data collecting server 2B is set to be a slave series (subordinate series), when it is determined that there is no abnormality, the interchange unit 14 sets the data collecting server 2A to be a slave series and the data collecting server 2B to a master series.

On the other hand, in the case where the standby redundant method is adopted as the redundant method, and the data collecting server 2A is set to be an active series (main series) and the data collecting server 2B is set to be a standby series (subordinate series), if it is determined that there is no abnormality, the interchange unit 14 sets the data collecting server 2A to be a standby series and the data collecting server 2B to be an active series.

The second comparison unit 15 compares management target data received from the main-series data collecting server after the interchange with management target data stored in the third storage unit 19.

Here, the second comparison unit 15 sets, as the comparison target, the management target data received from the main-series data collecting server before the main and subordinate series are interchanged, out of the pieces of management target data stored in the third storage unit 19. This is because the comparison processing by the second comparison unit 15 aims to confirm the consistency between the management target data received from the main series after the interchange (that is, the subordinate series before the interchange) and the management target data received from the main series before the interchange.

Hereinafter, description will be given on the

details of the comparison processing by the second comparison unit 15.

(2-1) Case where the comparison target is the measurement date and time included in the management target data: calculated is a difference ratio of an interval of the measurement dates and times, which is based on temporally successive measurement dates and times received from the main-series data collecting server after the interchange, to an interval of the measurement dates and times, which is based on temporally successive measurement dates and times stored in the third storage unit 19, thus comparing the comparison targets.

(2-2) Case where the comparison target is the measured value included in the management target data: calculated is a difference ratio of the measured value received from the main-series data collecting server after the interchange to the measured value stored in the third storage unit 19, thus comparing the comparison targets.

(2-3) Case where the comparison target is the quality information included in the management target data: the quality information received from the main-series data collecting server after the interchange and the quality information stored in the third storage unit 19 are compared with each other, thus comparing the comparison targets.

The second determination unit 16 determines whether there is an abnormality or not based on a comparison result of the second comparison unit 15. This determination will be described in detail below.

In the cases of (2-1) and (2-2) described above, the second determination unit 16 determines whether there is an abnormality or not based on whether the difference ratio between the comparison targets falls outside a preset allowable range (second allowable range) or not, the difference ratio being calculated by the second comparison unit 15. In other words, in the case where the difference ratio falls outside the allowable range, the second determination unit 16 determines that there is an abnormality, and in the case where the difference ratio falls within the allowable range, the second determination unit 16 determines that there is no abnormality.

In the case of (2-3) described above, the second determination unit 16 determines whether there is an abnormality or not based on whether there is a difference between the comparison targets compared by the second comparison unit 15. In other words, in the case where there is a difference between the comparison targets, the second determination unit 16 determines that there is an abnormality, and in the case where there is no difference between the comparison targets, the second determination unit 16 determines that there is no abnormality.

Next, with reference to Fig. 2, description will be given on an operation when the data recording server 1 executes the abnormality determination processing in the case where the parallel redundant method is adopted as the redundant method. This operation is started when an abnormality determination instruction is input according to an operating instruction by the administrator.

First, the first comparison unit 11 of the data

recording server 1 compares the collecting server data stored in the first storage unit 17 with the collecting server data stored in the second storage unit 18 (Step S101).

5 Subsequently, the first determination unit 13 determines whether there is an abnormality or not based on a comparison result in Step S101 (Step S102). In the case of YES in the determination (Step S102; YES), the first determination unit 13 notifies the administrator of
10 the existence of an abnormality (Step S106) and terminates this operation.

 The notification to the administrator may be performed by, for example, displaying a message on a monitor, outputting a sound message to a loudspeaker, or
15 transmitting a message to a portable terminal or the like owned by the administrator.

 On the other hand, when it is determined in Step S102 described above that there is no abnormality (Step S102; NO), the interchange unit 14 interchanges the
20 master series and the slave series, which are set for the data collecting servers 2A and 2B, respectively (Step S103).

 Subsequently, the second comparison unit 15 compares the management target data, which is received from the
25 master-series data collecting server after the master and slave series are interchanged in Step S103 described above, with the management target data stored in the third storage unit 19 (Step S104).

 Subsequently, the second determination unit 16
30 determines whether there is an abnormality or not based on a comparison result in Step S104 described above (Step

S105). In the case of YES in the determination (Step S105; YES), the second determination unit 16 notifies the administrator of the existence of an abnormality (Step S106) and terminates this operation.

5 On the other hand, when it is determined in Step S105 described above that there is no abnormality (Step S105; NO), this operation is terminated.

 Next, with reference to Fig. 3, description will be given on an operation when the data recording server 1
10 executes the abnormality determination processing in the case where the standby redundant method is adopted as the redundant method. This operation is started when an abnormality determination instruction is input according to an operating instruction by the administrator.

15 Here, the details of the processing of Steps S202 to S207 shown in Fig. 3 are similar to those of the processing of Steps S101 to S106 shown in Fig. 2. It should be noted that the master series and the slave series in Steps S101 to S106 are referred to as an active series and a standby series in Steps S202 to S207,
20 respectively. Hereinafter, description on Steps S202 to S207 of Fig. 3 will be omitted, and description on only Step S201 will be given.

 First, the transmission unit 12 of the data
25 recording server 1 transmits an activation instruction to the standby-series data collecting server, the activation instruction instructing the standby-series data collecting server to start collecting the management target data (Step S201). Consequently, the standby-
30 series data collecting server starts collecting the management target data, and the collected management

target data is transmitted to the data recording server 1 to be recorded in any of the first storage unit 17 and the second storage unit 18.

5 As described above, according to the data recording server 1 of the embodiment, the following operations are enabled: the first comparison unit 11 compares the collecting server data received from the main-series data collecting server and the collecting server data received from the subordinate-series data collecting server; the
10 first determination unit 13 determines whether there is an abnormality or not based on whether a difference between the pieces of collecting server data compared by the first comparison unit 11 falls outside a predetermined allowable range or not; the interchange
15 unit 14 interchanges the main series and the subordinate series in the case where the first determination unit 13 determines that there is no abnormality; the second comparison unit 15 compares the management target data received from the main-series data collecting server
20 after the interchange and the management target data received from the main-series data collecting server before the interchange; and the second determination unit 16 determines whether there is an abnormality or not based on whether a difference between the pieces of
25 management target data compared by the second comparison unit 15 falls outside a predetermined allowable range or not.

In other words, in the abnormality determination processing executed when an administrator inputs an
30 abnormality determination instruction, as a determination in the first stage, the pieces of collecting server data

received from the main series and the subordinate series
are compared with each other to determine whether there
is an abnormality or not. In the case where there is no
abnormality in this determination, as a determination in
5 the second stage, the main series and the subordinate
series are interchanged, and the management target data
received from the main series after the interchange and
the management target data received from the main series
before the interchange are compared with each other to
10 determine whether there is an abnormality or not.

Therefore, according to the data recording server 1
of the embodiment, it is possible to confirm whether the
main series and the subordinate series normally operate
and to improve the safety of the redundant system.

15

What is claimed is:

1. An abnormality determination apparatus, comprising:

a first storage unit configured to store collecting
node data including management target data received from
a redundant first collection node, the first collection
node being configured to collect the management target
data from a management target device;

a second storage unit configured to store collecting
node data including management target data received from
a redundant second collection node, the second collection
node being configured to collect the management target
data from the management target device;

a third storage unit configured to accumulate and
store the management target data collected by one of the
first collection node and the second collection node;

a first comparison unit configured to compare the
collecting node data stored in the first storage unit
with the collecting node data stored in the second
storage unit;

a first determination unit configured to determine
whether there is an abnormality or not based on whether a
difference between the pieces of collecting node data
compared by the first comparison unit falls outside a
preset first allowable range or not;

an interchange unit configured to interchange a main
series and a subordinate series of a redundant system in
a case where the first determination unit determines that
there is no abnormality, the main series and the
subordinate series being respectively set for the first
collection node and the second collection node;

a second comparison unit configured to compare the

management target data received from a main-series
collection node out of the first collection node and the
second collection node after the interchange by the
interchange unit, with the management target data stored
5 in the third storage unit; and
a second determination unit configured to determine
whether there is an abnormality or not based on whether a
difference between the pieces of management target data
compared by the second comparison unit falls outside a
10 preset second allowable range or not.

2. The abnormality determination apparatus according to
claim 1, further comprising
a transmission unit configured to transmit an
activation instruction that instructs the other
15 subordinate-series collection node to start collecting
the management target data, in a case where the redundant
system adopts a standby redundant method, wherein
the first comparison unit is configured to perform
comparison using the pieces of collecting node data
20 received from the first collection node and the second
collection node, after the subordinate-series collection
node is activated according to the activation instruction.

3. The abnormality determination apparatus according to
claim 1 or 2, wherein
25 the management target data includes a measurement
date and time that is measured by the management target
device,
the first comparison unit is configured to calculate
a difference ratio of the measurement date and time
30 stored in the first storage unit to the measurement date
and time stored in the second storage unit, and

the first determination unit is configured to determine whether there is an abnormality or not based on whether the difference ratio calculated by the first comparison unit falls outside the preset first allowable range or not.

5 4. The abnormality determination apparatus according to claim 3, wherein

the second comparison unit is configured to calculate a difference ratio of an interval of the measurement dates and times that are temporally successive and received from the main-series collection node, to an interval of the measurement dates and times that are temporally successive and stored in the third storage unit, and

15 the second determination unit is configured to determine whether there is an abnormality or not based on whether the difference ratio calculated by the second comparison unit falls outside the preset second allowable range or not.

20 5. The abnormality determination apparatus according to claim 1 or 2, wherein

the management target data includes a measured value that is measured by the management target device,

the first comparison unit is configured to calculate a difference ratio of the measured value stored in the first storage unit to the measured value stored in the second storage unit, and

the first determination unit is configured to determine whether there is an abnormality or not based on whether the difference ratio calculated by the first comparison unit falls outside the preset first allowable

range or not.

6. The abnormality determination apparatus according to claim 5, wherein

5 the second comparison unit is configured to calculate a difference ratio of the measured value received from the main-series collection node to the measured value stored in the third storage unit, and

10 the second determination unit is configured to determine whether there is an abnormality or not based on whether the difference ratio calculated by the second comparison unit falls outside the preset second allowable range or not.

7. The abnormality determination apparatus according to claim 1 or 2, wherein

15 the management target data includes quality information on the quality of the management target data,

20 the first comparison unit is configured to compare the quality information stored in the first storage unit with the quality information stored in the second storage unit, and

the first determination unit is configured to determine whether there is an abnormality or not based on whether there is a difference between the pieces of quality information compared by the first comparison unit.

25 8. The abnormality determination apparatus according to claim 7, wherein

30 the second comparison unit is configured to compare the quality information received from the main-series collection node with the quality information stored in the third storage unit, and

the second determination unit is configured to

determine whether there is an abnormality or not based on whether there is a difference between the pieces of quality information compared by the second comparison unit.

5 9. The abnormality determination apparatus according to claim 1 or 2, wherein

 the collecting node data includes definition information on collection of the management target data,

 the first comparison unit is configured to compare
10 the definition information stored in the first storage unit with the definition information stored in the second storage unit, and

 the first determination unit is configured to
determine whether there is an abnormality or not based on
15 whether there is a difference between the pieces of definition information compared by the first comparison unit.