US010299739B2

(12) **United States Patent**
Watanabe

(10) **Patent No.: US 10,299,739 B2**
(45) **Date of Patent: May 28, 2019**

(54) **MEDICAL MONITORING APPARATUS**

(71) Applicant: **OLYMPUS CORPORATION**, Tokyo (JP)

(72) Inventor: **Nobuyuki Watanabe**, Yokohama (JP)

(73) Assignee: **Olympus Corporation**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **15/833,449**

(22) Filed: **Dec. 6, 2017**

(65) **Prior Publication Data**

US 2018/0153482 A1 Jun. 7, 2018

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2016/086007, filed on Dec. 5, 2016.

(51) **Int. Cl.**
G08B 21/02 (2006.01)
A61B 5/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***A61B 5/746*** (2013.01); ***A61B 5/02055*** (2013.01); ***A61B 5/0402*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC A61B 5/087; A61B 5/412; A61B 5/4818; A61B 5/726; A61B 5/0205;
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

2007/0060872 A1* 3/2007 Hall A61B 5/14546 604/66
2008/0071177 A1* 3/2008 Yanagidaira A61B 5/024 600/483

(Continued)

FOREIGN PATENT DOCUMENTS

JP 2008-237686 A 10/2008
JP 2015-042293 A 3/2015
WO WO 2005/055824 A1 6/2005

OTHER PUBLICATIONS

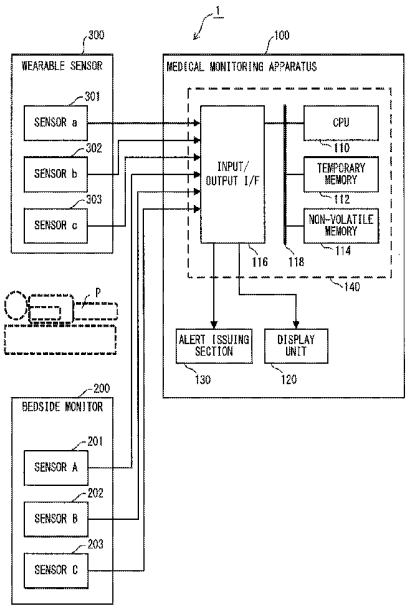
PCT/ISA/210 issued in PCT/JP2016/086007, dated Feb. 21, 2017.
Written opinion of the ISA of PCT/JP2016/086007, dated Feb. 21, 2017 (with partial English translation).

Primary Examiner — Daniel Previl
(74) *Attorney, Agent, or Firm* — Greer Burns & Crain, Ltd.

(57) **ABSTRACT**

A medical monitoring apparatus that monitors a status of a patient according to biological information of the patient includes a reliability evaluator **510** configured to obtain first biological information measured by a bedside monitor **200** and second biological information measured by a wearable sensor **300**, and to evaluate a reliability of the second biological information according to a correlation between the first biological information and the second biological information, the first biological information and the second biological information belonging to an identical measurement item, and an alert determinator **600** configured to determine, using the first biological information and the second biological information, whether to issue an alert about an abnormality under a condition that depends on the reliability.

11 Claims, 9 Drawing Sheets



(51) **Int. Cl.**

G16H 40/67	(2018.01)
G16H 40/63	(2018.01)
A61B 5/0402	(2006.01)
A61B 5/0476	(2006.01)
A61B 5/0205	(2006.01)
G16H 40/20	(2018.01)
A61B 5/024	(2006.01)
A61B 5/021	(2006.01)

(52) **U.S. Cl.**

CPC ***A61B 5/0476*** (2013.01); ***A61B 5/7221*** (2013.01); ***A61B 5/742*** (2013.01); ***A61B 5/7405*** (2013.01); ***G16H 40/20*** (2018.01); ***G16H 40/63*** (2018.01); ***G16H 40/67*** (2018.01); *A61B 5/021* (2013.01); *A61B 5/02438* (2013.01); *A61B 5/7246* (2013.01); *A61B 5/7282* (2013.01)

(58) **Field of Classification Search**

CPC ... A61B 5/14551; A61B 5/0836; A61B 5/145; A61B 7/003; A61B 5/00; A61B 5/0024; A61B 5/01; A61B 5/0476; A61B 5/7282; A61B 5/742

USPC 340/573.1, 870.07, 566, 568.1, 568.2, 340/572.1, 582, 601, 614, 683, 691.6, 340/692, 3.1, 5.32, 5.82, 7.58, 7.61, 7.62, 340/825.52

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2013/0066395	A1*	3/2013	Simon	A61N 2/006 607/48
2013/0116578	A1*	5/2013	An	A61B 5/0205 600/484
2015/0057554	A1*	2/2015	Watson	A61B 5/02125 600/485
2015/0205931	A1*	7/2015	Wang	G16H 40/63 702/19
2016/0199007	A1*	7/2016	Kudo	A61B 5/7221 340/870.07
2018/0055386	A1*	3/2018	Zielinski	A61B 5/0002

* cited by examiner

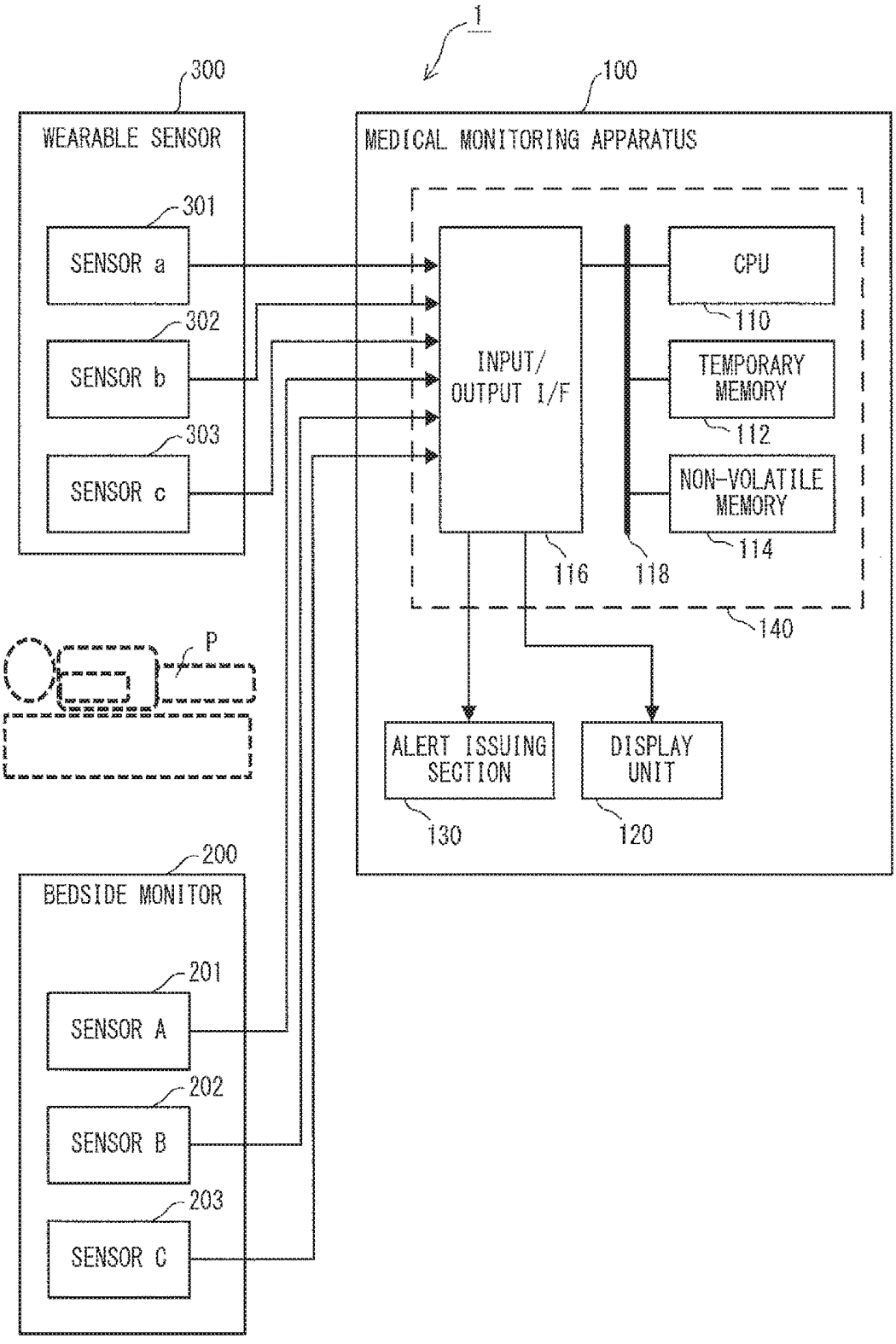

1
300
WEARABLE SENSOR
301
SENSOR a
302
SENSOR b
303
SENSOR c
100
MEDICAL MONITORING APPARATUS
INPUT/
OUTPUT I/F
CPU
110
TEMPORARY
MEMORY
112
NON-VOLATILE
MEMORY
114
116
118
140
P
ALERT ISSUING
SECTION
130
DISPLAY
UNIT
120
200
BEDSIDE MONITOR
201
SENSOR A
202
SENSOR B
203
SENSOR C

FIG. 1

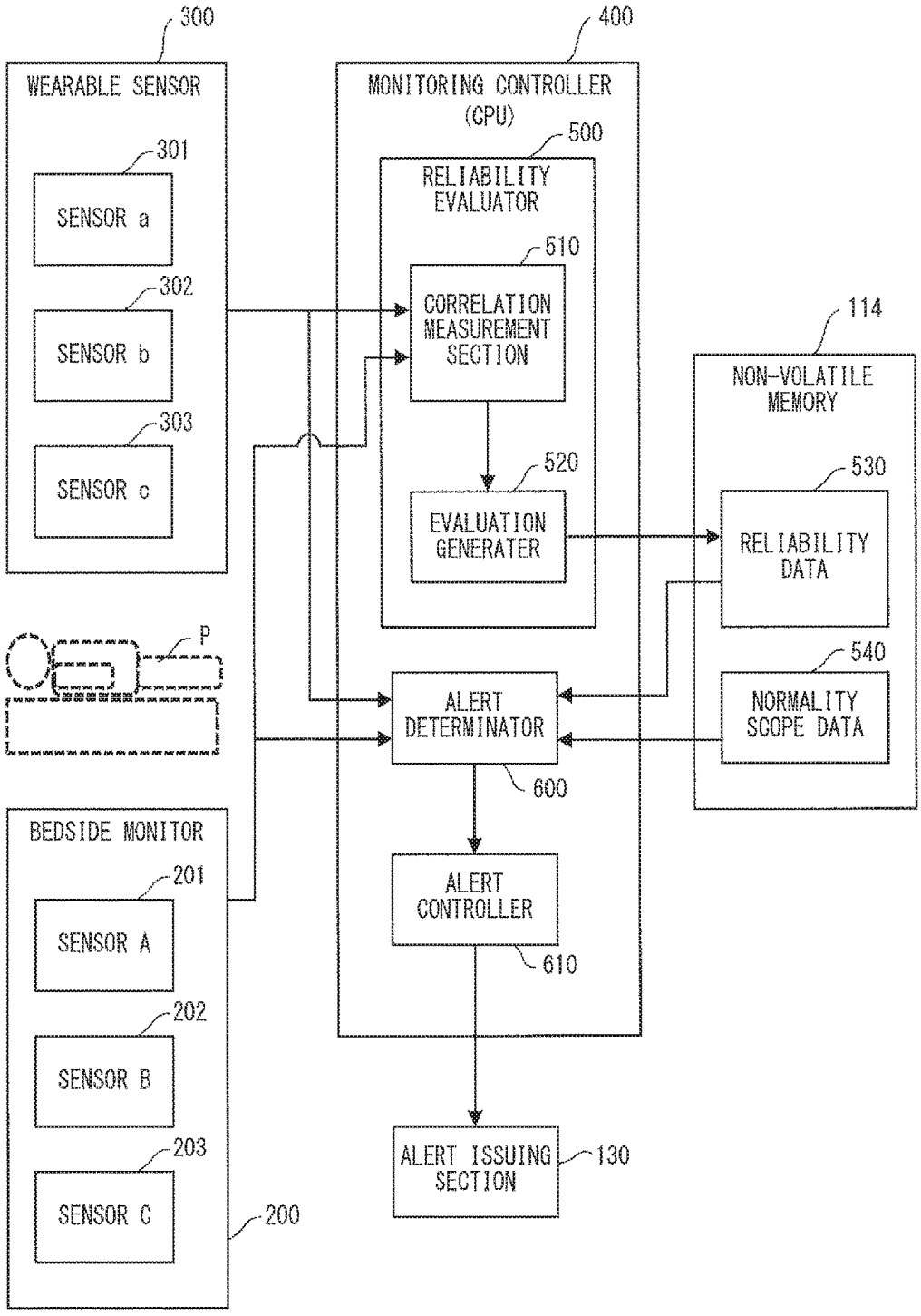

300
WEARABLE SENSOR
301
SENSOR a
302
SENSOR b
303
SENSOR c
P
BEDSIDE MONITOR
201
SENSOR A
202
SENSOR B
203
SENSOR C
200
400
MONITORING CONTROLLER
(CPU)
500
RELIABILITY
EVALUATOR
510
CORRELATION
MEASUREMENT
SECTION
520
EVALUATION
GENERATER
ALERT
DETERMINATOR
600
ALERT
CONTROLLER
610
ALERT ISSUING
SECTION
130
114
NON-VOLATILE
MEMORY
530
RELIABILITY
DATA
540
NORMALITY
SCOPE DATA

FIG. 2

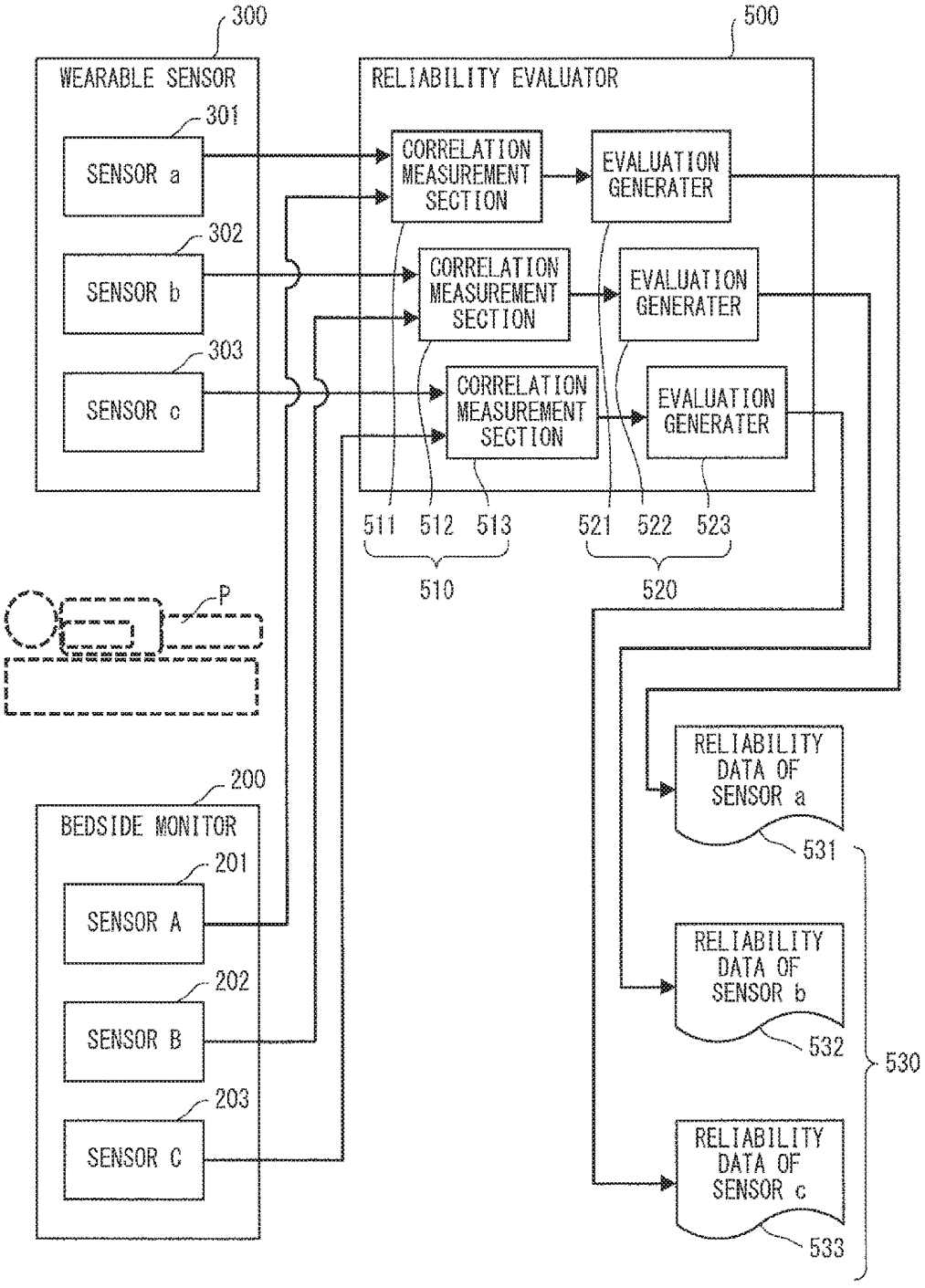

300
WEARABLE SENSOR
301
SENSOR a
302
SENSOR b
303
SENSOR c
500
RELIABILITY EVALUATOR
CORRELATION MEASUREMENT SECTION
CORRELATION MEASUREMENT SECTION
CORRELATION MEASUREMENT SECTION
EVALUATION GENERATER
EVALUATION GENERATER
EVALUATION GENERATER
511 512 513
510
521 522 523
520
P
200
BEDSIDE MONITOR
201
SENSOR A
202
SENSOR B
203
SENSOR C
RELIABILITY DATA OF SENSOR a
531
RELIABILITY DATA OF SENSOR b
532
RELIABILITY DATA OF SENSOR c
533
530

FIG. 3

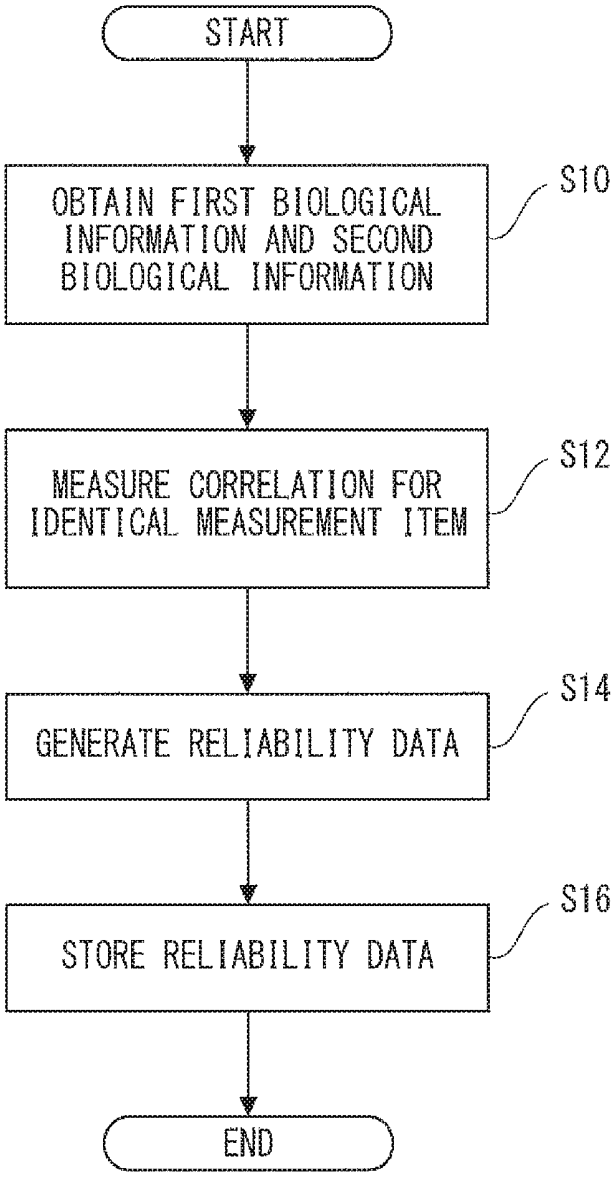

START
OBTAIN FIRST BIOLOGICAL INFORMATION AND SECOND BIOLOGICAL INFORMATION
S10
MEASURE CORRELATION FOR IDENTICAL MEASUREMENT ITEM
S12
GENERATE RELIABILITY DATA
S14
STORE RELIABILITY DATA
S16
END

FIG. 4

CORRELATION	LEVEL OF RELIABILITY
70% OR LOWER	1
70~80%	2
80% OR HIGHER	3

FIG. 5A

CORRELATION	LEVEL OF RELIABILITY
50% OR LOWER	1
50~90%	2
90% OR HIGHER	3

FIG. 5B

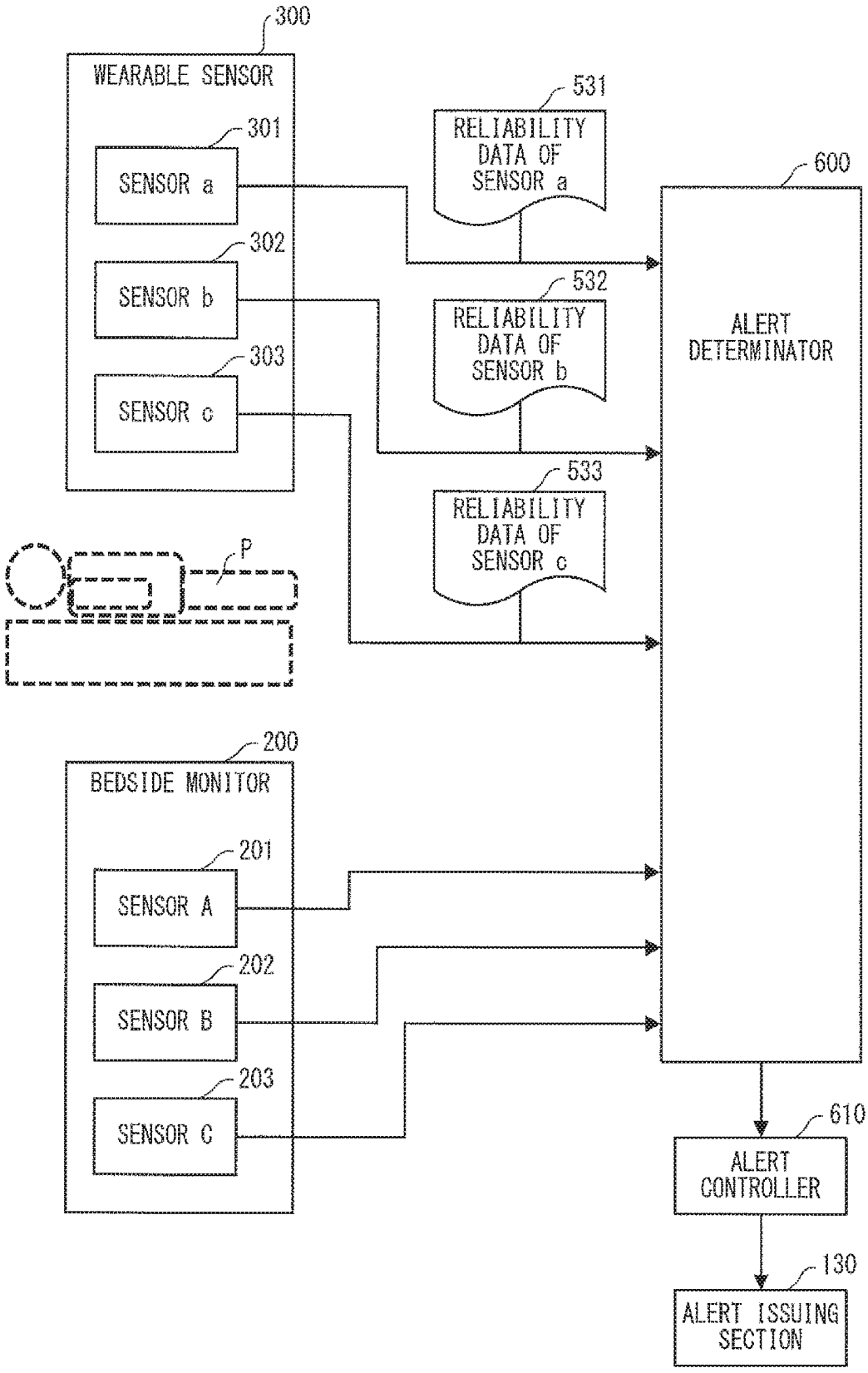

300
WEARABLE SENSOR
301
SENSOR a
302
SENSOR b
303
SENSOR c
P
531
RELIABILITY DATA OF SENSOR a
532
RELIABILITY DATA OF SENSOR b
533
RELIABILITY DATA OF SENSOR c
600
ALERT DETERMINATOR
200
BEDSIDE MONITOR
201
SENSOR A
202
SENSOR B
203
SENSOR C
610
ALERT CONTROLLER
130
ALERT ISSUING SECTION

FIG. 6

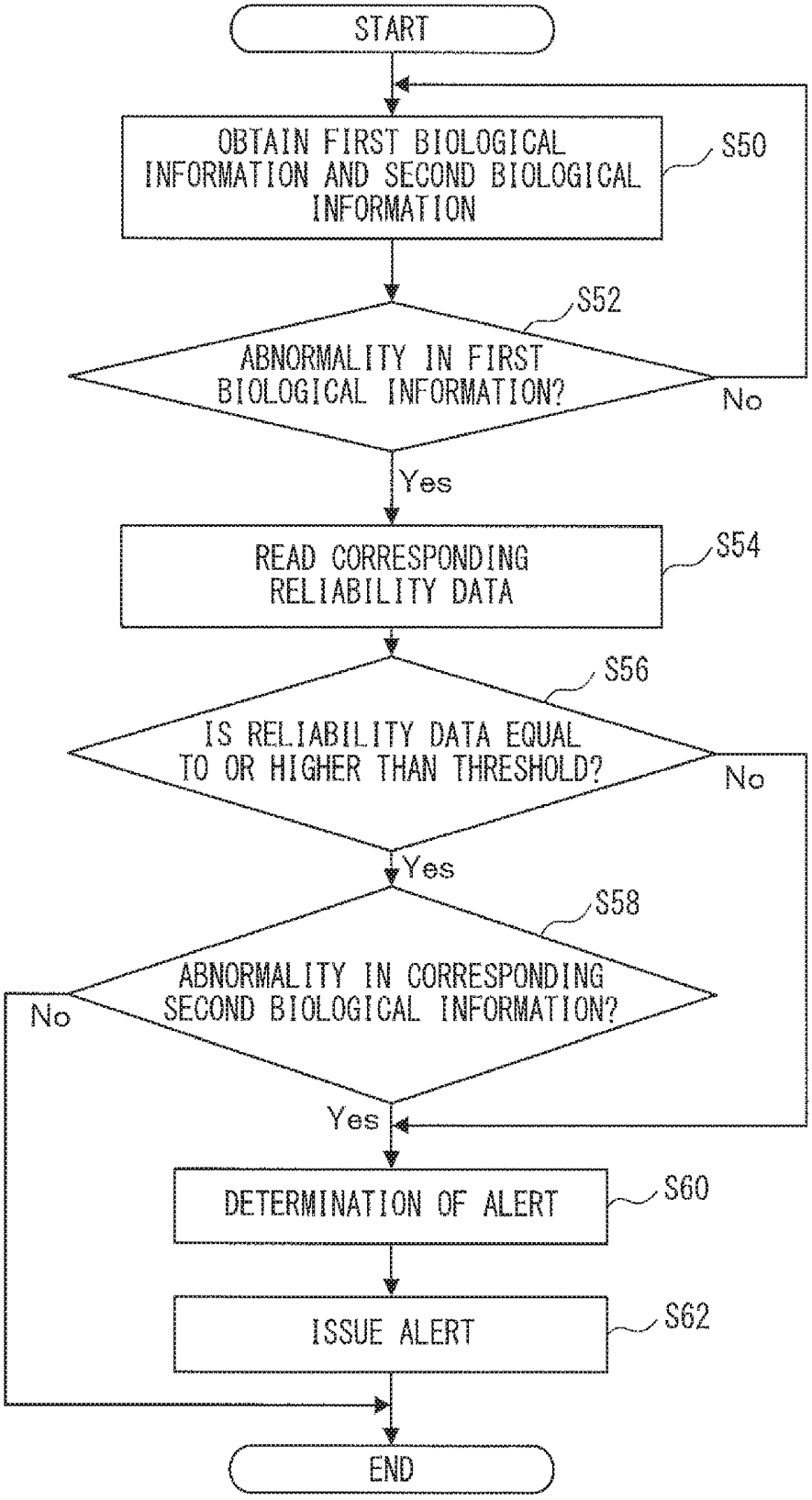

START
OBTAIN FIRST BIOLOGICAL INFORMATION AND SECOND BIOLOGICAL INFORMATION
S50
S52
ABNORMALITY IN FIRST BIOLOGICAL INFORMATION?
No
Yes
READ CORRESPONDING RELIABILITY DATA
S54
S56
IS RELIABILITY DATA EQUAL TO OR HIGHER THAN THRESHOLD?
No
Yes
S58
ABNORMALITY IN CORRESPONDING SECOND BIOLOGICAL INFORMATION?
No
Yes
DETERMINATION OF ALERT
S60
ISSUE ALERT
S62
END

FIG. 7

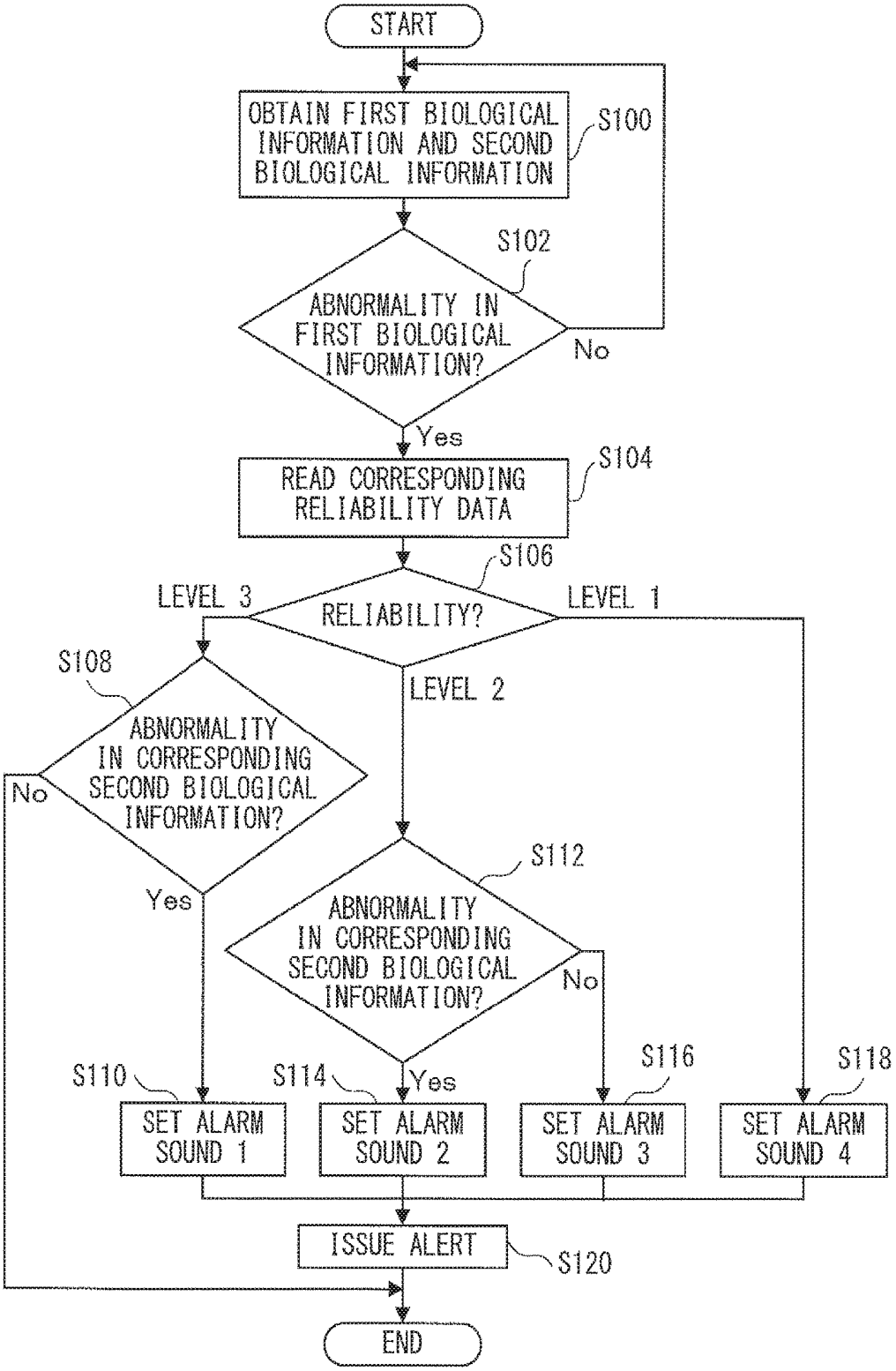

START
OBTAIN FIRST BIOLOGICAL INFORMATION AND SECOND BIOLOGICAL INFORMATION
S100
S102
ABNORMALITY IN FIRST BIOLOGICAL INFORMATION?
No
Yes
READ CORRESPONDING RELIABILITY DATA
S104
S106
RELIABILITY?
LEVEL 3
LEVEL 1
LEVEL 2
S108
ABNORMALITY IN CORRESPONDING SECOND BIOLOGICAL INFORMATION?
No
Yes
S112
ABNORMALITY IN CORRESPONDING SECOND BIOLOGICAL INFORMATION?
No
Yes
S110
S114
S116
S118
SET ALARM SOUND 1
SET ALARM SOUND 2
SET ALARM SOUND 3
SET ALARM SOUND 4
ISSUE ALERT
S120
END

FIG. 8

MEDICAL MONITORING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a Continuation application of PCT Application No. PCT/JP2016/86007, filed Dec. 5, 2016, the entire contents of all of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention is related to a medical monitoring apparatus that monitors the status of a patient so as to issue an alert.

Description of the Related Art

In order to monitor the statuses of patients who are under treatment, medical institutions such as hospitals widely employ biological information monitoring apparatuses that comprehensively monitor the biological information of the patients. Such biological information monitoring apparatuses are generally referred to as bedside monitors.

As is suggested by the name, bedside monitors are installed at the bedside of patients in wards, CCUs, ICUs, etc. Doctors, nurses, and other medical staffs obtain biological information such as the heart rate, blood pressure, body temperature, respiratory rate, etc. of a patient through the bedside monitor, and understand the status of that patient. A system is also proposed in which a bedside monitor is connected to a nurse call function so that when an abnormality occurs in the biological information of a patient, an alert is issued in the form of a nurse call (Patent Document 1). [Patent document 1] WO2005/055824

SUMMARY OF THE INVENTION

A medical monitoring apparatus that monitors a status of a patient according to biological information of the patient includes a reliability evaluator configured to obtain first biological information measured by a first measurement apparatus and second biological information measured by a second measurement apparatus, and to evaluate a reliability of the second biological information according to a correlation between the first biological information and the second biological information, the first biological information and the second biological information belonging to an identical measurement item, and an alert determinator configured to determine, using the first biological information and the second biological information, whether to issue an alert about an abnormality under a condition that depends on the reliability.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram illustrating a basic configuration example of a medical monitoring system according to the present embodiment;

FIG. **2** is a functional block diagram of an alert determination process performed by the medical monitoring system;

FIG. **3** is a block diagram of a process of generating reliability data;

FIG. **4** is a flowchart explaining the sequence of a process of generating reliability data;

FIG. **5**A illustrates an example of a reliability table;

FIG. **5**B illustrates an example of a reliability table;

FIG. **6** is a block diagram explaining the first embodiment of an alert determination process;

FIG. **7** is a flowchart explaining the sequence of the first embodiment of an alert determination process; and

FIG. **8** is a flowchart explaining the sequence of an alert determination process according to the second embodiment.

DESCRIPTION OF THE EMBODIMENTS

Hereinafter, explanations will be given for the embodiments of the present invention by referring to the drawings. FIG. **1** is a block diagram illustrating a basic configuration example of a medical monitoring system **1** according to the present embodiment. The medical monitoring system **1** includes a medical monitoring apparatus **100**, a bedside monitor **200** and a wearable sensor **300**.

The medical monitoring apparatus **100** obtains biological information from sensors (the bedside monitor **200** and the wearable sensor **300**) for detecting the status (state) of a patient, and issues an alert to doctors or nurses (medical staff members) when an abnormality occurs in the patient.

The bedside monitor **200** is a main measurement apparatus that measures the biological information of a patient. The bedside monitor **200** will also be referred to as a first measurement apparatus. Biological information detected by the bedside monitor **200** is body temperature, heart rate, blood pressure, irregular pulse, Co2 concentration in blood, EEG (Electroencephalogram) and ECG (Electrocardiogram).

The bedside monitor **200** is provided with a sensor corresponding to each item of biological information (such as body temperature, heart rate, etc.). The sensors of the bedside monitor **200** in principle detect biological information with the patient laid on a bed. The present embodiment describes three sensors: sensor A **201**, sensor B **202** and sensor C **203**. For example, sensor A **201** is a sensor for detecting body temperatures, sensor B **202** is a sensor for detecting blood pressure, and sensor C **203** is a sensor for detecting heart rates. Also, the bedside monitor **200** may be provided with a monitor device (not illustrated) that displays biological information detected through the respective sensors.

In order to detect the status of a patient accurately, the bedside monitor **200** is generally provided with highly accurate sensors or highly sensitive sensors. However, highly accurate sensors or highly sensitive sensors cause problems as well. For example, the high sensitivity of a sensor for measuring heart rates may lead to a case where a change accompanying ambient vibrations or movements of a patient is falsely detected as a change in the heart rate. Similarly, highly sensitive electrocardiogram sensors tend to pick up signals accompanying ambient radio waves, ambient electric noise and movements of patients.

Because various factors may also cause false detection in the bedside monitor **200** as described above, determinations of abnormalities of patients based on information from the bedside monitor **200** alone would lead to the inclusion of false alerts.

Thus, in order to verify an abnormality of a patient detected by the bedside monitor **200**, the present embodiment utilizes a sensor that is for the same measurement target as that of a sensor in the bedside monitor **200** and that has a measurement principle, measurement accuracy or an attaching position that is different from the sensor in the bedside monitor **200**. This sensor having a different mea-

surement principle, measurement accuracy or attaching position will also be referred to as a second measurement apparatus.

The present embodiment uses a wearable sensor as a second measurement apparatus. The wearable sensor **300** is a general term for sensors that are attached directly to the body of a patient so as to detect various types of biological information of the patient. The wearable sensor **300** is a second measurement apparatus for preventing false issuance of alerts that is based on biological information detected by the respective sensors in the bedside monitor **200**.

The wearable sensor **300** can also be considered to be a sensor of a size that is small enough to allow the patient to move while wearing it. The wearable sensor **300** is for example a wristwatch-type sensor to be attached to wrists.

As described above, sensors that detect biological information belonging to measurement items identical to those of the respective sensors of the bedside monitor **200** are provided as the wearable sensor **300**. Sensor a **301**, sensor b **302** and sensor c **303** in the wearable sensor **300** have measurement items that are identical to those of sensor A **201**, sensor B **202** and sensor C **203** of the bedside monitor **200**.

For example, sensor A **201** is a thermistor-type thermometer, and sensor a **301** is an infrared thermometer. Also, sensor C **203** is a sensor that measures heart rate by being attached to the chest, and sensor c **303** is a sensor that measures heart rate by being worn on the wrist. Note that biological information measured by the bedside monitor **200** will be referred to as first biological information and biological information measured by the wearable sensor **300** will be referred to as second biological information hereinafter.

The medical monitoring apparatus **100** includes a CPU (Central Processing Unit) **110**, a temporary memory **112**, a non-volatile memory **114**, an input/output I/F (interface) **116**, a bus **118**, a display unit **120** and an alert issuing section **130**.

The CPU **110** reads a control program from the non-volatile memory **114**, and comprehensively controls the medical monitoring apparatus **110** through a software process in accordance with the read control program. The temporary memory **112**, the non-volatile memory **114** and the input/output I/F **116** are connected to the CPU **110** via the bus **118**.

The temporary memory **112** temporarily stores a control program and various types of data. The temporary memory **112** is for example a DRAM (Dynamic Random Access Memory). The non-volatile memory **114** stores a control program, various types of tables, and reliability data, which will be described later, etc. The non-volatile memory **114** is for example an HDD (Hard Disk Drive) or a flash memory.

The input/output I/F **116** controls sensor A **201** etc. of the bedside monitor **200**, sensor a **301** etc. of the wearable sensor **300**, and input/output with external devices. Biological information output from the bedside monitor **200** or the wearable sensor **300** is input to the medical monitoring apparatus **100** via the input/output I/F **116**.

Also, the input/output I/F **116** is connected to the display unit **120** and the alert issuing section **130**. The display unit **120** displays biological information obtained by the sensors or information etc. of correlations and reliabilities, which will be described later. Note that the CPU **110**, the temporary memory **112**, the non-volatile memory **114**, the input/output I/F **116** and the bus **118** may be units of an information processing apparatus **140** such as a personal computer.

The alert issuing section **130** is a speaker that reports an abnormality of a patient to a medical staff member such as a doctor, a nurse or other medical staff members. The alert issuing section **130** may include a display device that displays an alert window. A speaker or a display device serving as the alert issuing section **130** may be of for example a stationary type that is to be set in a nurse station or may be of for example a portable type that is carried by a doctor or a nurse.

FIG. **2** is a functional block diagram of a monitoring process performed by the medical monitoring system **1**. A monitoring controller **400** performs a monitoring process, and is implemented by a software process performed by the CPU that has read a control program. The monitoring controller **400** includes a reliability evaluator **500**, an alert determinator **600** and an alert controller **610**.

The reliability evaluator **500** evaluates the reliability of biological information of the wearable sensor **300**, and generates reliability data **530**. The reliability data **530** is data used for making a determination about an alert performed by the alert determinator **600** when an abnormality is detected in the biological information during the monitoring of the status of a patient.

The reliability evaluator **500** obtains first biological information and second biological information, and evaluates the reliability of the biological information of the wearable sensor **300** on the basis of a correlation between the two pieces of biological information.

The reliability evaluator **500** includes a correlation measurement section **510** and an evaluation generator **520**. The correlation measurement section **510** measures a correlation between first biological information and second biological information that belong to an identical measurement item. In other words, the correlation measurement section **510** measures correlations respectively for data between sensor A and sensor a, data between sensor B and sensor b, and data between sensor C and sensor c.

Also, the evaluation generator **520** generates the reliability data **530** of the second biological information from the correlation between the first biological information and the second biological information measured by the correlation measurement section **510**. The reliability data **530** generates reliability data respectively for sensors (sensor a, sensor b and sensor c).

The evaluation generator **520** stores the generated reliability data in the non-volatile memory **114**. Note that the reliability evaluator **500** evaluates a reliability and stores the reliability data prior to the monitoring of a patient. Also, the reliability evaluator **500** measures a correlation so as to generate latest reliability data on an as-needed basis or at prescribed timings (once per day for example) during the monitoring. It is suitable that reliability data be updated to latest versions on an as-needed basis.

The alert determinator **600** uses first biological information and second biological information to determine whether to issue an alert about an abnormality under a condition that depends upon reliability data. First, the alert determinator **600** determines whether an abnormality occurred in the first biological information of any of sensor A **201** and other sensors. The alert determinator **600** makes a determination about the occurrence of an abnormality by comparing normality scope data **540** of sensor A **201** and other sensors of the bedside monitor **200** and the first biological information, the normality scope data **540** being stored in the non-volatile memory **114** in advance. When it is determined that an abnormality has occurred in any of the pieces of the first biological information, the alert determinator **600** deter-

mines whether to issue an alert about the abnormality on the basis of the second biological information belonging to the identical measurement item and the reliability data **530** of that second biological information. Hereafter, the second biological information belonging to an identical item will also be referred to as "corresponding second biological information".

Then, the alert determinator **600** makes a determination of an alert in accordance with the level of the reliability data **530** of the corresponding second biological information. Also, the alert determinator **600** may set different alarm sounds depending upon the reliability data **530** of the second biological information for which an alert determination was made. This will be described in more detail later.

When the alert determinator **600** determines that an alert is to be issued, the alert controller **610** controls the alert issuing section **130** so as to make it generate an alarm sound.

Next, explanations will be given for a process that is performed by the aforementioned evaluation generator **520** for generating reliability data. FIG. **3** is a block diagram of a process of generating reliability data. FIG. **4** is a flowchart explaining the sequence of a process of generating reliability data.

As illustrated in FIG. **3**, the reliability evaluator **500** includes correlation measurement sections **511**, **512** and **513** as the correlation measurement section **510**. The correlation measurement section **511** measures a correlation of data between sensor A and sensor a. The correlation measurement section **512** measures a correlation of data between sensor B and sensor b. The correlation measurement section **513** measures a correlation of data between sensor C and sensor c.

Also, the reliability evaluator **500** includes evaluation generators **521**, **522** and **523** as the evaluation generator **520**. The evaluation generator **521** generates reliability data **531** of sensor a on the basis of the correlation measured by the correlation measurement section **511**. Similarly, the evaluation generator **522** generates reliability data **532** of sensor b on the basis of the correlation measured by the correlation measurement section **512**. Similarly, the evaluation generator **523** generates reliability data **533** of sensor c on the basis of the correlation measured by the correlation measurement section **513**.

By referring to FIG. **4**, explanations will be given for the sequence of a process of generating reliability data. Note as described above that the process of generating reliability data is a process performed prior to the actual monitoring of the status of a patient. The reliability evaluator **500** obtains first biological information and second biological information (step S**10**). The correlation measurement section **510** measures correlations between the first biological information and the second biological information for identical measurement items (step S**12**).

The evaluation generator **520** generates the reliability data **530** of the second biological information from the respective measured correlations (step S**14**).

Examples of the generated reliability data will be described. FIG. **5**A and FIG. **5**B illustrate generation tables of the reliability data **530**. It is assumed that the generation tables are provided in association with the respective sensors. For example, FIG. **5**A illustrates the generation table of the reliability data **531** of sensor a and FIG. **5**B illustrates the generation table of the reliability data **532** of sensor b. The levels of the reliabilities correspond to reliability data. While the levels of reliabilities are described in three steps in this example, the levels may be described in four or more steps. Also, different numbers of steps may be provided depending upon the sensors.

When the correlation of sensor a is measured to be 75%, level 2 is generated as the reliability of sensor a on the basis of the generation table illustrated in FIG. **5**A. When the correlation of sensor b is measured to be 95%, level 3 is generated as the reliability of sensor b on the basis of the generation table illustrated in FIG. **5**B.

The evaluation generator **520** stores the generated reliability data **530** in the non-volatile memory **114** (step S**16**). The levels of the reliabilities generated on the basis of the generation tables are stored as the reliability data **530**.

Next, explanations will be given for an alert determination process in a case when an abnormality occurred in biological information during the monitoring of a patient. An alert determination process is performed by the alert determinator **600**. Two embodiments (first and second embodiments) will be explained for an alert determination process.

First Embodiment

FIG. **6** is a block diagram explaining the first embodiment of an alert determination process. FIG. **7** is a flowchart explaining the sequence of the first embodiment of an alert determination process.

As illustrated in FIG. **6**, the alert determinator **600** obtains first biological information from sensor A, sensor B and sensor C, and obtains second biological information from sensor a, sensor b and sensor c. The alert determinator **600** uses the first biological information and second biological information to determine whether to issue an alert about an abnormality under a condition corresponding to the reliability data. When the alert determinator **600** determines that an alert is to be issued, the alert controller **610** controls the alert issuing section **130** and makes it generate for example an alarm sound.

In FIG. **7**, the alert determinator **600** obtains the first biological information and second biological information (step S**50**). The alert determinator **600** determines whether an abnormality occurred in any of the pieces of first biological information (step S**52**). The alert determinator **600** compares each value of the first biological information and the corresponding normality scope data **540**, and determines that an abnormality occurred when any of the pieces of the first biological information is out of the corresponding normality scope data **540**.

When it is determined that an abnormality occurred in none of the pieces of the first biological information (NO in step S**52**), the alert determinator **600** returns to step S**50**.

When it is determined that an abnormality occurred in any of the pieces of the first biological information (YES in step S**52**), the alert determinator **600** reads the reliability data **530** of the wearable sensor **300** corresponding to the first biological information in which the abnormality occurred (step S**54**). For example, when an abnormality occurred in the data of sensor A **201**, the reliability data **531** of sensor a **301** is read.

The alert determinator **600** determines whether the reliability data **530** is equal to or greater than a threshold (step S**56**). In the example of the reliabilities (levels 1 through 3) as explained in FIG. **5**A and FIG. **5**B, if the reliability of a corresponding sensor is level 3 in a case when the threshold is 2, the determination result is YES. Note that the threshold is stored in the non-volatile memory **114**.

When it is determined that the reliability data **530** is not equal to or greater than the threshold (NO in step S**56**), the alert determinator **600** makes a determination of an alert (step S**60**). The alert controller **610** causes an alarm sound to be generated (step S**62**). Specifically, the alert determinator **600** determines that an alert is to be issued by adopting the result of the bedside monitor **200** without taking the corresponding second biological information into consideration because the reliability of the wearable sensor **300** is low.

The explanation returns to step S**56**. When it is determined that the reliability data **530** is equal to or greater than the threshold (YES in step S**56**), the alert determinator **600** determines whether an abnormality was detected in the corresponding second biological information as well (step S**58**).

When it is determined that an abnormality was not detected in the corresponding second biological information (NO in step S**58**), the alert determinator **600** determines not to issue an alert and terminates the present process. This is because an abnormality is not detected in the highly reliable wearable sensor **300**, leading to an estimation that a sensor of the bedside monitor **200** malfunctioned.

When it is determined that an abnormality was detected in the corresponding second biological information (YES in step S**58**), the alert determinator **600** determines that an alert is to be issued (step S**60**). The alert controller **610** causes an alarm sound to be generated (step S**62**). Because the reliability of the wearable sensor **300** is high, the alert determinator **600** determines that an abnormality occurred by also taking the information from the bedside monitor **200** into consideration.

Note that the alert determinator **600** may set an alarm sound issued when the determination result is YES in step S**58** to be louder than an alarm sound issued when the determination result is NO in step S**56**. This is because an abnormality is more likely to have occurred in a case when the determination result is YES in step S**58** than in a case when the determination result is NO in step S**56**.

Second Embodiment

FIG. **8** is a flowchart explaining the sequence of an alert determination process according to the second embodiment. The block diagram of an alert determination process according to the second embodiment is identical to the block diagram (FIG. **6**) according to the first embodiment, and thus explanations thereof will be omitted.

The alert determinator **600** obtains first biological information and second biological information (step S**100**). The alert determinator **600** determines whether an abnormality occurred in any of the pieces of the first biological information (step S**102**). The alert determinator **600** compares each value of the first biological information and the corresponding normality scope data **540**, and determines that an abnormality occurred when any of the pieces of the first biological information is out of the corresponding normality scope data **540**.

When it is determined that an abnormality occurred in none of the pieces of the first biological information (NO in step S**102**), the alert determinator **600** returns to step S**100**.

When it is determined that an abnormality occurred in any of the pieces of the first biological information (YES in step S**102**), the alert determinator **600** reads the reliability data **530** of the wearable sensor **300** corresponding to the first biological information in which the abnormality occurred (step S**104**).

The alert determinator **600** selects a process, depending upon the read reliability. When it is determined that the corresponding reliability is level 3 in step S**106**, the alert determinator **600** determines whether an abnormality occurred in the corresponding second biological information (step S**108**). Level 3 is a high reliability. For example, when an abnormality occurred in data of sensor A, the process in step S**108** is performed if the reliability data **531** of sensor a is level 3. In step S**108**, whether an abnormality occurred in data of sensor a is determined.

When it is determined that an abnormality did not occur in the corresponding second biological information (NO in step S**108**), the alert determinator **600** terminates the process without issuing an alert. This is because an abnormality is not detected in the highly reliable wearable sensor **300**, leading to an estimation that a sensor of the bedside monitor **200** malfunctioned.

When it is determined that an abnormality occurred in the corresponding second biological information (YES in step S**108**), the alert determinator **600** sets alarm sound 1 (step S**110**). The alert controller **610** causes an alert to be issued in the form of alarm sound 1 (step S**120**). The alert controller **610** sets different sounds as alarm sounds depending upon the likelihood of abnormalities. Alarm sound 1 is the sound that draws attention the most, and the sound becomes more moderate as the number becomes greater. One or two of the volume, the pitch, the tone, the length, and the rhythm of the sound may be combined so as to change alarm sounds 1 through 4. Because an abnormality was detected in the highly reliable wearable sensor **300**, the occurrence of an abnormality is determined by also taking the information from the bedside monitor **200** into consideration.

The explanation returns to step S**106**. When it is determined that the reliability of the corresponding second biological information in step S**106** is level 2, the alert determinator **600** determines whether an abnormality occurred in the corresponding second biological information (step S**112**).

The alert determinator **600** determines that an abnormality occurred in the corresponding second biological information (YES in step S**112**), and sets alarm sound 2 (step S**114**). The alert controller **610** causes an alert to be issued in the form of alarm sound 2 (step S**120**). Because an abnormality was detected in the highly reliable wearable sensor **300**, the occurrence of an abnormality is determined by also taking the information from the bedside monitor **200** into consideration. However, the reliability of the second biological information is slightly lower than in step S**110**, and accordingly alarm sound 2, which has for example a volume slightly lower than alarm sound 1 in step S**110**, is set.

The alert determinator **600** determines that an abnormality did not occur in the corresponding second biological information (NO in step S**112**), and sets alarm sound 3 (step S**116**). The alert controller **610** causes an alert to be issued in the form of alarm sound 3 (step S**120**). Because the reliability of the second biological information is slightly lower than in step S**114**, alarm sound 3 is set, which has for example a volume further lower than in step S**114**.

Explanation returns to step S**106**. When it is determined that the reliability of the corresponding second biological information is level 1 in step S**106**, the alert determinator **600** sets alarm sound 4 (step S**118**). The alert controller **610** causes an alert to be issued in the form of alarm sound 4 (step S**120**). Because the reliability of the corresponding wearable sensor **300** is low, results of the bedside monitor alone are adopted.

<Effects>

According to the present embodiments, second biological information (data of the wearable sensor **300**) is appropriately combined with first biological information (sensor data of the bedside monitor **200**), which is the main biological information, making it possible to prevent the issuance of false alerts (false issuance) while preventing oversights of the occurrence of abnormalities. Prevention of false alerts can reduce burdens on medical staff members.

Also, by combining the second measurement apparatus (the wearable sensor **300**) based on sensors having sensitivities and types different from the sensors of the first measurement apparatus (the bedside monitor **200**), the likelihood of errors occurring at the same time can be reduced and issuance of false alerts can be prevented.

Because second biological information is used for a determination of an alert in a case when the reliability of the second biological information is high, it is possible to prevent false issuance from being caused by second biological information that is of a low reliability. The higher the reliability of second biological information, the louder the alarm sound is set to be. This makes it possible for medical staff members who hear an alarm sound to decide the level of the importance or urgency by an aspect of an alarm sound (for example, the volume of the sound, the pitch of the sound and the frequency of the sound in a pulse form).

Variation Example 1

While differences in levels between alerts are utilized as aspects of alarm sounds in the second embodiment, visual effects such as the display or the blinking of an LED (color, interval of blinking) in tablets carried by doctors or nurses may be presented in accordance with the levels of alerts. The alert controller **610** includes a visual effect displaying section that displays visual effects.

Variation Example 2

The second measurement apparatus is not limited to a wearable sensor. This is because any sensor can be used as long as it can verify the accuracy of a bedside monitor. The second measurement apparatus does not have to be a wearable sensor as long as the second measurement apparatus is a sensor of a type and scheme different from those of sensors of a bedside monitor.

Note that the present invention is not directly limited to the above embodiments, but can be embodied with modifications on the constituents without departing from the spirit of the present invention in embodying phases. Also, various inventions can be formed by an appropriate combination of a plurality of constituents disclosed in the above embodiments. For example, all the constituents disclosed in the embodiments may be combined appropriately. Further, constituents may be combined appropriately across different embodiments. As a matter of course, various modifications and applications are possible without departing from the spirit of the invention.

NUMERALS

1 MEDICAL MONITORING SYSTEM
100 MEDICAL MONITORING APPARATUS
110 CPU
112 TEMPORARY MEMORY
114 NON-VOLATILE MEMORY
116 INPUT/OUTPUT I/F
118 BUS
120 DISPLAY UNIT
130 ALERT ISSUING SECTION
140 INFORMATION PROCESSING APPARATUS
200 BEDSIDE MONITOR
201 SENSOR A
202 SENSOR B
203 SENSOR C
300 WEARABLE SENSOR
301 SENSOR a
302 SENSOR b
303 SENSOR c
400 MONITORING CONTROLLER
500 RELIABILITY EVALUATOR
510 CORRELATION MEASUREMENT SECTION
520 EVALUATION GENERATOR
530 RELIABILITY DATA
600 ALERT DETERMINATOR
610 ALERT CONTROLLER

What is claimed is:

1. A medical monitoring apparatus that monitors a status of a patient according to biological information of the patient, the medical monitoring apparatus comprising:

a reliability evaluator configured to obtain first biological information measured by a first measurement apparatus together with second biological information measured by a second measurement apparatus, and to evaluate a reliability of the second biological information according to a correlation between the first biological information and the second biological information, the first biological information and the second biological information belonging to an identical measurement item and the second measurement apparatus having accuracy or sensitivity lower than accuracy or sensitivity of the first measurement apparatus; and

an alert determinator configured to determine, using the first biological information and the second biological information, whether to issue an alert about an abnormality of the patient under a condition that depends on the reliability;

wherein in a case where the reliability evaluator has determined that the reliability of the second biological information is high, the alert determinator determines that an alert is to be issued when both the first biological information and the second biological information indicate an abnormality, and

in a case where the reliability evaluator has determined that the reliability of the second biological information is low, the alert determinator determines that an alert is to be issued when the first biological information indicates an abnormality.

2. The medical monitoring apparatus according to claim **1**, wherein

the biological information of the patient measured by the first measurement apparatus and the biological information of the patient measured by the second measurement apparatus are at least any one of a body temperature, an electrocardiogram, a heart rate, brain waves, and a blood pressure.

3. The medical monitoring apparatus according to claim **1**, wherein

the first measurement apparatus is a bedside monitor, and

the second measurement apparatus is a wearable sensor attached directly to the patient.

4. The medical monitoring apparatus according to claim 1, wherein

the reliability evaluator repeatedly calculates the correlation at predetermined timings during the monitoring, and evaluates the reliability by comparing the calculated correlation with a predetermined threshold.

5. The medical monitoring apparatus according to claim 1, wherein

the reliability evaluator sets a level for the reliability according to the correlation.

6. The medical monitoring apparatus according to claim 5, comprising:

an alert controller configured to control an alert mode,

wherein the alert controller changes the alert mode in accordance with the set level of the reliability.

7. The medical monitoring apparatus according to claim 6, comprising:

a speaker configured to generate an alarm sound;

wherein the alert controller changes the mode of the alarm sound in accordance with the set level of the reliability.

8. The medical monitoring apparatus according to claim 7, wherein

the alarm controller makes a change in at least one of alarms mode i.e. volume, tone, duration of cyclic alarm, as the level of the reliability changes.

9. The medical monitoring apparatus according to claim 6, comprising:

a visual effect displaying section configured to display an visual effect,

wherein the alert controller changes the mode of the visual effect in accordance with the set level of the reliability.

10. A medical monitoring apparatus that includes a controller that determines whether to issue an alarm about an abnormality of a patient according to biological information of the patient, wherein

the controller obtains first biological information measured by a first measurement apparatus together with second biological information measured by a second measurement apparatus, and evaluates a correlation between the first biological information and second biological information, the first biological information and the second biological information belonging to an identical measurement item and the second measurement apparatus having accuracy or sensitivity lower than accuracy or sensitivity of the first measurement apparatus,

the controller determines a level of a reliability of the second biological information according to the correlation, and stores the determined level of the reliability in a storage, and

the controller determines, using the first biological information and the second biological information, whether to issue an alert about an abnormality of the patient under a condition that depends on the level of the reliability stored in the storage;

wherein in a case where the reliability of the second biological information is determined to be high, the controller determines that an alert is to be issued when both the first biological information and the second biological information indicate an abnormality, and

in a case where the reliability of the second biological information is determined to be low, the controller determines that an alert is to be issued when the first biological information indicates an abnormality.

11. A non-transitory computer-readable medium having stored therein a program for causing a computer to perform a process comprising:

performing an alarm method to determine whether to issue an alert about an abnormality of a patient according to biological information of the patient;

obtaining first biological information measured by a first measurement apparatus together with second biological information measured by a second measurement apparatus, the first biological information and the second biological information belonging to an identical measurement item and the second measurement apparatus having accuracy or sensitivity lower than accuracy or sensitivity of the first measurement apparatus;

evaluating a reliability of the second biological information according to a correlation between the first biological information and the second biological information; and

determining, using the first biological information and the second biological information, whether to issue an alert about an abnormality of the patient under a condition that depends on the reliability;

wherein in a case where the reliability of the second biological information is determined to be high, an alert is issued when both the first biological information and the second biological information indicate an abnormality, and

in a case where the reliability of the second biological information is determined to be low, an alert is issued when the first biological information indicates an abnormality.

* * * * *

专利名称(译)	医疗监测仪器		
公开(公告)号	US10299739	公开(公告)日	2019-05-28
申请号	US15/833449	申请日	2017-12-06
[标]申请(专利权)人(译)	奥林巴斯株式会社		
申请(专利权)人(译)	OLYMPUS CORPORATION		
当前申请(专利权)人(译)	OLYMPUS CORPORATION		
[标]发明人	WATANABE NOBUYUKI		
发明人	WATANABE, NOBUYUKI		
IPC分类号	G08B21/02 A61B5/00 G16H40/67 G16H40/63 A61B5/0402 A61B5/0476 A61B5/0205 G16H40/20 A61B5/024 A61B5/021		
CPC分类号	A61B5/746 A61B5/02055 A61B5/0402 A61B5/0476 A61B5/7221 A61B5/742 G16H40/20 G16H40/63 G16H40/67 A61B5/7405 A61B5/7282 A61B5/021 A61B5/02438 A61B5/7246		
其他公开文献	US20180153482A1		
外部链接	Espacenet		

摘要(译)

根据患者的生物信息监测患者状态的医疗监测设备包括可靠性评估器510，其被配置为获得由床边监测器测量的第一生物信息200和第二生物信息由可穿戴传感器测量300，并根据第一生物信息与第二生物信息，第一生物信息和第二生物信息之间的相关性评估第二生物信息的可靠性属于相同测量项目的信息，以及警报确定器600，其被配置为使用第一生物信息和第二生物信息确定是否在取决于取决于的情况下发出关于异常的警报。可靠性。