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(54) **AUTOMATIC ANALYZER AND MAINTENANCE SUPPORTING SYSTEM**

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(57) **ABSTRACT**

Provided are an automatic analysis device and a maintenance support system which prevent a failure that occurs between regular inspection periods to thereby reduce the downtime of the automatic analysis device. A maintenance support system acquires, from each of a plurality of automatic analysis devices (**100**), pulse information transmitted from the automatic analysis device (**100**) provided with a mechanism which is driven by a pulse motor, and a transmission means which transmits pulse information including tow among a driving pulse value for driving the pulse motor, a consumed pulse amount that is a pulse amount consumed when the pulse motor has actually been driven, and a remaining pulse amount obtained by subtracting the consumed pulse amount from the driving pulse value, and stores at least the consumed pulse amount.

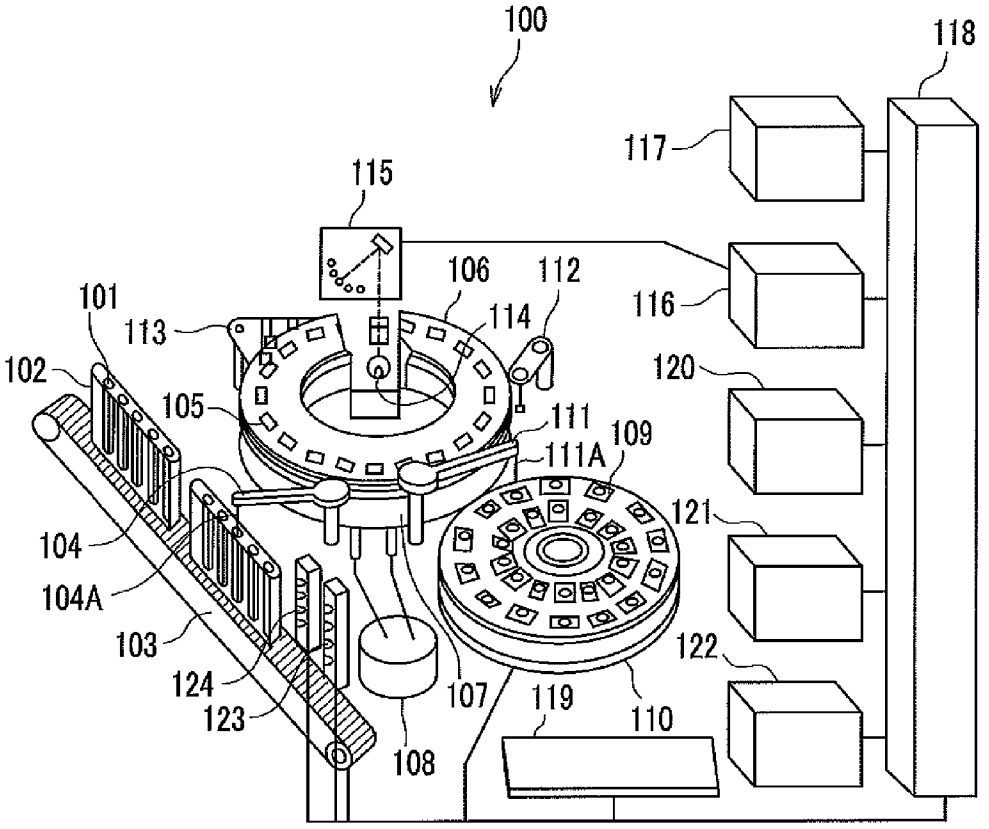


FIG. 1

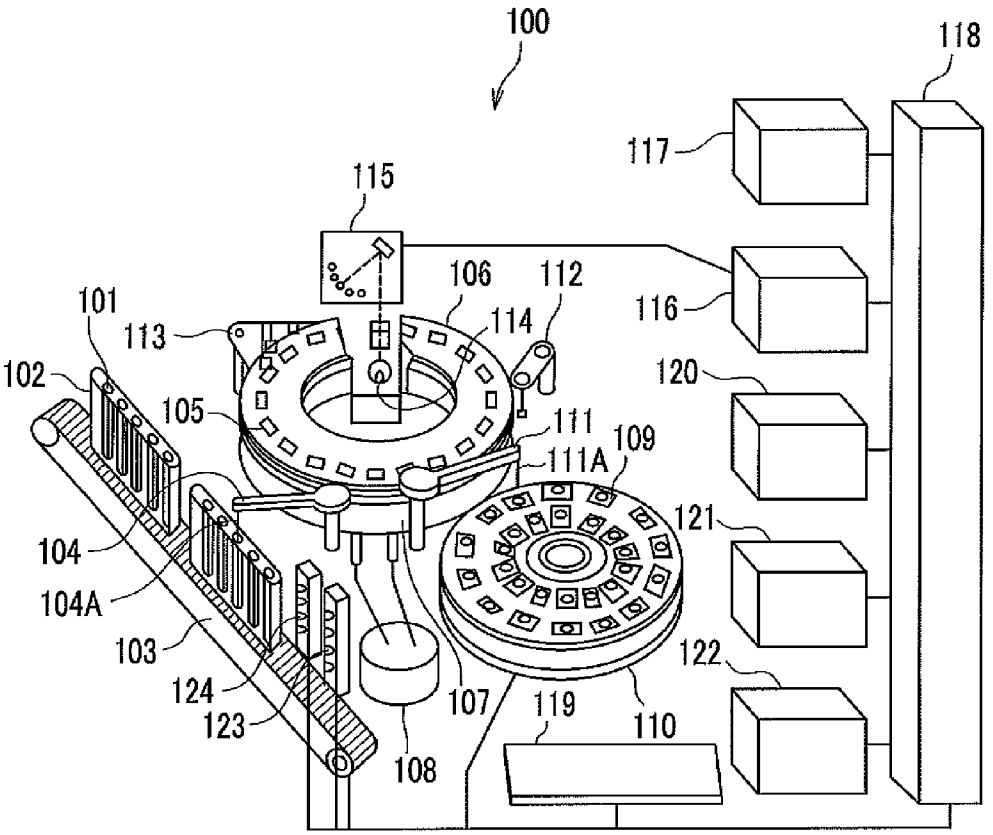

100
118
117
115
106
112
116
101
113
114
102
120
105
111
109
111A
121
104
104A
103
122
124
107
119
123
110
108

FIG.2

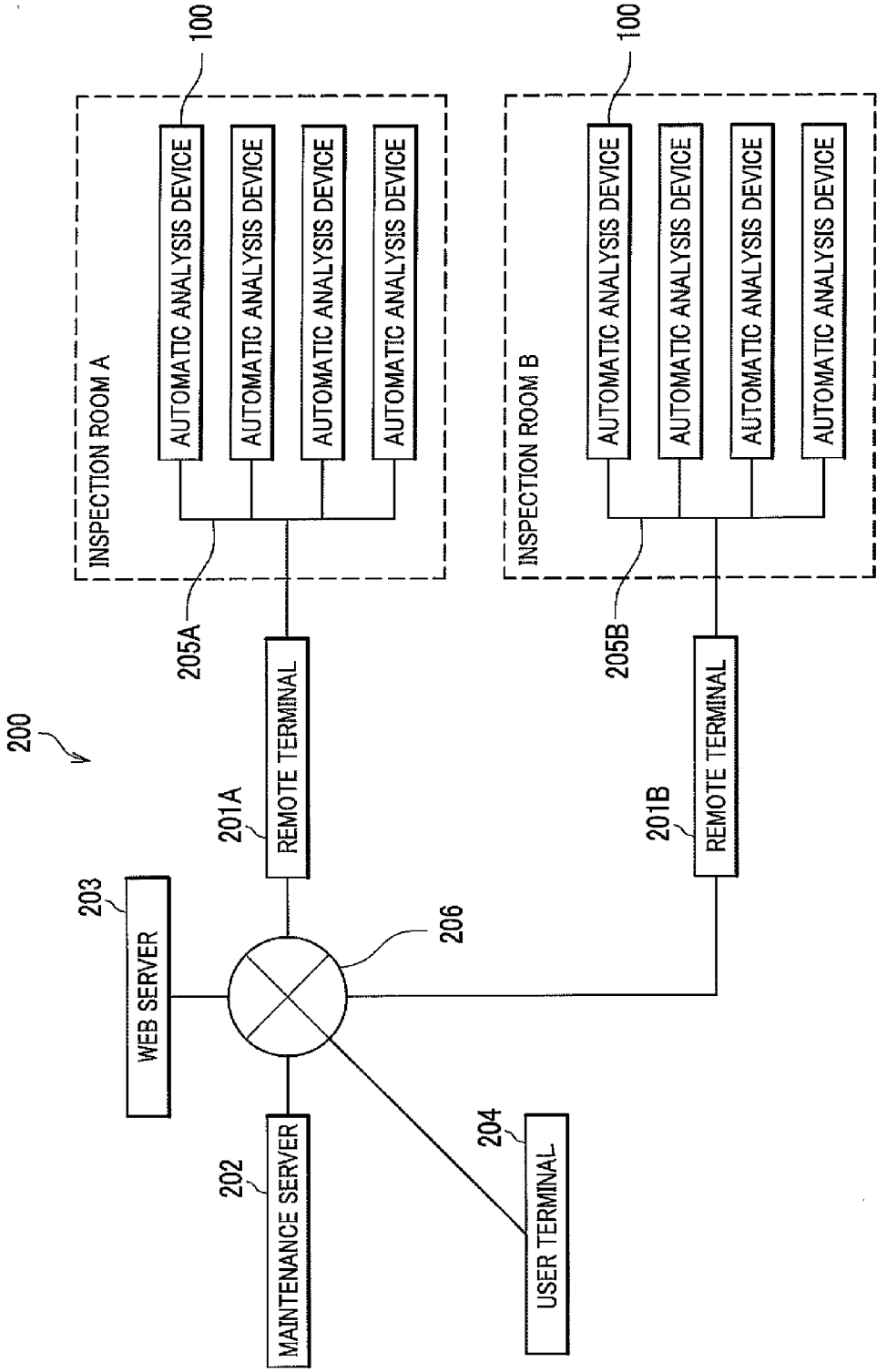

200
INSPECTION ROOM A
INSPECTION ROOM B
100
100
AUTOMATIC ANALYSIS DEVICE
AUTOMATIC ANALYSIS DEVICE
AUTOMATIC ANALYSIS DEVICE
AUTOMATIC ANALYSIS DEVICE
AUTOMATIC ANALYSIS DEVICE
AUTOMATIC ANALYSIS DEVICE
AUTOMATIC ANALYSIS DEVICE
AUTOMATIC ANALYSIS DEVICE
205A
205B
REMOTE TERMINAL
REMOTE TERMINAL
201A
201B
203
WEB SERVER
206
MAINTENANCE SERVER
202
USER TERMINAL
204

FIG.3A

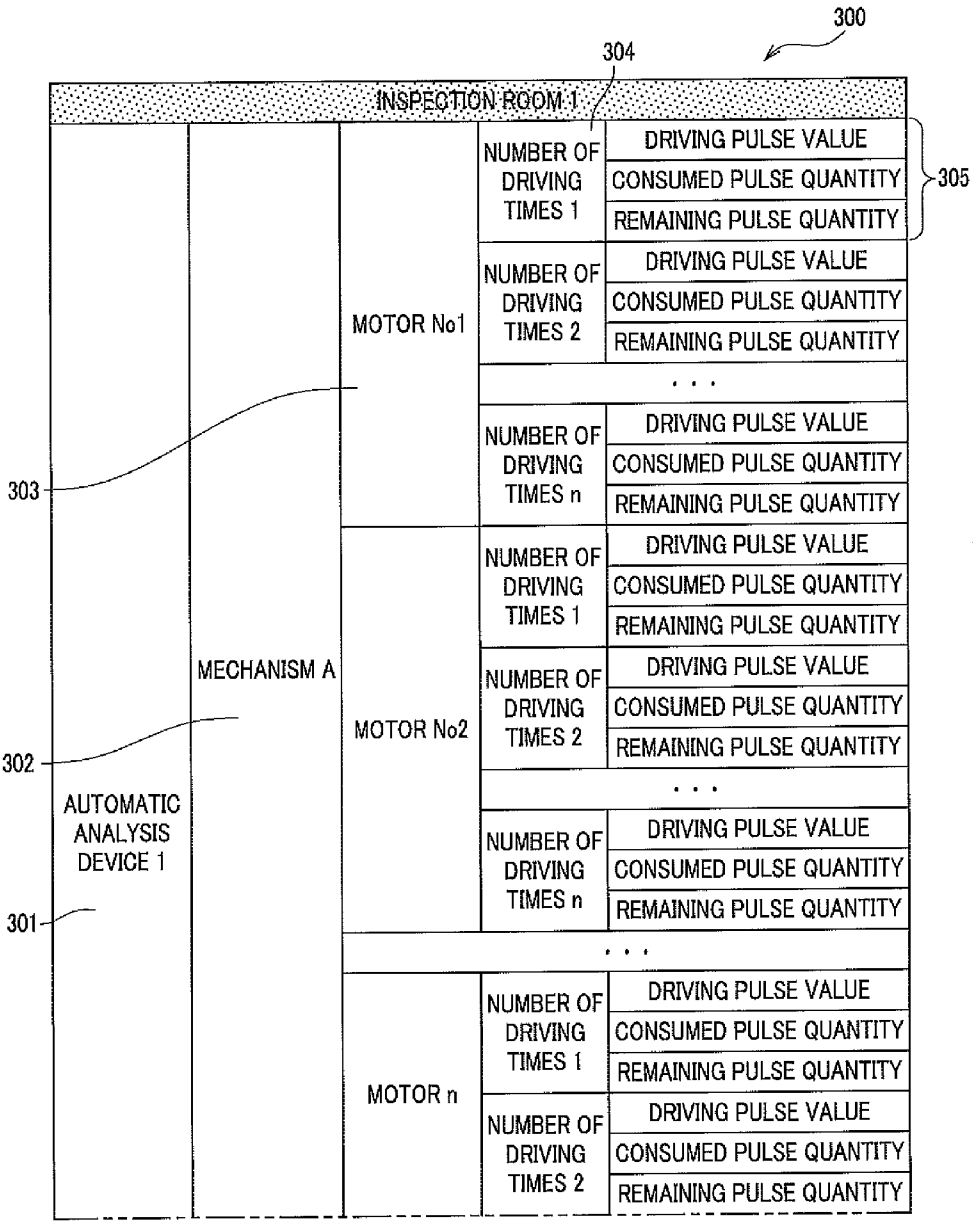

300
304
INSPECTION ROOM 1
AUTOMATIC ANALYSIS DEVICE 1
MECHANISM A
MOTOR No1
MOTOR No2
MOTOR n
NUMBER OF DRIVING TIMES 1
NUMBER OF DRIVING TIMES 2
NUMBER OF DRIVING TIMES n
DRIVING PULSE VALUE
CONSUMED PULSE QUANTITY
REMAINING PULSE QUANTITY
305
303
302
301

FIG.3B

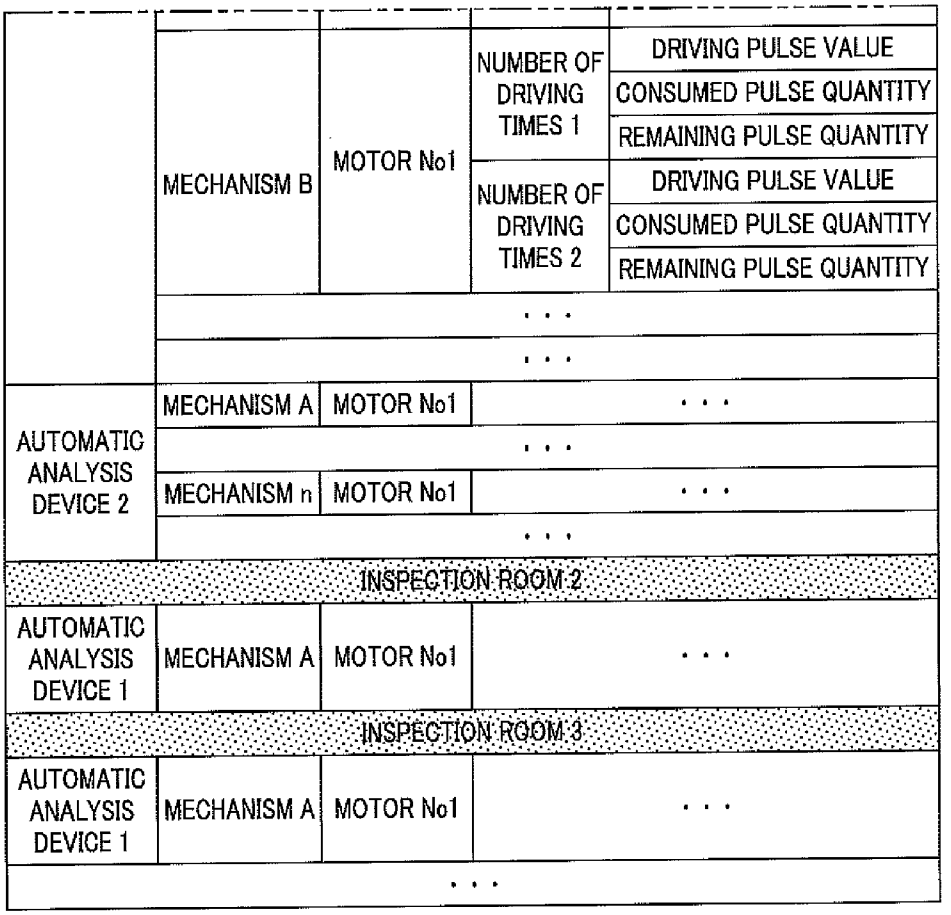

MECHANISM B
MOTOR No1
NUMBER OF DRIVING TIMES 1
DRIVING PULSE VALUE
CONSUMED PULSE QUANTITY
REMAINING PULSE QUANTITY
NUMBER OF DRIVING TIMES 2
DRIVING PULSE VALUE
CONSUMED PULSE QUANTITY
REMAINING PULSE QUANTITY
AUTOMATIC ANALYSIS DEVICE 2
MECHANISM A
MOTOR No1
MECHANISM n
MOTOR No1
INSPECTION ROOM 2
AUTOMATIC ANALYSIS DEVICE 1
MECHANISM A
MOTOR No1
INSPECTION ROOM 3
AUTOMATIC ANALYSIS DEVICE 1
MECHANISM A
MOTOR No1

FIG.4

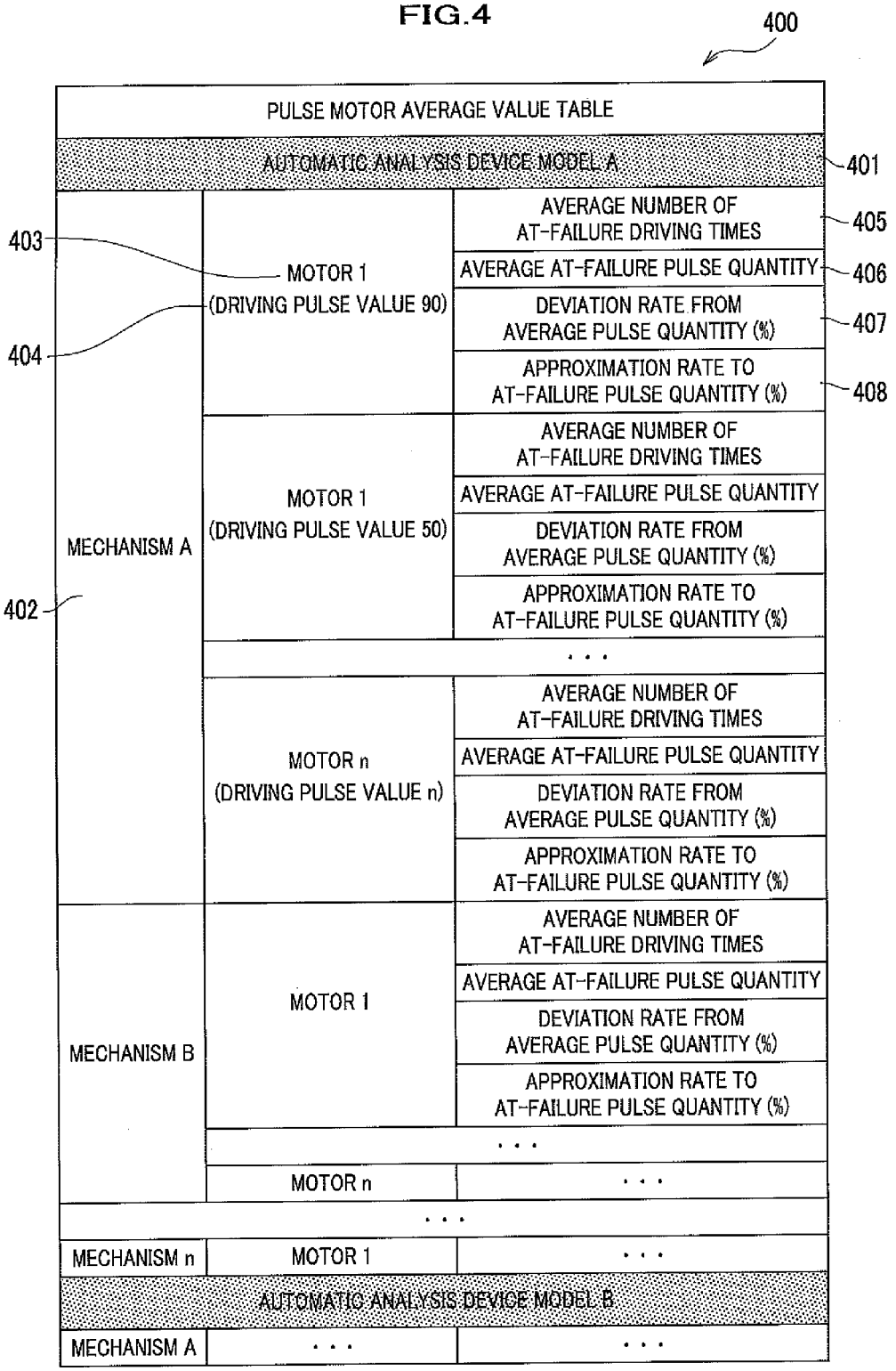

400
PULSE MOTOR AVERAGE VALUE TABLE
AUTOMATIC ANALYSIS DEVICE MODEL A
401
403
404
402
MECHANISM A
MOTOR 1
(DRIVING PULSE VALUE 90)
AVERAGE NUMBER OF AT-FAILURE DRIVING TIMES
405
AVERAGE AT-FAILURE PULSE QUANTITY
406
DEVIATION RATE FROM AVERAGE PULSE QUANTITY (%)
407
APPROXIMATION RATE TO AT-FAILURE PULSE QUANTITY (%)
408
MOTOR 1
(DRIVING PULSE VALUE 50)
AVERAGE NUMBER OF AT-FAILURE DRIVING TIMES
AVERAGE AT-FAILURE PULSE QUANTITY
DEVIATION RATE FROM AVERAGE PULSE QUANTITY (%)
APPROXIMATION RATE TO AT-FAILURE PULSE QUANTITY (%)
MOTOR n
(DRIVING PULSE VALUE n)
AVERAGE NUMBER OF AT-FAILURE DRIVING TIMES
AVERAGE AT-FAILURE PULSE QUANTITY
DEVIATION RATE FROM AVERAGE PULSE QUANTITY (%)
APPROXIMATION RATE TO AT-FAILURE PULSE QUANTITY (%)
MECHANISM B
MOTOR 1
AVERAGE NUMBER OF AT-FAILURE DRIVING TIMES
AVERAGE AT-FAILURE PULSE QUANTITY
DEVIATION RATE FROM AVERAGE PULSE QUANTITY (%)
APPROXIMATION RATE TO AT-FAILURE PULSE QUANTITY (%)
MOTOR n
MECHANISM n
MOTOR 1
AUTOMATIC ANALYSIS DEVICE MODEL B
MECHANISM A

FIG.5

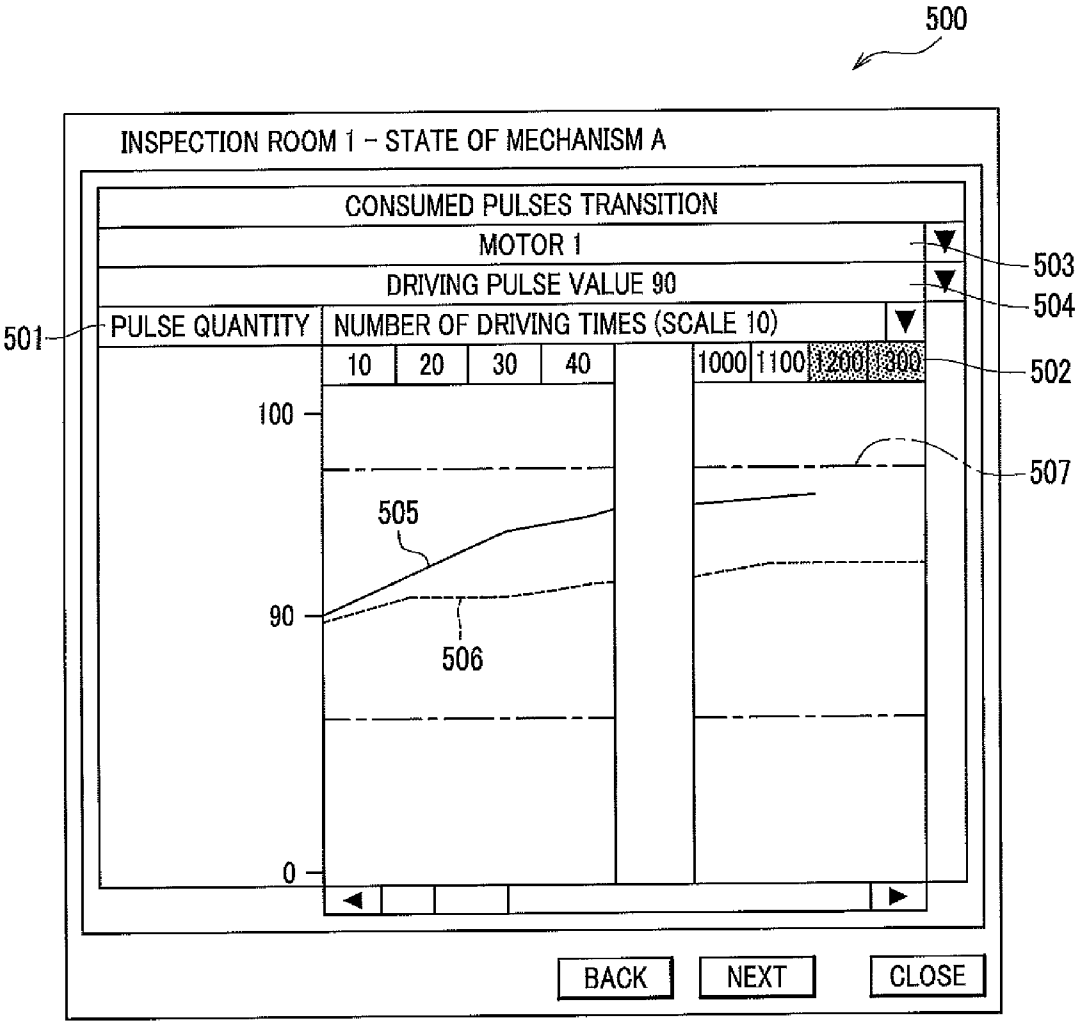

500
INSPECTION ROOM 1 - STATE OF MECHANISM A
CONSUMED PULSES TRANSITION
MOTOR 1
DRIVING PULSE VALUE 90
PULSE QUANTITY
NUMBER OF DRIVING TIMES (SCALE 10)
10
20
30
40
1000
1100
1200
1300
100
90
0
501
502
503
504
505
506
507
BACK
NEXT
CLOSE

FIG.6

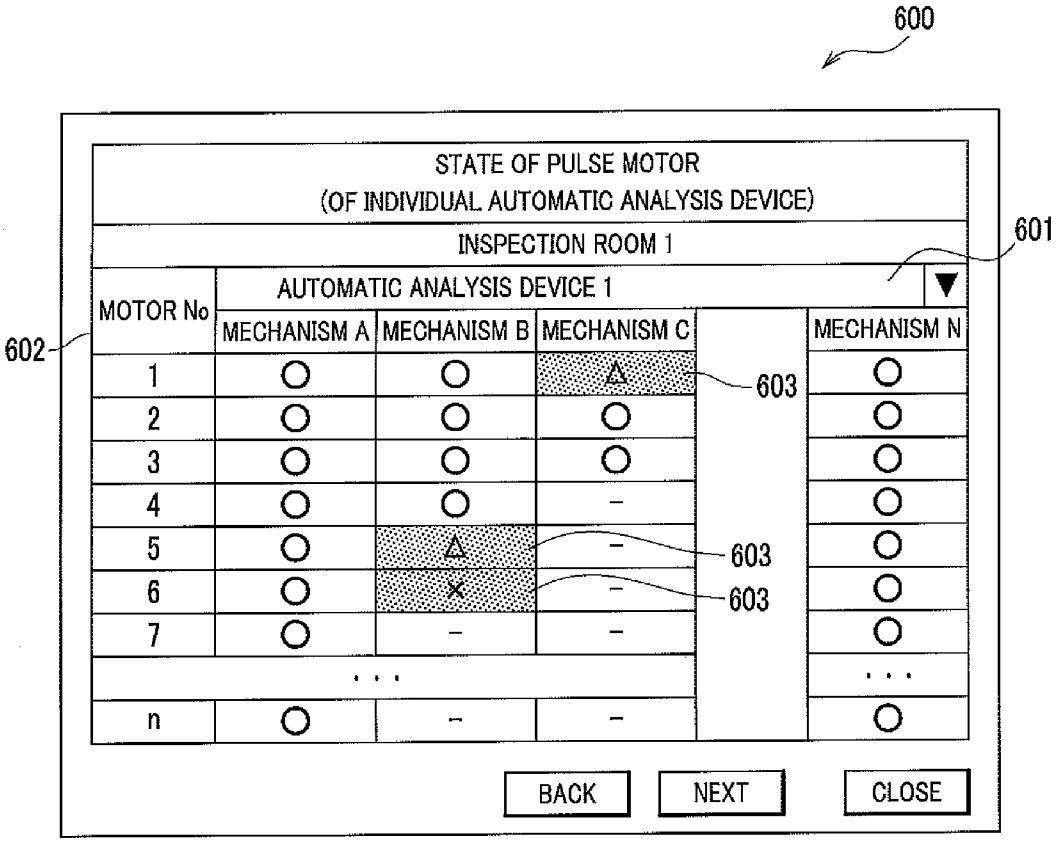

600
STATE OF PULSE MOTOR
(OF INDIVIDUAL AUTOMATIC ANALYSIS DEVICE)
INSPECTION ROOM 1
601
AUTOMATIC ANALYSIS DEVICE 1
602
MOTOR No
MECHANISM A
MECHANISM B
MECHANISM C
MECHANISM N
1 ○ ○ △ ○
2 ○ ○ ○ ○
3 ○ ○ ○ ○
4 ○ ○ – ○
5 ○ △ – ○
6 ○ × – ○
7 ○ – – ○
n ○ – – ○
603
603
603
BACK
NEXT
CLOSE

FIG.7

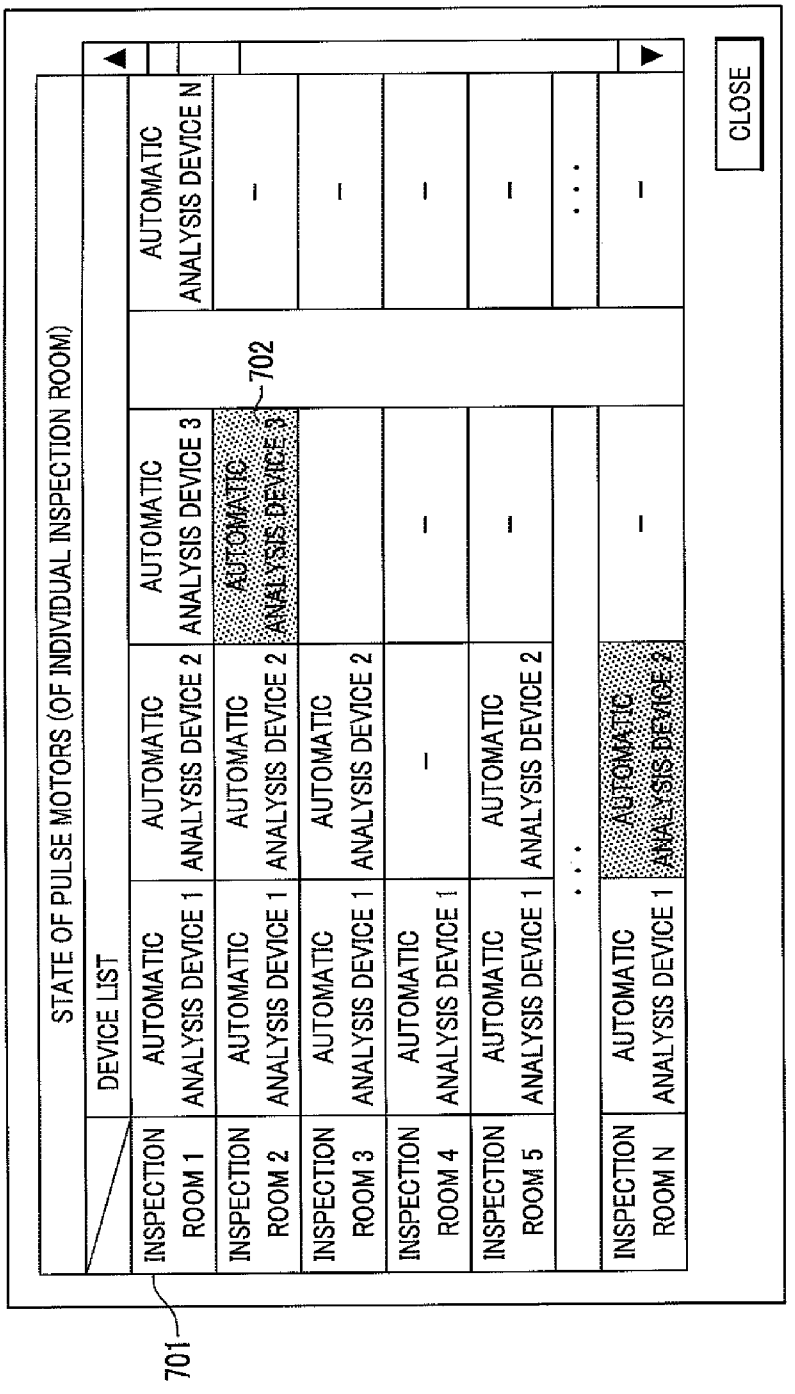
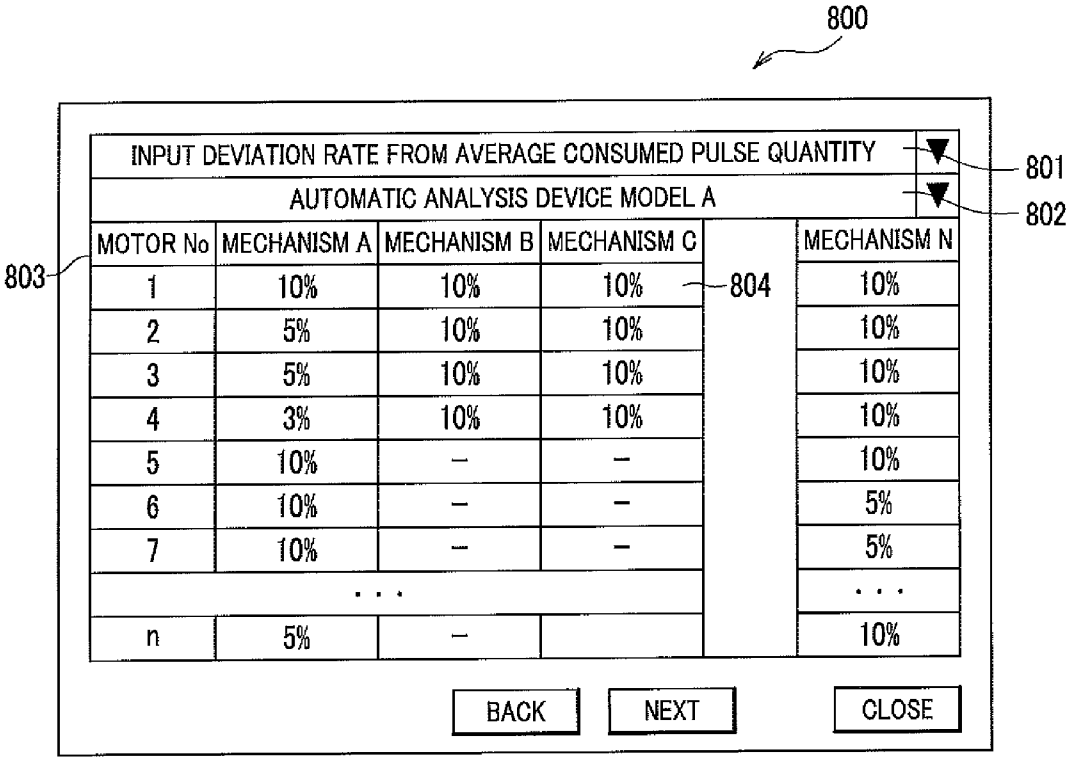
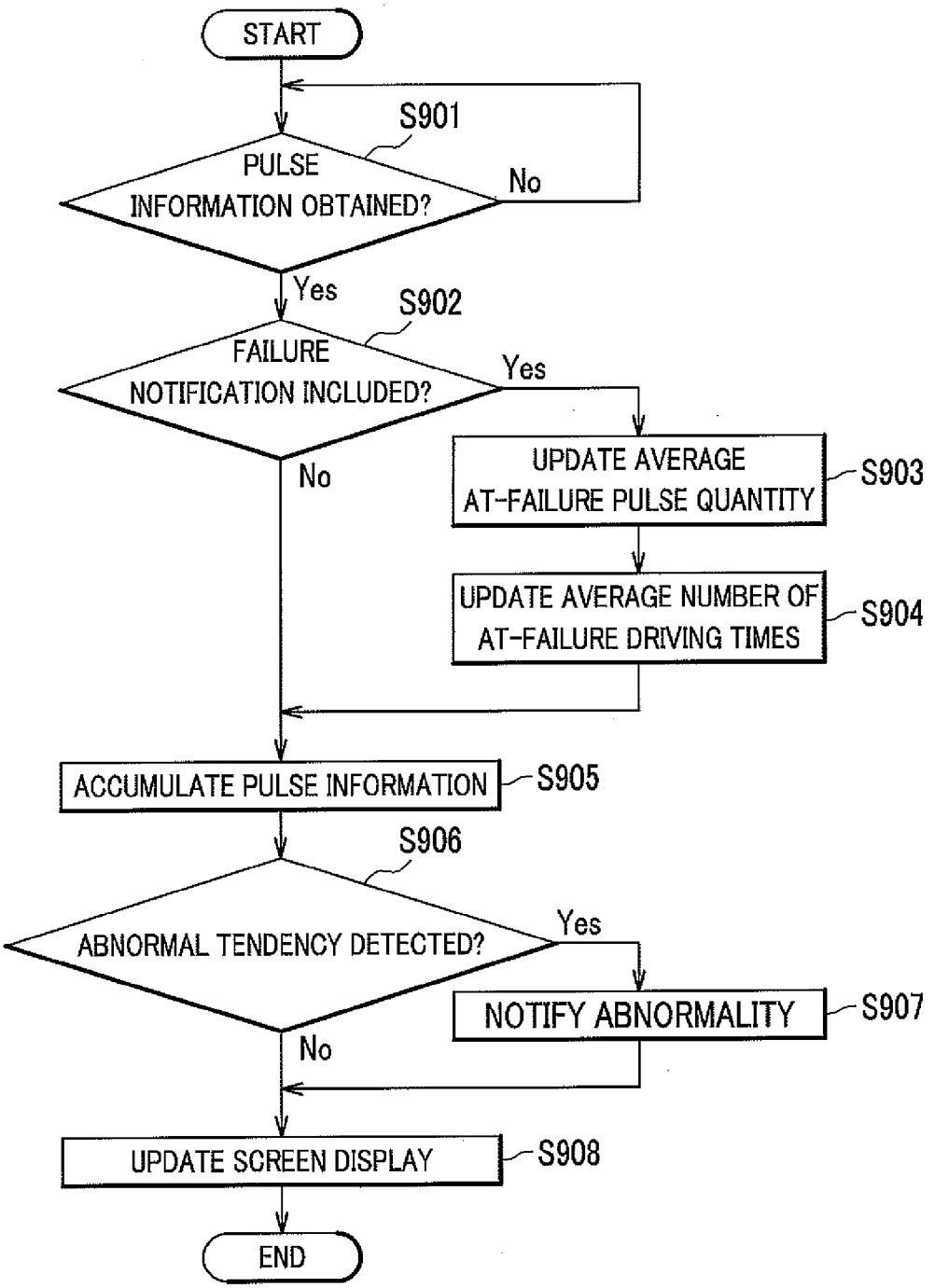

700
701
702
STATE OF PULSE MOTORS (OF INDIVIDUAL INSPECTION ROOM)
DEVICE LIST
INSPECTION ROOM 1
INSPECTION ROOM 2
INSPECTION ROOM 3
INSPECTION ROOM 4
INSPECTION ROOM 5
INSPECTION ROOM N
AUTOMATIC ANALYSIS DEVICE 1
AUTOMATIC ANALYSIS DEVICE 2
AUTOMATIC ANALYSIS DEVICE 3
AUTOMATIC ANALYSIS DEVICE N
AUTOMATIC ANALYSIS DEVICE 2
CLOSE

FIG.8



MOTOR No	MECHANISM A	MECHANISM B	MECHANISM C	MECHANISM N
1	10%	10%	10%	10%
2	5%	10%	10%	10%
3	5%	10%	10%	10%
4	3%	10%	10%	10%
5	10%	–	–	10%
6	10%	–	–	5%
7	10%	–	–	5%
. . .				. . .
n	5%	–		10%

FIG.9


START
S901
PULSE INFORMATION OBTAINED?
No
Yes
S902
FAILURE NOTIFICATION INCLUDED?
Yes
No
UPDATE AVERAGE AT-FAILURE PULSE QUANTITY
S903
UPDATE AVERAGE NUMBER OF AT-FAILURE DRIVING TIMES
S904
ACCUMULATE PULSE INFORMATION
S905
S906
ABNORMAL TENDENCY DETECTED?
Yes
NOTIFY ABNORMALITY
S907
No
UPDATE SCREEN DISPLAY
S908
END

AUTOMATIC ANALYZER AND MAINTENANCE SUPPORTING SYSTEM

TECHNICAL FIELD

[0001] The present invention relates to an automatic analyzer and a maintenance supporting system.

BACKGROUND ART

[0002] For example, there is known an automatic analysis device for qualitative/quantitative analysis of a biological sample, such as blood and urine.

[0003] Service companies periodically perform maintenance of respective mechanisms of an automatic analysis device in order to operate the automatic analysis device in normal conditions. Maintenance includes a case of performing component replacement due to duration of use, based on starting inspection, finishing inspection, periodic inspection, or the like, and a case of notifying an alarm to a service company when an automatic analysis device has fallen into an abnormal state and performing component replacement through checking and maintenance, as necessary, of the conditions of respective mechanisms.

SUMMARY OF THE INVENTION

Problems to be Solved by the Invention

[0004] For normal operation of an automatic analysis device, expiration dates are placed on the respective components of the automatic analysis device, and a service person of a service company performs periodic replacement of mechanism components. Thus, failure of components due to aging is prevented, and down time of the automatic analysis device is reduced.

[0005] However, even during an interval between periodic inspections, in some cases, abnormality occurs due to high usage frequency of a component or an unexpected external factor, and component replacement is performed. Incidentally, for a conventional automatic analysis device, component replacement is performed, according to an alarm output from an automatic analysis device or a certain period of time as an indication for replacing a mechanism component.

[0006] In this situation, an object of the present invention is to provide automatic analysis devices and a maintenance support system for preventing failures occurring during a cycle, of periodic inspections and reducing down time of the automatic analysis devices.

Means for Solving the Problem

[0007] In order to solve the above-described problem, an automatic analysis device according to the present invention includes: a mechanism driven by a pulse motor; and transmitting means for transmitting pulse information including two out of a driving pulse value for driving the pulse motor, a consumed pulse quantity that is a quantity of pulses having been consumed during actual driving of the pulse motor, and a remaining pulse quantity that is obtained by subtracting the consumed pulse quantity from the driving pulse value.

[0008] Further, a maintenance support system according to the invention obtains pulse information transmitted from plural automatic analysis devices; accumulates at least consumed pulse quantities; determines whether or not an obtained consumed pulse quantity of a pulse motor deviates, by a predetermined deviation rate or more, from an average consumed pulse quantity that is an average value of the accumulated consumed pulse quantities; and determines that the pulse motor is in an abnormal tendency if the deviation has been determined.

[0009] Still further, the maintenance support system determines whether or not the obtained consumed pulse quantity of the pulse motor approximates to an average at-failure pulse quantity that is an average value of consumed pulse quantities at failure occurrence on pulse motors, by a predetermined approximation rate or more; and determines that the pulse motor is in an abnormal tendency of if the approximation has been determined.

Advantage of the Invention

[0010] According to the present invention, it is possible to provide automatic analysis devices and a maintenance support system for preventing failures occurring during a cycle of periodic inspections and reducing down time of the automatic analysis devices.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. **1** is a schematic structural diagram of an automatic analysis device in the present embodiment;

[0012] FIG. **2** is a structural block diagram of a maintenance support system for the automatic analysis device in the present embodiment;

[0013] FIG. **3**A and FIG. **3**B show an example of a table of pulse information accumulated in a maintenance server;

[0014] FIG. **4** shows an example of a pulse motor average value table stored in the maintenance server;

[0015] FIG. **5** shows an example of a screen displaying graphs representing variation in a consumed pulse quantity of an individual pulse motor;

[0016] FIG. **6** shows an example of a screen displaying states of pulse motors in an individual automatic analysis device;

[0017] FIG. **7** shows an example of a screen displaying states of automatic analysis devices;

[0018] FIG. **8** shows an example of an input screen for input of a deviation rate and an approximation rate; and

[0019] FIG. **9** is a flowchart showing a process by the maintenance server.

EMBODIMENT FOR CARRYING OUT THE INVENTION

[0020] An embodiment for carrying out the present invention (hereinafter, referred to as 'embodiment') will be described below in detail, referring to the drawings, as appropriate. Incidentally, the same symbol will be assigned to a common element in the respective drawings, and overlapping description will be omitted.

(Automatic Analysis Device)

[0021] The structure of an automatic analysis device **100** in the present embodiment will be described, using FIG. **1**. FIG. **1** is a schematic structural diagram of the automatic analysis device **100** in the present embodiment. Incidentally, in the following description, the automatic analysis device **100** will be described as one for measuring absorbance of light, however, the invention is not limited thereto.

[0022] The automatic analysis device **100** includes a rack transportation device **103** for transporting specimen racks **102** on which plural specimen containers **101** containing

specimen are mounted, a specimen dispensing mechanism **104**, a reaction disc **106** on which plural reaction containers **105** are mounted on a concentric circle, a heat retaining bath **107**, a constant temperature bath **108**, a reagent disc **110** on which plural reagent bottles **109** containing various reagents are mounted on a concentric circle, a reagent dispensing mechanism **111**, an agitation device **112**, a cleaning device **113**, a light source **114**, a multi-wavelength photometer **115**, an A/D convertor **116**, a computer **117**, an interface **118**, an input device **119**, a printer **120**, a monitor **121**, a storage device **122**, a rack number reading device **123**, and a specimen ID reading device **124**.

[0023] The rack transportation device **103** is configured to be able to transport, along a transportation line, the specimen racks **102**, on which plural specimen containers **101** containing specimen are mounted on the rotation circumference of the specimen dispensing mechanism **104** and along a tangent line of the reaction disc **106**. Incidentally, the rack transportation device **103** is driven by a pulse motor and controlled by the computer **117** via the interface **118**.

[0024] The rack number reading device **123** and the specimen ID reading device **124** are disposed along the transportation line of the rack transportation device **103**. Incidentally, information having been read by the rack number reading device **123** and the specimen ID reading device **124** is input via the interface **118** to the computer **117**.

[0025] The specimen dispensing mechanism **104** is configured to be able to dispense a predetermined amount of the specimen in a specimen container **101** into a reaction container **105**, using a specimen dispensing probe **104**A and under control by the computer **117**. The specimen dispensing mechanism **104** has a rotation driving mechanism (not shown) for moving the specimen dispensing probe **104**A between the specimen container **101** and the reaction container **105**. Further, the specimen dispensing mechanism **104** has a driving mechanism (not shown) for vertically moving the specimen dispensing probe **104**A. Incidentally, the rotation driving mechanism and the driving mechanism of the specimen dispensing mechanism **104** are configured to be driven by a pulse motor and controlled via the interface **118** by the computer **117**.

[0026] On the reaction disc **106**, plural reaction containers **105** are disposed on a circle concentric with the reaction disc **106**. The reaction disc **106** is rotatably installed and has a rotation driving mechanism (not shown). The rotation driving mechanism of the reaction disc **106** is driven by a pulse motor and is controlled via the interface **118** by the computer **117**. Incidentally, the reaction disc **106** is configured to be maintained at a predetermined temperature by the heat retaining bath **107** communicated with the constant temperature bath **108**.

[0027] On the reagent disc **110**, plural reagent bottles **109** containing various reagent are mounted on a circle concentric with the reagent disc **110**. The reagent disc **110** is rotatably installed and has a rotation driving mechanism (not shown). The rotation driving mechanism of the reagent disc **110** is driven by a pulse motor and is controlled via the interface **118** by the computer **117**.

[0028] The reagent dispensing mechanism **111** is configured to be able to dispense a predetermined amount of the reagent in a reagent bottle **109** into a reaction container **105**, using a reagent dispensing probe **111**A and under control by the computer **117**. The reagent dispensing mechanism **111** has a rotation driving mechanism (not shown) for moving the reagent dispensing probe **111**A between the reagent bottle **109** and the reaction container **105**. Further, reagent dispensing mechanism **111** has a driving mechanism (not shown) for vertically moving the reagent dispensing probe **111**A. Incidentally, the rotation driving mechanism and the driving mechanism of the reagent dispensing mechanism **111** are configured to be driven by a pulse motor and controlled via the interface **118** by the computer **117**.

[0029] The agitation device **112** is configured to be able to agitate specimen and reagent dispensed in a reaction container **105**. Incidentally, the agitation device **112** has a driving mechanism (not shown). Incidentally, the driving mechanism of the agitation device **112** is driven by a pulse motor and controlled via the interface **118** by the computer **117**.

[0030] The cleaning device **113** is configured to be able to clean the reaction containers **105**. Incidentally, the agitation device **112** has a driving mechanism (not shown). Incidentally, the driving mechanism of the cleaning device **113** is configured to be driven by a pulse motor and controlled via the interface **118** by the computer **117**.

[0031] The multi-wavelength photometer **115** is configured to be able to measure the absorbance of light of the liquid (reaction solution) in a reaction container **105**, using the light source **114**. A measured absorbance signal is converted by the A/D convertor **116** from an analog signal into a digital signal to be input via the interface **118** to the computer **117**.

[0032] The computer **117** is configured to be able to control the entire automatic analysis device **100** by controlling the respective mechanisms. The computer **117** is connected via the interface **118** with the input device **119** for input of various operation conditions, the printer **120** and the monitor **121**, which are output devices, and the storage device **122** for storing various data.

[0033] The computer **117** controls the rack transportation device **103** to transport the specimen racks **102**. An individual serial number (rack number) is assigned to the each specimen rack **102**, and the each serial number is read by the rack number reading device **123** during when the specimen rack **102** is transported on the transportation line. Further, when a specimen ID number is assigned to the specimen container **101** held by a specimen rack **102**, the specimen ID number is read by the specimen ID reading device **124**. Incidentally, information having been read by the rack number reading device **123** and the specimen ID reading device **124** is input via the interface **118** to the computer **117**.

[0034] The computer **117** controls the rack transportation device **103** to move the specimen racks **102** until a first specimen container **101** held by a specimen rack **102** comes to a position directly under the specimen dispensing probe **104**A of the specimen dispensing mechanism **104**. Then, the computer **117** controls the specimen dispensing mechanism **104** to dispense a predetermined amount of the reagent contained in the first specimen container **101** into a first reaction container **105**, using the specimen dispensing probe **104**A.

[0035] Similarly, the computer **117** controls the rack transportation device **103** and moves the specimen racks **102** until a second specimen container **101** held by a specimen rack **102** comes to the position directly under the specimen dispensing probe **104**A of the specimen dispensing mechanism **104**. Further, the computer **117** controls the reaction disc **106** to rotate it by a predetermined angle. Then, the computer **117** controls the specimen dispensing mechanism **104** to dispense a predetermined amount of the reagent contained in the second specimen container **101** into a second reaction container

105, using the specimen dispensing probe 104A. Subsequently, the rest of specimens are dispensed similarly into reaction containers 105.

[0036] A reaction container 105 into which a specimen has been dispensed rotates and moves on the reaction disc 106 by a rotation operation of the reaction disc 106. Meanwhile, the computer 117 controls the reagent disc 110 to move it until a reagent bottle 109 containing a certain reagent comes to a position directly under the reagent dispensing probe 111A of the reagent dispensing mechanism 111. Then, the computer 117 controls the reagent dispensing mechanism 111 to dispense the reagent contained in the reagent bottle 109 into the reaction container 105 by a predetermined amount, using the reagent dispensing probe 111A. Then, the computer 117 controls the agitation device 112 to agitate liquid (reaction solution) of the specimen and the reagent having been dispensed into the reaction container 105.

[0037] Then, the absorbance of light of the liquid (reaction solution) in the reaction container 105 is measured with the light source 114 and the multi-wavelength photometer 115, and a signal of the measured absorbance is converted by the A/D convertor 116 into a digital signal to be input via the interface 118 to the computer 117. A reaction container 105 on which analysis has been finished is cleaned by the cleaning device 113.

[0038] The computer 117 converts the absorbance into the concentration of the component of the measuring object in the specimen, and creates data that is associated with information (rack number, specimen ID) having been read by the rack number reading device 123 and the specimen ID reading device 124. The created data is printed out from the printer 120 via the interface 118, displayed in a screen on the monitor 121, and stored in the storage device 122.

(Control of Pulse Motor and Detection of Abnormal Tendency)

[0039] Herein, as described above, in the automatic analysis device 100 in the present embodiment, mechanisms are arranged such that the rack transportation device 103, the specimen dispensing mechanism 104, the reaction disc 106, the reagent disc 110, the reagent dispensing mechanism 111, the agitation device 112, and the cleaning device 113 are driven by pulse motors.

[0040] The operation speeds (operation angular velocities) and the operation distances (operation angles) of the respective mechanisms are controlled by pulses (electrical power transmission amount) to the pulse motors. Taking into account faults by aging, noises, and the like of the respective components of a mechanism, a pulse value, which is larger than the pulse value for an operation speed (operation angular velocity) and an operation distance (operation angular velocity) as the operation purpose, is set as a driving pulse value. On the other hand, there are also mechanisms that perform control, using sensors (not shown) such that operation distances (operation angles) do not exceed the operation distances (operation angles) as the operation purpose of mechanism.

[0041] The computer 117 of the automatic analysis device 100 in the present embodiment is configured to store and accumulate driving pulse values and consumed pulse quantities in the storage device 122, recognizing a pulse quantity having been consumed, on a driving pulse value for driving a pulse motor, during actual driving of the pulse motor as a consumed pulse quantity. Further, remaining pulse quantities, each of which is obtained by subtracting a consumed pulse quantity from a driving pulse value, are also stored and accumulated in the storage device 122.

[0042] Herein, if some failure has occurred or aging has proceeded on a mechanism driven by a pulse motor, the consumed pulse quantity becomes a value that gradually deviates from a driving pulse value, and later deviates up to a value that prohibits operation for the purpose, and phenomenon of some failure occurs.

[0043] In this situation, the computer 117 of an automatic analysis device 100 in the present embodiment functions as means for transmitting information of the driving pulse values, the consumed pulse quantities, and the remaining pulse quantities of a pulse motor stored and accumulated in the storage device 122, to a maintenance support system 200 (a later described maintenance server 202 (see FIG. 2)) in the present embodiment via the interface 118. Further, in addition to the information of the driving pulse values, the consumed pulse quantities, and the remaining pulse quantities, it is also possible to transmit the number of driving times and the failure state of the pulse motor.

[0044] The maintenance support system 200 (see the later-described FIG. 2) in the present embodiment is configured to be able to specify a mechanism with a pulse motor in a tendency of abnormality, in other words, a mechanism with a possibility of occurrence of failure, by collecting, accumulating, and monitoring driving pulse values, consumed pulse quantities, and remaining pulse quantities from plural facilities where automatic analysis devices 100 are installed. Further, by adding the specified mechanism to the check items of periodical inspection, it is possible to prevent failures occurring during a cycle of periodic inspections and reducing down time of the automatic analysis device 100.

[0045] Further, by performing statistical processing of such information collected from the respective facilities, it is also possible to update in real time the number of driving time, of a mechanism, up to causing a failure, predict an appropriate time of component replacement, and specify a mechanism that needs improvement. Still further, it is possible to detect a mechanism with a high failure frequency in an automatic analysis device 100, and thereby obtain a target of improvement in an automatic analysis device in operation or an automatic analysis device under development.

(Maintenance Support System for Automatic Analysis Devices)

[0046] In the following, the maintenance support system 200 for automatic analysis devices 100 will be described, referring to FIG. 2. FIG. 2 is a structural block diagram of the maintenance support system 200 for the automatic analysis devices 100 in the present embodiment. Incidentally, in the example in FIG. 2, it is assumed that there are two inspection rooms (inspection room A and inspection room B), and plural (four in the example in FIG. 2) automatic analysis devices 100 are installed in the each inspection room.

[0047] As shown in FIG. 2, the maintenance support system 200 for automatic analysis devices 100 is provided with remote terminals 201A, 201B, a maintenance server 202, and a WEB server 203, which are connected by communication lines 205A, 205B, and 206. Incidentally, symbol 204 represents a user terminal.

[0048] The remote terminal 201A is connected with automatic analysis devices 100 installed in the inspection room A via the communication line (for example, LAN (Local Area

Network)) **205**A. The remote terminal **201**B is connected with automatic analysis devices **100** installed in the inspection room B via the communication line (for example, LAN) **205**B.

[0049] The remote terminals **201**A, **201**B are communicatably connected with the maintenance server **202** via the communication line (for example, a dedicated line or Internet connection) **206**. Further, the maintenance server **202**, the WEB server **203**, and the user terminal **204** are communicatably connected via the communication line **206**.

[0050] The each automatic analysis device **100** is configured to be able to transmit the driving pulse value, the consumed pulse quantity, and the remaining pulse quantity of a pulse motor arranged for a corresponding mechanism, via the remote terminal **201**A or **201**B to the maintenance server **202**. Incidentally, in the following description, driving pulse values, consumed pulse quantities, and remaining pulse quantities, which are output from the respective automatic analysis devices **100**, will be collectively referred to as pulse information.

[0051] Herein, the relationship between a driving pulse value, a consumed pulse quantity, and a remaining pulse quantity satisfies the following Expression (1).

$$\text{Remaining pulse quantity} = \text{Driving pulse value} - \text{Consumed pulse quantity} \quad (1)$$

[0052] An automatic analysis device **100** is configured to be able to transmit a notification of occurrence of failure together with pulse information to the maintenance server **202** in case that a failure has occurred on a pulse motor arranged for the corresponding mechanism.

[0053] The maintenance server **202** is configured to be able to obtain and accumulate pulse information on pulse motors arranged for the respective mechanisms of an automatic analysis device **100** via the remote terminal **201**A or **201**B. Incidentally, a pulse information table **300** in which pulse information is accumulated will be described later, referring to FIG. **3**.

[0054] Further, in case that the maintenance server **202** has received a notification of failure occurrence on a pulse motor arranged for the corresponding mechanism of an automatic analysis device **100**, the maintenance server **202** can compute the average values of various information of pulse motors at the times of failure occurrence and store the computed average values. Incidentally, a pulse motor average value table **400** at failure occurrence will be described later, referring to FIG. **4**.

[0055] Further, the maintenance server **202** is configured to be able to determine whether or not a pulse motor, whose pulse information has been obtained, has a possibility of occurrence of failure, based on the pulse information table **300** (see FIG. **3**) and the pulse motor average value table **400** (see FIG. **4**). If the maintenance server **202** has determined a possibility of occurrence of failure, the maintenance server **202** can notify the user terminal **204** of this determination by a mail.

[0056] Herein, determination on whether or not there is a possibility of occurrence of failure is made, for example, such that a possibility of occurrence of failure is determined if the consumed pulse quantity of a pulse motor has deviated by a predetermined or a larger quantity from the average value of consumed pulse quantities of pulse motors in all the inspection rooms, or has approximated to a failure value (the average value at the times of failure occurrence). Incidentally, determination on whether or not a failure possibly occurs will be described later, referring to FIG. **5**.

[0057] The WEB server **203** is configured to be able to obtain pulse information and the like from the maintenance server **202**, and store a screen **500** (see FIG. **5** described later) displaying graphs, a screen **600** (see FIG. **6** described later) displaying the states of the respective mechanisms of a single automatic analysis device **100**, and a screen **700** (see FIG. **7** described later) displaying the states of automatic analysis devices **100**.

[0058] The user terminal **204** is a terminal installed in a service company for services of maintenance and inspection and the like of automatic analysis devices **100**, and is connected to the WEB server **203** via the communication line **206** to be able to refer to screens (FIG. **5**, FIG. **6**, and FIG. **7** described later) stored in the WEB server **203**.

[0059] The user terminal **204** is configured to be able to display an input screen **800** (see FIG. **8** described later) and input a deviation rate and an approximation rate for determination of possibility of failure occurrence.

(Pulse Information Table)

[0060] In the following, an example of a pulse information table **300**, in the maintenance server **202**, for accumulating pulse information will be described, referring to FIG. **3**.

[0061] The pulse information table **300** for storing pulse information of pulse motors is, as shown in FIG. **3**, formed with the automatic analysis device numbers **301** of automatic analysis devices **100** installed in respective inspection rooms, the mechanism numbers **302** of respective mechanisms configuring the automatic analysis devices **100**, the pulse motor numbers **303** of pulse motors configuring the mechanisms, and pulse information **305** for the respective numbers of driving times **304** of the pulse motors. The pulse information **305** is formed with driving pulse values, consumed pulse quantities, and remaining pulse quantities.

[0062] In such a manner, pulse information of all the mechanisms of the automatic analysis devices **100** installed in all the inspection rooms is accumulated in the maintenance server **202**.

(Pulse Motor Average Value Table)

[0063] In the following, an example of the pulse motor average value table **400**, in the maintenance server **202**, for storing average values at failure occurrence will be described, referring to FIG. **4**.

[0064] The pulse motor average value table **400** stores various average values computed from the numbers of driving times at failure occurrence on pulse motors and pulse information (driving pulse value, consumed pulse quantity, and remaining pulse quantity), which have been extracted out from the pulse information, of all the inspection rooms, accumulated in the pulse information table **300** (see FIG. **3**).

[0065] As shown in FIG. **4**, the pulse motor average value table **400** is formed for an individual model **401** of automatic analysis device **100**. Further, the pulse motor average value table **400** stores the average numbers of at-failure driving times **405**, which are obtained by computing the averages of numbers of driving times at the time of failure occurrence, and the average at-failure pulse quantities **406**, which are obtained by computing the averages of consumed pulse quantities at the time of failure occurrence, for the respective

mechanism numbers **402**, the respective pulse motor numbers **403**, and the respective driving pulse values **404**.

[0066] Further, the deviation rates (deviation rates from the average pulse quantities) **407** of deviations from the average consumed pulse quantities (see graph **506** in FIG. **5** described later) for detecting the possibility of failure occurrence on a pulse motor are stored. Still further, the approximation rates (approximation rates to at-failure pulse quantities) **408** to the average at-failure pulse quantities **406** (see graph **507** in FIG. **5** described later) for detecting the possibility of failure occurrence on a pulse motor are stored. Incidentally, deviation rates **407** and approximation rates **408** may be a preset value and may be, as described later, a value input via an input screen **800** (see FIG. **8**).

(Screen for Displaying Variation in Consumed Pulse Quantity of Individual Pulse Motor)

[0067] In the following, an example of a screen **500**, which is stored in the WEB server **203** and displayed on the user terminal **204**, for displaying graphs representing variation in the consumed pulse quantity of an individual motor will be described, referring to FIG. **5**.

[0068] The graphs on the screen **500** represent a pulse quantity **501** by y-axis (vertical axis) and a number of driving times **502** by x-axis (horizontal axis). The graphs are created for an individual driving pulse value **504** of a pulse motor **503** as an object.

[0069] The graph **505** is a graph of consumed pulse quantities plotted for a corresponding individual driving pulse value **504** of a pulse motor **503** to be an object.

[0070] The graph **506** is a graph of average consumed pulse quantities of the same pulse motors (pulse motors installed at the same position of the same mechanism of the same model) as the pulse motor **503** to be an object in terms of motor, having all the facilities as the object of averaging.

[0071] The graph **507** is a graph of averages of the consumed pulse quantities at failure occurrence on the same pulse motors (the average at-failure pulse quantities **406** in FIG. **4**).

[0072] Herein, determination of a possibility of failure occurrence on a pulse motor by the maintenance server **202** will be described, referring to FIG. **5**.

[0073] A possibility of failure occurrence is determined if the graph **505** has deviated from the graph **506** of plotted average consumed pulse quantities by a predetermined deviation rate (the average pulse quantity deviation rate **407** in FIG. **4**) or more. Further, a possibility of failure occurrence is also determined if the graph **505** has approximated to the graph **507** representing the average at-failure pulse quantities **406** by a predetermined approximation rate (approximation rate to at-failure pulse quantity **408** in FIG. **4**) or more. Incidentally, if a possibility of failure occurrence has been determined, for example, the display color of the graph **505** is changed for visual recognition of the possibility of a failure.

(Screen for Displaying Pulse Motor States of Individual Automatic Analysis Device)

[0074] In the following, an example of a screen **600**, displayed on the user terminal **204**, for displaying the states of the pulse motors of an individual automatic analysis device will be described, referring to FIG. **6**.

[0075] The screen **600** shown in FIG. **6** is displayed for an individual automatic analysis device **601** and displayed in a matrix structure **602**, wherein respective mechanisms of an automatic analysis device are disposed along the horizontal axis, and motor numbers are disposed along the vertical axis such that a single cell corresponds to a single pulse motor.

[0076] A cell of a pulse motor determined, in association with the graphs shown in FIG. **5**, to have a possibility of failure occurrence is represented by an indication **603** with a different mark and in a different color. Incidentally, it is also possible to assign different colors or marks depending on whether the determination has been made by deviation from the average consumed pulse quantity or by approximation to the average at-failure pulse quantity.

[0077] Incidentally, in the screen **600** in FIG. **6**, by selection of the cell corresponding to a pulse motor, a screen **500** (see FIG. **5**) displaying variation in the consumed pulse quantity of an individual pulse motor is displayed.

(Screen for Displaying States of Automatic Analysis Devices)

[0078] In the following, an example of a screen **700**, displayed on the user terminal **204**, for displaying the states of automatic analysis devices will be described, referring to FIG. **7**.

[0079] The screen **700** shown in FIG. **7** is displayed in a matrix structure **701** in which the numbers of inspection rooms are disposed along the vertical axis and the numbers of automatic analysis devices in the respective inspection rooms are disposed along the horizontal axis such that a single cell corresponds to a single automatic analysis device.

[0080] A cell of an automatic analysis device having a pulse motor determined, in association with the graphs shown in FIG. **5**, to have a possibility of failure occurrence is represented by an indication **702** with a different mark or in a different color. Incidentally, it is also possible to assign different colors or marks depending on whether the determination has been made by deviation from the average consumed pulse quantity or by approximation to the failure average pulse quantity.

[0081] Incidentally, in the screen **700** in FIG. **7**, by selection of the cell corresponding to an automatic analysis device, a screen **600** (see FIG. **6**) displaying the states of pulse motors of the corresponding individual automatic analysis device is displayed.

(Input Screen for Input of Deviation Rate and Approximation Rate)

[0082] In the following, an example of an input screen **800**, displayed on the user terminal **204**, for input of a deviation rate and an approximation rate will be descried, referring to FIG. **8**.

[0083] The input screen shown in FIG. **8** allows switching between input of a deviation rate and input of an approximation rate by pull-down **801**, and allows switching between models of automatic analysis device by pull-down **802**.

[0084] The screen is displayed in a matrix structure **803**, in which the respective mechanisms of an automatic analysis device are disposed along the horizontal axis and the numbers of motors are disposed along the vertical axis, for an individual model of automatic analysis device selected via the pull-down **802** such that a single cell corresponds to a single pulse motor.

[0085] Then, by inputting a numeric value into a cell **804** corresponding to the pulse motor, a deviation rate or an approximation rate selected via the pull-down **801** can be input.

[0086] Incidentally, a deviation rate or an approximation rate having been input via the input screen **800** is stored via the WEB server **203** and the communication line **206** into the deviation rate **407** or the approximation rate **408** of the pulse motor average value table **400** (see FIG. **4**) of the maintenance server **202**.

(Process by Maintenance Server **202**)

[0087] In the following, a process by the maintenance server **202** will be described, referring to FIG. **9**. FIG. **9** is a flowchart showing the process by the maintenance server **202**.

[0088] First, an automatic analysis device **100** is configured to be able to transmit a telegram message in which pulse information (driving pulse value, consumed pulse quantity, remaining pulse quantity), the number of driving times, and the failure state of a pulse motor are stored.

[0089] In step S**901**, the maintenance server **202** determines whether or not it has received, from an automatic analysis device **100**, a telegram message including pulse information (driving pulse value, consumed pulse quantity, remaining pulse quantity), the number of driving times, and a failure state. If the maintenance server **202** has not yet received a telegram message including pulse information (S**901**, No), the maintenance server **202** repeats step S**901** until it obtains such a telegram message. When the maintenance server **202** has obtained a telegram message including pulse information (S**901**, Yes), the process by the maintenance server **202** proceeds to step S**902**.

[0090] In step S**902**, the maintenance server **202** determines whether or not the telegram message, obtained in step S**901**, including pulse information includes a notification representing that the failure state of the pulse motor is failure. If a notification of the failure of the pulse motor is included (S**902**, Yes), the process by the maintenance server **202** proceeds to step sS**903**. If a notification of failure of the pulse motor is not included (S**902**, No), the process by the maintenance server **202** proceeds to step S**905**.

[0091] In step S**903**, the maintenance server **202** computes an average value, based on the consumed pulse quantity obtained in step S**901** and at-failure consumed pulse quantities in the past, and updates the average at-failure pulse quantities **406** of the pulse motor average value table **400** (see FIG. **4**).

[0092] In step S**904**, the maintenance server **202** computes an average value, based on the number of driving times in the telegram message obtained in step S**901** and the numbers of at-failure driving times in the past, and updates the average number of at-failure driving times **405** in the pulse motor average value table **400** (see FIG. **4**). Then, the process by the maintenance server **202** proceeds to step S**905**.

[0093] In step S**905**, the maintenance server **202** accumulates the pulse information and the number of driving times obtained in step S**901** into the pulse information table **300** (see FIG. **3**). Herein, if the pulse motor is not in failure, the maintenance server **202** computes the average consumed pulse quantity (see graph **506** in FIG. **5**) of the same pulse motors (pulse motors being of the same model and installed at the same position of the same mechanism), as the pulse motor to be the object, in all the facilities as the object of averaging computation.

[0094] In step S**906**, the maintenance server **202** detects the abnormal tendency of a pulse motor. Concretely, if the consumed pulse quantity obtained in step S**901** deviates at a larger rate than the deviation rate **407** (see FIG. **4**) from the average consumed pulse quantity (see graph **506** in FIG. **5**), a possibility of failure occurrence is determined, and an abnormal tendency is thus detected. Further, if the consumed pulse quantity obtained in step S**901** approximates to the average at-failure pulse quantity **406** (see FIG. **4**) at the approximation rate **408** (see FIG. **4**), a possibility of failure occurrence on the pulse motor is determined, and an abnormal tendency is thus detected.

[0095] If an abnormal tendency is detected (S**906**, Yes), the process by the maintenance server **202** proceeds to step S**907**. If an abnormal tendency is not detected (S**906**, No), the process by the maintenance server **202** proceeds to step S**908**.

[0096] In step S**907**, the maintenance server **202** notifies the user terminal **204** of abnormality. Then, the process by the maintenance server **202** proceeds to step S**908**.

[0097] In step S**908**, the maintenance server **202** updates the screens **500**, **600**, and **700** (see FIG. **5**, FIG. **6**, and FIG. **7**), and transmits them to the WEB server **203**.

[0098] In such a manner, the maintenance server **202** is configured to obtain pulse information from an automatic analysis device **100**, detect abnormal tendency of a pulse motor (possibility of failure occurrence), and notify the user terminal **204** of it.

[0099] Therefore by adding a mechanism of an automatic analysis device **100** on which an abnormal tendency has been detected to check items of periodic inspection, it is possible to prevent failure occurrence on a pulse motor, and reduce the down time of an automatic analysis device **100** occurring during a cycle of periodic inspections.

[0100] Further, the average number of at-failure driving times **405** (see FIG. **4**) is updated in real time, and it is thereby possible to appropriately predict a time of component replacement and specify a mechanism that needs improvement. Still further, it is possible to detect a mechanism with a high failure frequency in an automatic analysis device **100**, and thereby obtain a target of improvement in an automatic analysis device in operation or an automatic analysis device under development.

Modified Examples

[0101] Incidentally, an automatic analysis device and a maintenance support system in the present embodiment are not limited to the arrangement in the foregoing embodiment, and various changes and modifications can be made in a range without departing from the purpose of the invention.

[0102] It has been described that a driving pulse value, a consumed pulse quantity, and a remaining pulse quantity are transmitted as pulse information from an automatic analysis device **100** to the maintenance support system **200**, however, the invention is not limited thereto. When any two out of the driving pulse value, the consumed pulse quantity, and the remaining pulse quantity are known to satisfy the relationship represented by the above-described Expression (1), the remaining one can be computed by Expression (1). Accordingly, arrangement may be made such that any two out of a driving pulse value, a consumed pulse quantity, and a remaining pulse quantity are transmitted as pulse information from an automatic analysis device **100** to the maintenance support

system **200**, and information of the remaining one is computed by Expression (1) on the maintenance support system **200**.

[0103] It has been described that the maintenance server **202** detects an abnormal tendency (see S**906** in FIG. **9**), based on a consumed pulse quantity, however, the invention is not limited thereto.

[0104] For example, an abnormal tendency may be detected, based on a remaining pulse quantity. That is, when the remaining pulse quantity of a pulse motor as an object has deviated from the average value of the remaining pulse quantities of pulse motors in all the inspection rooms by a predetermined quantity or more or has approximated to the average value of at-failure-occurrence remaining pulse quantities by a predetermined quantity or more, the maintenance server **202** determines that the pulse motor has a possibility of failure occurrence, and thus detects an abnormal tendency.

DESCRIPTION OF REFERENCE SYMBOLS

[0105] **100** . . . automatic analysis device (mechanisms driven by pulse motors)
[0106] **103** . . . rack transportation device (a mechanism driven by a pulse motor)
[0107] **104** . . . specimen dispensing mechanism (a mechanism driven by a pulse motor)
[0108] **106** . . . reaction disc (a mechanism driven by a pulse motor)
[0109] **110** . . . reagent disc (a mechanism driven by a pulse motor)
[0110] **111** . . . reagent dispensing mechanism (a mechanism driven by a pulse motor)
[0111] **112** . . . agitation device (a mechanism driven by a pulse motor)
[0112] **113** . . . cleaning device (a mechanism driven by a pulse motor)
[0113] **117** . . . computer (transmitting means)
[0114] **118** . . . interface (transmitting means)
[0115] **200** . . . maintenance support system
[0116] **202** . . . maintenance server
[0117] **203** . . . WEB server
[0118] **204** . . . user terminal
[0119] **300** . . . pulse information table
[0120] **304** . . . number of driving times
[0121] **305** . . . pulse information
[0122] **400** . . . pulse motor average value table
[0123] **405** . . . average number of at-failure driving times
[0124] **406** . . . average at-failure pulse quantity
[0125] **407** . . . deviation rate (deviation rate from average pulse quantity)
[0126] **408** . . . approximation rate (approximation rate to at-failure pulse quantity)
[0127] **505** . . . consumed pulse quantity
[0128] **506** . . . average consumed pulse quantity
[0129] **507** . . . average at-failure pulse quantity
[0130] **800** . . . input screen (setting means)

1. An automatic analysis device, comprising:
a mechanism driven by a pulse motor; and
transmitting means for transmitting pulse information including two out of a driving pulse value for driving the pulse motor, a consumed pulse quantity that is a quantity of pulses having been consumed during actual driving of the pulse motor, and a remaining pulse quantity that is obtained by subtracting the consumed pulse quantity from the driving pulse value.

2. A maintenance support system that:
obtains pulse information transmitted from plural automatic analysis devices each of which includes a mechanism driven by a pulse motor and transmitting means for transmitting the pulse information as pulse information including two out of a driving pulse value for driving the pulse motor, a consumed pulse quantity that is a quantity of pulses having been consumed during actual driving of the pulse motor, and a remaining pulse quantity that is obtained by subtracting the consumed pulse quantity from the driving pulse value;
accumulates at least the consumed pulse quantities;
determines whether or not an obtained consumed pulse quantity of a pulse motor deviates, by a predetermined deviation rate or more, from an average consumed pulse quantity that is an average value of the accumulated consumed pulse quantities; and
determines that the pulse motor is in an abnormal tendency if the deviation has been determined.

3. The maintenance support system according to claim **2**, wherein the maintenance support system that:
determines whether or not the obtained consumed pulse quantity of the pulse motor approximates to an average at-failure pulse quantity by a predetermined approximation rate or more, the average at-failure pulse quantity being an average value of consumed pulse quantities at failure occurrence on pulse motors; and
determines that the pulse motor is in an abnormal tendency if the approximation has been determined.

4. A maintenance support system that:
obtains pulse information transmitted from plural automatic analysis devices each of which includes a mechanism driven by a pulse motor and transmitting means for transmitting the pulse information as pulse information including two out of a driving pulse value for driving the pulse motor, a consumed pulse quantity that is a quantity of pulses having been consumed during actual driving of the pulse motor, and a remaining pulse quantity that is obtained by subtracting the consumed pulse quantity from the driving pulse value;
accumulates at least the remaining pulse quantities;
determines whether or not an obtained remaining pulse quantity of a pulse motor deviates, by a predetermined deviation rate or more, from an average remaining pulse quantity that is an average value of the accumulated remaining pulse quantities; and
determines that the pulse motor is in an abnormal tendency if the deviation has been determined.

5. The maintenance support system according to claim **4**, wherein the maintenance support system:
determines whether or not the obtained remaining pulse quantity of the pulse motor approximates to an average at-failure pulse quantity that is an average value of remaining pulse quantities at failure occurrence on pulse motors, by a predetermined approximation rate or more; and
determines that the pulse motor is in an abnormal tendency if the approximation has been determined.

6. The maintenance support system according to claim **2**, comprising:
setting means for setting the predetermined deviation rate.

7. The maintenance support system according to claim **3**, comprising:

setting means for setting the predetermined approximation rate.

8. The maintenance support system according to claim **3**, wherein the maintenance support system creates a display screen for displaying the consumed pulse quantity of the pulse motor, the average consumed pulse quantity, and the average at-failure pulse quantity.

9. The maintenance support system according to claim **5**, wherein the maintenance support system creates a display screen for displaying the remaining pulse quantity of the pulse motor, the average remaining pulse quantity, and the average at-failure pulse quantity.

10. The maintenance support system according to claim **4**, comprising:

setting means for setting the predetermined deviation rate.

11. The maintenance support system according to claim **5**, comprising:

setting means for setting the predetermined approximation rate.

* * * * *