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(54) **COMPUTING SYSTEM FOR ANALYZING FACTORY, AND METHOD FOR USING COMPUTING SYSTEM IN ORDER TO MANAGE FACTORY**

RECHNERSYSTEM ZUR ANALYSE EINER FABRIK UND VERFAHREN ZUR VERWENDUNG EINES RECHNERSYSTEMS ZUR VERWALTUNG EINER FABRIK

SYSTÈME INFORMATIQUE D’ANALYSE D’USINE, ET PROCÉDÉ D’UTILISATION D’UN SYSTÈME INFORMATIQUE AFIN DE GÉRER UNE USINE

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Description

[TECHNICAL FIELD]

[0001] The present disclosure relates to a computing system, and more particularly, relates to a computing system for analyzing a factory and a method of using the computing system to manage the factory.

[BACKGROUND ART]

[0002] Factory automation refers to automatize overall procedures for control, management, and operation of a factory producing products by using robots, computers, and the like. Nowadays, as an information technology (IT) develops, a smart factory is being introduced beyond the factory automation. The smart factory is an intelligent factory capable of improving productivity of a factory and a product quality by applying information and communication technologies to overall processes that are performed in the factory.

[0003] One of technologies that are used in the smart factory is to build a virtual factory. The virtual factory may be implemented in a virtual environment based on a result of modeling a real factory. A process that is performed in the real factory is modeled so as to be expressed by a factory model implemented in the virtual environment. Accordingly, as the virtual factory is used, even though a product is not really produced in the real factory, procedures for producing products may be virtually implemented or duplicated through simulation in the virtual environment.

[0004] EP 2755096 A1 describes an imaging device and terminal device for each of plural work areas. Image data sets, capturing time data sets, and imaging unit identifiers transmitted by imaging device are stored in association with each other in an image database.

[0005] WO 2008/116282 A1 describes a method and system for identifying, quantifying and presenting to a user constraints in an automated manufacturing or processing facility. A data processing system continuously receives basic status signals and state signals from automation equipment in the facility and evaluates and processes these signals to derive a throughput capability measure (a measure of constraint) of each given manufacturing workstation in the process.

[DETAILED DESCRIPTION OF THE INVENTION]

[TECHINICAL PROBLEM]

[0006] An object of the present disclosure is directed to provide a computing system for building a virtual factory reflecting a situation of a real factory and analyzing the situation of the real factory and a method of managing the real factory by using the computing system.

[TECHNICAL SOLUTION]

[0007] According to an embodiment of the present disclosure, there is provided a computing system for building a virtual factory as recited in claim 1.

[0008] According to an embodiment of the present disclosure, there is provided a method of using a computing system as recited in claim 3.

[ADVANTAGEOUS EFFECTS OF THE INVENTION]

[0009] The present disclosure may gather data associated with a real factory from the real factory. According to an embodiment of the present disclosure, a monitoring device may be installed on a facility to gather data associated with the facility. Also, the monitoring device may be installed in a surrounding area adjacent to the facility to gather data associated with both the facility and a process.

[0010] The present disclosure may analyze and predict a situation of a real factory in real time by using data gathered from the real factory.

[0011] According to an embodiment of the present disclosure, because a situation of a real factory is analyzed and predicted in real time, the user may establish a producing plan capable of increasing the production of a factory with reference to the analysis result and the prediction result. Also, the user may manage works performed in a factory and products generated in the factory in an optimum state with reference to the analysis result and the prediction result.

[0012] The present disclosure builds a virtual factory, to which a situation of a real factory is reflected, by using data gathered from the real factory. Accordingly, a situation of a real factory may be displayed at a look in real time.

[0013] Also, the present disclosure may build a virtual factory on a cloud and may analyze a situation of a real factory. Accordingly, according to an embodiment of the present disclosure, users may access the virtual factory through a plurality of servers and may check a result of analyzing a situation of a real factory.

[DESCRIPTION OF THE DRAWINGS]

[0014]

FIG. 1 is a conceptual diagram illustrating a real factory and an image displayed in a display panel of the present disclosure.
FIG. 2 is a block diagram illustrating a device and a system used to manage a real factory of FIG. 1.
FIG. 3 is a conceptual diagram for describing an operation of a data processing module of FIG. 2.
FIG. 4 is a conceptual diagram illustrating a data gathering device gathering data from a real factory of FIG. 1.
FIG. 5 is a conceptual diagram illustrating an image

taken by a data gathering device for factory of FIG. 4.

FIG. 6 is a conceptual diagram illustrating an example method of gathering data by monitoring devices of FIG. 4.

FIG. 7 is a conceptual diagram illustrating an example method of gathering data by monitoring devices of FIG. 4.

FIG. 8 is a conceptual diagram for describing an operation of a virtual factory building module of FIG. 2.

FIG. 9 is a conceptual diagram illustrating a virtual factory displayed in a display panel of FIG. 2.

FIG. 10 is a conceptual diagram for describing an operation of a data analysis module of FIG. 2.

FIG. 11 is a conceptual diagram illustrating an analysis result of a real factory displayed in a display panel of FIG. 2.

FIG. 12 is a flowchart for describing a method of displaying a virtual factory and an analysis result of a situation of a real factory in a display panel of FIG. 2.

FIG. 13 is a flowchart for describing a method of building a virtual factory at a virtual factory building module of FIG. 2.

[BEST MODE]

[0015] Below, embodiments of the present disclosure may be described in detail and clearly to such an extent that one skilled in the art easily may carry out the present disclosure.

[0016] FIG. 1 is a conceptual diagram illustrating a real factory and an image displayed in a display panel of the present disclosure.

[0017] A real factory 1000 may be a physical work space that is used to produce, process, and/or pack any object or product. To this end, for example, the real factory 1000 may include facilities 311, 312, and 313, a vehicle 325, products 331a, 332a, 333a, and 334a, transport containers 331, 332, 333, and 334, and workers 341 and 342.

[0018] A real factory 1000 may be a physical work space that is used to produce, process, and/or pack any object or product. To this end, for example, the real factory 1000 may include facilities 311, 312, and 313, a vehicle 325, products 331a, 332a, 333a, and 334a, transport containers 331, 332, 333, and 334, and workers 341 and 342.

[0019] However, the real factory 1000 is illustrated by ways of example for better understanding of the present disclosure, and the present disclosure is not limited thereto. The real factory 1000 may include one or more facilities, one or more vehicles, one or more transport containers, and one or more workers and may further include components for operating the real factory 1000.

[0020] In the real factory 1000, the products 331a, 332a, 333a, and 334a may be produced and managed by the workers 341 and 342, the facilities 311, 312, and 313, the vehicle 325, and the transport containers 331, 332, 333, and 334. For example, the product 331a may be produced by the facilities 311, 312, and 313. For another example, the products 331a, 332a, 333a, and 334a may be kept or carried in a state of being put in the transport containers 331, 332, 333, and 334.

[0021] The term "work" used in the specification means one operation that is performed by the workers 341 and 342, the facilities 311, 312, and 313, and the vehicle 325 in the real factory 1000. For example, one work may be to move the product 332a by using the vehicle 325.

[0022] The term "process" used in the specification means a series of works that are performed to produce one product. For example, one process may be composed of one or more works of the following: a work for producing the product 332a by using the facilities 311, 312, and 313, a work for putting the product 332a in the transport container 332, and a work for transporting the product 332a by using the vehicle 325.

[0023] The expression "data associated with a real factory" used in the specification means data gathered from the real factory 1000. The data associated with the real factory may include data that are measured or observed (or monitored) from the facilities 311, 312, and 313, the vehicle 325, the products 331a, 332a, 333a, and 334a, the transport containers 331, 332, 333, and 334, and the workers 341 and 342.

[0024] The expression "situation of a real factory" used in the specification means a "structure of a real factory" and a "progress situation of a work being performed in a real factory". The structure of the real factory means locations of the facilities 311, 312, and 313, the vehicle 325, the transport containers 331, 332, 333, and 334, and the workers 341 and 342 in the real factory 1000. The progress situation of the work being performed in the real factory means whether the facilities 311, 312, and 313 normally operate, how much products are produced, and the like.

[0025] The present disclosure may gather data associated with the real factory 1000 from the real factory 1000 and builds a virtual factory, to which a situation of the real factory 1000 is reflected, by using the data associated with the real factory 1000. Also, the present disclosure may analyze a situation of the real factory 1000 by using the data associated with the real factory 1000.

[0026] The present disclosure may display a two-dimensional (2D) image and/or a three-dimensional (3D) image of an analysis result 2200, which is obtained by analyzing the situation of the real factory 1000, and a virtual factory 2100 in a display panel 2000. Accordingly, a user may manage the real factory 1000 with reference to the virtual factory 2100 and the analysis result 2200 displayed in the display panel 2000. With reference to the virtual factory 2100 and the analysis result 2200, the user may establish a producing plan capable of making productivity of the real factory 1000 high.

[0027] The real factory 1000, the virtual factory 2100, and the analysis result 2200 will be described in more detail with reference to FIGS. 2 to 13.

[0028] FIG. 2 is a block diagram illustrating a device and a system used to manage a real factory of FIG. 1.

[0029] A data gathering device 100 may include a data gathering device for equipment 110, a data gathering device for vehicle 120, a data gathering device for container 130, a data gathering device for worker 140, and a data gathering device for factory 150. The data gathering devices 110, 120, 130, 140 and 150 may gather data d01, d02, d03, d04, and d05 associated with the real factory 1000 from the real factory 1000. The data gathering devices 110, 120, 130, 140, and 150 and the data d01, d02, d03, d04, and d05 will be described in detail with reference to FIGS. 4 to 6.

[0030] The data gathering devices 110, 120, 130, 140, and 150 may respectively output the data d01, d02, d03, d04, and d05 to a middleware system 200 through interfaces 111, 121, 131, 141, and 151. Below, for better understanding of the present disclosure, the expression "that devices and modules output and/or receive data" may be used but may mean that real devices and modules output and/or receive signals including data.

[0031] In the present disclosure, a "module" may be implemented with a hardware circuit (e.g., an analog circuit and a logic circuit) configured to perform given and/or reconfigurable operations and functions. Alternatively, a "module" may be implemented by a program code of software configured to perform given and/or programmable operations and functions, and an instruction set of the program code may be executed by a processing device (e.g., a central processing unit (CPU) or a graphic processing unit (GPU)). In some cases, a "module" may be implemented in a hybrid form of hardware and software.

[0032] The middleware system 200 may include interfaces 210 and 230 and a data processing module 220. The data gathering device 100 and a computing system 300 may communicate with each other through the middleware system 200. The middleware system 200 may use a communication technology such as TCP/IP (Transmission Control Protocol/Internet Protocol), database access middleware, DCOM (Distributed Component Object Model), CORBA (Common Object Request Broker Architecture), Bluetooth, 3G, 4G, 5G, Wi-Fi (Wireless Fidelity), or the like.

[0033] The middleware system 200 may receive the data d01, d02, d03, d04, and d05 through the interface 210. The data processing module 220 may receive the data d01, d02, d03, d04, and d05 from the interface 210. The data processing module 220 may process the data d01, d02, d03, d04, and d05 to generate data d1.

[0034] The data d1 includes information for analyzing the real factory 1000. For example, the data d01 includes information about an image taken by the data gathering device for equipment 110. The data processing module 220 calculates a processing time taken to perform a work in the real factory 1000, by using the data d01. The data d1 may include information about a processing time. The data d01, d02, d03, d04, and d05 and the data d1 will be described in detail with reference to FIGS. 3 to 6.

[0035] As data are processed by the data processing module 220, the amount of data to be transmitted to the computing system 300 may decrease. This may mean that the amount of data to be processed by the computing system 300 decreases. The decrease in the amount of data to be processed by the computing system 300 may also improve a speed at which the computing system 300 processes data.

[0036] The data processing module 220 may output the data d1 to the interface 230. The middleware system 200 may output the data d1 to the computing system 300 through the interface 230.

[0037] The computing system 300 includes an interface 310, database 320, a modeling module 330, a virtual factory building module 340, a display device 350, and a data analysis module 360. In some embodiments, the computing system 300 may further include a processing (or computing) device configured to execute an instruction set of a program code for some operations and functions, which is implemented by software, and a memory for storing data to be used by the processing device. Some modules to be described below may be implemented by a program code and may be executed by the processing device.

[0038] The computing system 300 may receive the data d1 through the interface 310. The computing system 300 builds the virtual factory 2100, to which a situation of the real factory 1000 is reflected, by using the data d1 and analyzes the situation of the real factory 1000.

[0039] For example, the computing system 300 may be connected with the data gathering device 100 through a short range network or a long range network. The middleware system 200 may arbitrate communication between the data gathering device 100 and the computing system 300 on a network and may perform appropriate data processing for the computing system 300 by using the data processing module 220.

[0040] For example, the computing system 300 may be implemented within the real factory 1000 and may be directly accessed by the user present in the real factory 1000. Alternatively, all or a part of components of the computing system 300 may be separated from the real factory 1000 and may be remotely accessed by users present in the real factory 1000. The middleware system 200 may be separated from the computing system 300 and may be implemented inside or outside the real factory 1000.

[0041] For example, the computing system 300 may build the virtual factory 2100 that is driven in a cloud environment and may analyze a situation of the real factory 1000. For example, the computing system 300 may use AWS (Amazon Web Service), Microsoft Azure, or the like, or the computing system 300 may automatically build and use a cloud server or a web server. Accordingly, users may access the virtual factory 2100 through one or more servers and may check a result of analyzing a situation of the real factory 1000 by accessing the virtual factory 2100.

[0042] The display device 350 may display a 2D image and/or a 3D image of the analysis result 2200, which is obtained by analyzing the situation of the real factory 1000, and the virtual factory 2100 in the display panel 2000 as illustrated in FIG. 1.

[0043] The database 320 may store data such as a location and a size of each facility, the number of workers, and kinds of processes to be performed in a factory. The database 320 may store data that are input in advance by the user. For example, to build a virtual factory, the user may input data to the database 320 before operating a computing system. For another example, before the data gathering device 100 gathers the data d01, d02, d03, d04, and d05 from the real factory 1000, the user may input data to the database 320.

[0044] Also, the database 320 may store data indicating a situation of the real factory 1000. For example, the database 320 may receive data d2 from the interface 310 and may store the data d2.

[0045] The modeling module 330 may generate modeling data by using data stored in the database 320. For example, the modeling module 330 may include a 2D, 3D modeling program and QUEST, such as Auto CAD, 3D MAX, or Pro-E, a simulation program such as eM-Plant or ARENA, or the like.

[0046] The modeling module 330 may generate modeling data associated with facilities, vehicles, products, workers, processes, and factories by using 3D computer aided design (CAD) information of facilities, vehicles, products, and workers. The modeling data may include information for displaying a configuration corresponding to the modeling data in the display panel 2000 in the shape of a 2D and/or 3D model. For example, the computing system 300 may display a 2D and/or 3D facility model in the display panel 2000 by using the facility modeling data. The database 320 may store the generated modeling data.

[0047] The virtual factory building module 340 may receive the data d2 from the interface 310. The data d2 may include a part of information included in the data d1. For example, the data d2 may include information about a size and a location of each facility, speeds of vehicles, speeds of transport containers, the number of workers, and the number and kinds of processes.

[0048] The virtual factory building module 340 builds the virtual factory 2100, to which a situation of the real factory 1000 is reflected, by using the data d2. The virtual factory building module 340 detects modeling data corresponding to the data d2 from the database 320. The case where the database 320 generates modeling data in real time by using the data d2 will be described in detail with reference to FIG. 13.

[0049] The virtual factory building module 340 may generate data d3 by using the data d2 and the modeling data. The data d3 may include information about the virtual factory 2100 to which a situation of the real factory 1000 is reflected. The virtual factory building module 340 may output the data d3 to the display device 350.

[0050] The display device 350 may receive the data d3. The display device 350 may display a 2D image and/or a 3D image of the virtual factory 2100 in the display panel 2000 by using the data d3 as illustrated in FIG. 1.

[0051] The data analysis module 360 may receive data d4 from the interface 310. The data d4 may include a part of information included in the data d1. For example, the data d4 may include information about a processing time, a mean time to repair (MTTR), and a mean time between failures (MTBF).

[0052] The data analysis module 360 may generate data d5 by using the data d4. The data d5 may include information about a result of analyzing a current situation of the real factory 1000 and/or a result of predicting a future situation of the real factory 1000. The data analysis module 360 may output the data d5 to the display device 350.

[0053] The display device 350 may receive the data d5. The display device 350 may display the current situation of the real factory 1000 and/or the analysis result 2200 of analyzing and predicting the future situation of the real factory 1000 in the display panel 2000 by using the data d5 as illustrated in FIG. 1.

[0054] FIG. 3 is a conceptual diagram for describing an operation of a data processing module of FIG. 2.

[0055] The data processing module 220 may generate the data d1 by using the data d01, d02, d03, d04, and d05. The data processing module 220 may generate the data d1 by processing a part of information included in the data d01, d02, d03, d04, and d05. Accordingly, the data d0 may include the same information as the part of the information included in the data d01, d02, d03, d04, and d05 or may include information obtained by converting the part of the information included in the data d01, d02, d03, d04, and d05. FIG. 3 will be described together with FIGS. 4 to 6.

[0056] FIG. 4 is a conceptual diagram illustrating a data gathering device gathering data from a real factory of FIG. 1.

[0057] The data gathering device 100 may include the data gathering device for equipment 110, the data gathering device for vehicle 120, the data gathering device for container 130, the data gathering device for worker 140, and the data gathering device for factory 150.

[0058] The data gathering device for vehicle 120, the data gathering device for container 130, and the data gathering device for worker 140 may include a variety of sensors. The data gathering device for vehicle 120, the data gathering device for container 130, and the data gathering device for worker 140 may be attached to the vehicle 325, the transport containers 331, 332, 333, and 334, and the workers 341 and 342 by using a magnet or an adhesive material. The data gathering device for vehicle 120, the data gathering device for container 130, and the data gathering device for worker 140 may operate based on a power supplied from an external power source or based on powers supplied from batteries respectively included in the data gathering device for vehicle 120, the data gathering device for container 130, and the data gathering device for worker 140.

[0059] The data gathering device for vehicle 120 may gather the data d02 associated with a location, a speed, acceleration, and a movement direction of the vehicle 325, and the intensity of a noise, the intensity of vibration, a temperature, illuminance, and humidity of a place where the vehicle 325 is located, through the sensors.

[0060] The data gathering device for container 130 may gather the data d03 associated with a location of each of the transport containers 331, 332, 333, and 334, and the intensity of a noise, the intensity of vibration, a temperature, illuminance, and humidity of each of places where the transport containers 331, 332, 333, and 334 are located, through the sensors.

[0061] The data gathering device for worker 140 may gather the data d04 associated with a blood pressure and a body temperature of each of the workers 341 and 342, a location of each of the workers 341 and 342, and the intensity of a noise, the intensity of vibration, a temperature, illuminance, and humidity of each of places where the workers 341 and 342 are located, through the sensors.

[0062] Referring to FIG. 3, the data processing module 220 may calculate the number of workers 341 and 342 by using information about blood pressures of the workers 341 and 342. The data d1 may include information about the number of workers 341 and 342, and may include information about speeds of the vehicle 325 and the transport containers 331, 332, 333, and 334.

[0063] The data gathering device for equipment 110 may include a plurality of monitoring devices 110a and 110b. The monitoring devices 110a and 110b may monitor a part of the facilities 311 and 313 from the outside of the facilities 311 and 313. The facilities 311 and 313 may be used to perform a process. The facilities 311 and 313 may be used to perform one work included in the process. The monitoring devices 110a and 110b may be installed in the real factory 1000 and components included in the real factory 1000 for the purpose of monitoring a part of the facilities 311 and 313. For example, the monitoring devices 110a and 110b may be installed in the facilities 311 and 313, respectively. For another example, the data gathering device for equipment 110 may be installed in a surrounding area adjacent to facilities. The case where the data gathering device for equipment 110 is installed in a surrounding area adjacent to facilities will be described in detail with reference to FIG. 7.

[0064] For example, the monitoring devices 110a and 110b may monitor a part of the facilities 311 and 313 and/or one work of a process by taking a part of the facility 311 and a part of the facility 313, respectively. In this case, the monitoring devices 110a and 110b may be a photographing device such as a digital camera.

[0065] For another example, in the case where products are located at a part of the facility 311 and a part of the facility 313, the monitoring devices 110a and 110b may monitor a part of each of the facilities 311 and 313 and/or one work of a process by monitoring the product. In this case, the monitoring devices 110a and 110b may be a sensor capable of recognizing an object, such as a depth sensor or a vision sensor.

[0066] The monitoring devices 110a and 110b may recognize the data gathering device for container 130 and/or the product 331a. In the case where the product 331a is at a location P1, the monitoring device 110a recognizes the data gathering device for container 130 attached to the transport container 331 and/or the product 331a. In the case of recognizing that the product 331a is at the location P1, the monitoring device 110a outputs a signal. For example, the signal includes information indicating that the product 331a is detected at the location P1. For another example, the signal includes information about an image taken by the monitoring device 110a when the product 331a is at the location P1.

[0067] In the case where the product 331a moves from the location P1 and is then located at a location P2, the monitoring device 110b may recognize the data gathering device for container 130 attached to the transport container 331 and/or the product 331a. In the case where the product 331a is at the location P2, the monitoring device 110b outputs a signal. For example, the signal includes information indicating that the product 331a is detected at the location P2. For another example, the signal includes information about an image taken by the monitoring device 110a when the product 331a is at the location P2.

[0068] Each of the signals output from the monitoring devices 110a and 110b includes time information about a time when the corresponding signal is output. The data processing module 220 calculates a time difference between a time at which the signal is output by the monitoring device 110a and a time at which the signal is output by the monitoring device 110b, by using the time information included in the signals. Accordingly, the data processing module 220 may calculate a time taken for the product 331a to move from the location P1 to the location P2.

[0069] However, the present disclosure is not limited thereto. For example, each of the monitoring devices 110a and 110b may continuously take the locations P1 and P2. Each of the monitoring devices 110a and 110b transmits a signal, which includes information about images obtained by taking the locations P1 and P2, to the data processing module 220 in real time. The signal includes information about times at which the images are taken. The data processing module 220 may process the signal to obtain time information about times at which the product 331a is taken at the locations P1 and P2.

[0070] The monitoring devices 110a and 110b may be installed at opposite ends of a facility, or may be installed at a start location and an end location of one process, which will be described in detail with reference to FIG. 6.

[0071] However, the present disclosure is not limited thereto. For example, the data gathering device for equipment 110 may include sensors. In this case, the sensors may be attached to the facilities 311, 312, and 313 to gather data associated with the intensity of a noise, the intensity of vibration, a temperature, illuminance, and humidity of each of places where the facilities 311, 312, and 313 are located.

[0072] The data gathering device for factory 150 may gather data associated with the whole structure of the real factory 1000 and the whole situation of the real factory 1000. The data gathering device for factory 150 may monitor the whole appearance of the real factory 1000. The data gathering device for factory 150 may be installed on an inner wall of the real factory 1000 to monitor the whole appearance of the real factory 1000. The data gathering device for factory 150 may be one of devices such as a digital camera, a depth camera, and a vision sensor.

[0073] The data processing module 220 may calculate a size and a location of each of the facilities 311, 312, and 313 by using an image taken by the data gathering device for factory 150 and/or a signal output from the data gathering device for factory 150. The data processing module 220 may calculate kinds, the number, and scales of processes by using the image taken by the data gathering device for factory 150 and/or the signal output from the data gathering device for factory 150.

[0074] FIG. 5 is a conceptual diagram illustrating an image taken by a data gathering device for factory of FIG. 4.

[0075] The data gathering device for factory 150 may take the whole appearance of the real factory 1000. An image 3000 taken by the data gathering device for factory 150 may include information about a structure of the real factory 1000 and the whole situation of the real factory 1000. For example, the image 3000 may include information about a size and a location of each of facilities 311, 312, 313, 314, and 315 and offices 351 and 352.

[0076] Referring to FIG. 3, the data processing module 220 may calculate the size and location of each of the facilities 311, 312, 313, 314, and 315 by using the image 3000. The data d1 may include information about the size and location of each of the facilities 311, 312, 313, 314, and 315, instead of the image 3000. The data processing module 220 may convert the information about the image 3000 into information about the size and the location of each of the facilities 311, 312, 313, 314, and 315 such that the amount of data d1 output from the data processing module 220 decreases.

[0077] FIG. 6 is a conceptual diagram illustrating an example method of gathering data by monitoring devices of FIG. 4.

[0078] The data gathering device for equipment 110 may monitor a part of the facilities 311, 312, 313, 314, and 315 by using monitoring devices 111a, 111b, 111c, and 111d. In the case where the facilities 311, 312, 313, 314, and 315 are used in one process, the data gathering device for equipment 110 may monitor one work of the process by using the monitoring devices 111a, 111b, 111c, and 111d. Referring to FIG. 3, the data processing module 220 may calculate a processing time, a mean time to repair (MTTR), and a mean time between failures (MTBF) by using a signal output from the data gathering device for equipment 110. The data processing module 220 may convert information included in the signal into information about the processing time, the mean time to repair, and the mean time between failures such that the amount of data d1 output from the data processing module 220 decreases.

[0079] The monitoring devices 111a and 111b may be installed at opposite ends P11 and P12 of the facility 311. While the transport container 331 moves from the location P11 to the location P12, the facility 311 may perform one work. The data processing module 220 may calculate a processing time taken for the facility 311 to perform a work, a mean time to repair of the facility 311, and a mean time between failures of the facility 311, by using signals output from the monitoring devices 111a and 111b.

[0080] The monitoring devices 111a and 111c may be respectively installed at ends P11 and P13 of the facilities 311 and 313 as described with reference to FIG. 4. While the transport container 331 moves from the location P11 to the location P13, the facilities 311, 312, and 313 may perform one work. The data processing module 220 may calculate a processing time taken for the facilities 311, 312, and 313 to perform a work, by using signals output from the monitoring devices 111a and 111c.

[0081] The monitoring devices 111a and 111d may be respectively installed at ends P11 and P14 of the facilities 311 and 315. While the transport container 331 moves from the location P11 to the location P14, the facilities 311 to 315 may perform one work. The data processing module 220 may calculate a processing time taken for the facilities 311 to 315 to perform a process, by using signals output from the monitoring devices 111a and 111d.

[0082] The data gathering device for equipment 110 may include a plurality of monitoring devices to monitor a product that moves over time. According to an embodiment of the present disclosure, a plurality of monitoring devices may be easily be attached or installed to or in facilities. Accordingly, even in the case where a facility incapable of automatically measuring a processing time is used in the real factory 1000, the present disclosure may easily gather data associated with a processing time of a facility by using a plurality of monitoring devices.

[0083] FIG. 7 is a conceptual diagram illustrating an example method of gathering data by monitoring devices of FIG. 4.

[0084] One process 1500a may be performed in a factory 1000a illustrated in FIG. 7. Facilities 311a to 314a and 311b to 314b, workers 343 and 344, and vehicles 326 and 327 may be required to perform the process 1500a. The process 1500a may include a series of works. The works may be performed by the facilities 311a to 314a and 311b to 314b. However, the present disclosure is not limited thereto. For example, a plurality of processes may be performed in the factory 1000a, and the process 1500a may be performed by one or more facilities, one or more workers, one or more vehicles, and one or more transport containers.

[0085] The data gathering device for equipment 110 may monitor a work, which is performed by the process 1500a and/or the facilities 311a to 314a and 311b to 314b, by using monitoring devices 111e, 111f, 111g, and 111h.

[0086] The process 1500a may start from the facility 311a and may be completed at the facility 314b. The facilities 311a and 314b may include a load device 319a and an unload device 319b, respectively. However, the present disclosure is not limited thereto. For example, the load device 319a and the unload device 319b may be devices independent of the facilities 311a and 314b. The load device 319a may be used to load the product 331a onto the facility 311a. The unload device 319b may be used to unload the product 331a from the facility 314b.

[0087] The monitoring devices 111e and 111f may monitor a start portion of the process 1500a and a complete portion of the process 1500a, respectively. In detail, the monitoring devices 111e and 111f may monitor the load device 319a and the unload device 319b, respectively. For example, the monitoring devices 111e and 111f may be installed in surrounding areas adjacent to the facilities 311a and 314b. For another example, the monitoring devices 111e and 111f may be installed in a surrounding areas adjacent to the load device 319a and a surrounding areas adjacent to the unload device 319b.

[0088] The data processing module 220 may calculate a tact time, a neck time, a cycle time of each process, and a net cycle time of each process, by using signals output from the monitoring devices 111e and 111f. The monitoring devices 111g and 111h may correspond to the monitoring devices 110a and 110b illustrated in FIG. 4. The monitoring devices 111g and 111h may be installed in surrounding areas adjacent to the facilities 311a and 311b. Below, the descriptions given above are omitted to avoid redundancy.

[0089] That is, the data gathering device for equipment 110 may gather data associated with process 1500a, as well as data associated with the facilities 311a to 314a and 311b to 314b. The present disclosure may obtain an analysis result of high reliability with respect to the process 1500a and the factory 1000a by gathering data associated with the process 1500a independently of the facilities 311a to 314a and 311b to 314b.

[0090] Also, direct installation in the facilities 311a to 314a and 311b to 314b and the devices 319a and 319b may be possible, and in addition, easy installation in surrounding areas adjacent to the facilities 311a to 314a and 311b to 314b and the devices 319a and 319b may be possible. Accordingly, even in the case where a part of the facilities 311a to 314a and 311b to 314b is under failure, highly reliable data associated with the facilities 311a to 314a and 311b to 314b and the process 1500a may be gathered.

[0091] FIG. 8 is a conceptual diagram for describing an operation of a virtual factory building module of FIG. 2. FIG. 9 is a conceptual diagram illustrating a virtual factory displayed in a display panel of FIG. 2. For better understanding, FIGS. 1, 8, and 9 will be referenced together.

[0092] Referring to FIG. 8, the virtual factory building module 340 may receive the data d2 from the interface 310. As described with reference to FIG. 2, the data d2 may include a part of information included in the data d1. The data d2 may include only information necessary to build the virtual factory 2100 from among the information included in the data d1. For example, the data d2 may include information about a size, a location, and a processing time of each facility, speeds of vehicles, speeds of transport containers, and the number of workers.

[0093] The virtual factory building module 340 may build the virtual factory 2100, to which a structure and a work situation of the real factory 1000 are reflected, by using the data d2. For example, the virtual factory building module 340 may build the virtual factory 2100 by disposing facility models at the virtual factory 2100 by using the information about the location of each facility included in the data d2.

[0094] The database 320 may store information about the data d2 and/or the built virtual factory 2100. The modeling module 330 may support visualization of the virtual factory 2100 based on the information stored in the database 320. Referring to FIG. 9, the display device 350 may provide the user with a visualized shape of the virtual factory 2100 through the display panel 2000.

[0095] FIG. 10 is a conceptual diagram for describing an operation of a data analysis module of FIG. 2. FIG. 11 is a conceptual diagram illustrating an analysis result of a real factory displayed in a display panel of FIG. 2. For better understanding, FIGS. 1, 10, and 11 will be referenced together.

[0096] Referring to FIG. 10, the data analysis module 360 may receive the data d4 from the interface 310. The data d4 may include a part of information included in the data d1. The data d4 may include only information necessary to analyze a current situation of the real factory 1000 and to predict a future situation of the real factory 1000 from among the information included in the data d1. For example, the data d4 may include information about a processing time, a mean time to repair, a mean time between failures, speeds of vehicles, speeds of transport containers, and the number of workers.

[0097] The data analysis module 360 may generate the data d5 by using the data d4. The data d5 may include information that is useful for the user to make a decision about a real factory.

[0098] For example, the data d5 may include information about primary KPIs (Key Performance Indicators) of a factory.

[0099] For another example, the data d5 may include information about a result of analyzing a current situation of the real factory 1000 and/or a result of predicting a future situation of the real factory 1000. Referring to FIG. 6, based on the signals output from the monitoring devices 111a and 111c, the data analysis module 360 analyzes a progress situation of a first work that is performed while the transport container 331 is moved from the location P11 to the location P13. After the first work starts, a second work starts from the facility 311. The second work may be performed by the facilities 311, 312, and 313. The data analysis module 360 predicts a progress situation of the second work based on the signals output from the monitoring devices 111a and 111c.

[0100] For another example, the data d5 may include information about the production of products, an operating state of a facility, a progress situation of a process, and the like. In detail, the data d5 may include information about a current lead time of a product, a predicted lead time of the product, a current production of the product, a predicted production of the product, a trend in production, a current stock of the product, a predicted stock of the product, a trend in product inventory, a tact time, a neck time, a cycle time for each process, a net cycle time for each process, a current capacity for each process, a predicted capacity for each process, a current work-in-process stock for each process, a predicted work-in-process stock of each process, a current capacity of each facility, predicted operation, congestion, waiting, and failure of each facility, current capacity of each transport device, predicted operation, congestion, waiting, and failure of each transport device, a congestion interval of a current process, and strength of each neck process.

[0101] The information included in the data d5 may be displayed in the display panel 2000. Referring to FIG. 11, the display device 350 may display a current situation of the real factory 1000 and the analysis result 2200 of a future situation of the real factory 1000 through the display panel 2000 in the shape of a graph or a chart. For example, the analysis result 2200 may display current production, predicted production of the real factory 1000, a current capacity of a facility, and a predicted capacity of a facility.

[0102] The user may grasp a current situation and a predicted situation of the real factory 1000 with reference to the analysis result 2200 displayed in the display panel 2000. With reference to the analysis result 2200, the user may establish a producing plan capable of optimally maintaining the real factory 1000.

[0103] FIG. 12 is a flowchart for describing a method of displaying a virtual factory and an analysis result of a situation of a real factory in a display panel of FIG. 2. For better understanding, FIG. 2 will be referenced together.

[0104] In operation S410, the data gathering device 100 may gather the data d01, d02, d03, d04, and d05 associated with the real factory 1000.

[0105] In operation S420, the data gathering device 100 may transmit the gathered data d01, d02, d03, d04, and d05 to the middleware system 200.

[0106] In operation S430, the middleware system 200 may receive the gathered data d01, d02, d03, d04, and d05. The middleware system 200 may generate the data d1 by processing the gathered data d01, d02, d03, d04, and d05 through the data processing module 220.

[0107] In operation S440, the middleware system 200 may transmit the data d1 to the computing system 300. The computing system 300 may receive the data d1.

[0108] In operation S450, the virtual factory building module 340 may receive the data d2. The virtual factory building module 340 may generate the data d3 by using the data d2. The data d3 may include information about a virtual factory. The virtual factory building module 340 may output the data d3 to the display device 350. Operation S450 will be described in detail with reference to FIG. 13.

[0109] In operation S460, the data analysis module 360 may receive the data d4. The data analysis module 360 may generate the data d5 by using the data d4. The data d5 may include information about a result of analyzing a situation of a real factory. The data analysis module 360 may output the data d5 to the display device 350.

[0110] In operation S470, the display device 350 may receive the data d3 and the data d5. The display device 350 may display a 2D image and/or a 3D image of the virtual factory 2100 and the analysis result 2200 of the situation of the real factory 1000 in the display panel 2000 by using the data d3 and d5.

[0111] FIG. 13 is a flowchart for describing a method of building a virtual factory at a virtual factory building module of FIG. 2. Operation S515 to operation S560 illustrated in FIG. 13 correspond to operation S450 described with reference to FIG. 12.

[0112] In operation S510, the interface 310 may receive the data d1 from the middleware system 200.

[0113] In operation S515, the interface 310 may transmit the data d2 to the virtual factory building module 340 based on the received data d1.

[0114] In operation S520, the interface 310 may transmit the data d2 to the database 320.

[0115] In operation S525, the database 320 may store the data d2.

[0116] In operation S530, the database 320 may transmit the data d2 to the modeling module 330.

[0117] In operation S535, the modeling module 330 may generate modeling data corresponding to the data d2 by using the data d2.

[0118] In operation S540, the modeling module 330 may transmit the modeling data to the database 320.

[0119] In operation S545, the database 320 stores the modeling data. The database 320 may store information about a correspondence relationship between the modeling data and the data d2. Through operation S525 to operation S545, the database 320 may store the modeling data, the data d2, and the information about the correspondence relationship between the modeling data and the data d2. When the modeling data, the data d2, and the information about the correspondence relationship between the modeling data and the data d2 are stored in the database 320, the virtual factory building module 340 may detect the modeling data corresponding to the data d2 from the database 320.

[0120] In operation S550, the database 320 may transmit the modeling data to the virtual factory building module 340.

[0121] In operation S555, the virtual factory building module 340 may generate the data d3 by using the data d2 and the modeling data. The data d3 may include information about the virtual factory 2100 to which a situation of the real factory 1000 is reflected.

[0122] In operation S560, the virtual factory building module 340 may transmit the data d3 to the display device 350.

[0123] In operation S565, the display device 350 may output a visualized shape of the virtual factory 2100 through the display panel 2000 based on the data d3.

[0124] The above description refers to detailed embodiments for carrying out the present disclosure.

[0125] As well as the embodiments described above, embodiments in which a design is changed simply or which are easily changed may be included in the present disclosure.

[0126] In addition, technologies that may be easily changed and carried out by using the embodiments of the present disclosure may be included.

Claims

1. A computing system for building a virtual factory (2100), comprising:

    a database (320) configured to store modeling data;
    a data analysis module (360); and
    a virtual factory building module (340), wherein the virtual factory building module (340) is configured to:
    build the virtual factory (2100) in which a progress situation of a first work performed from a first portion (P1) to a second portion (P2) is displayed, based on the modeling data and a time difference between an output time of a first signal and an output time of a second signal, which is calculated based on:

        the first signal output when a product (331) is at the first portion (P1) on one or more facilities (311, 312, 313, 314, 315) monitored from a first location outside of the one or more facilities (311, 312, 313, 314, 315) used in a real factory (1000), wherein the first signal is output from a first monitoring device configured to recognize the product and wherein the first signal includes information about an image of the first portion (P1) taken from the first location when the product (331) is at the first portion (P1), and the second signal output when the product (331) is at the second portion (P2) on the one or more facilities (311, 312, 313, 314, 315) monitored from a second location outside of the one or more facilities (311, 312, 313, 314, 315), wherein the second signal is output from a second monitoring device configured to recognize the product and wherein the second signal includes information about an image of the second portion (P2) taken from the second location when the product (331) is at the second portion (P2),

    wherein the first location is spaced from the second location,
    wherein the first portion (P1) is spaced from the second portion (P2);
    wherein the data analysis module (360) is configured to analyze the progress situation of the first work based on the time difference; and
    wherein the computer system is characterized to predict a progress situation of a second work based on the time difference, wherein the second work is performed from the first portion (P1) to the second portion (P2) after the first work is performed.

2. The computing system of claim 1, wherein the virtual factory building module (340) is configured to build the virtual factory (2100) to which a situation of the real factory (1000) is reflected, based on data gathered from the real factory (1000) and the modeling data.

3. A method of using a computing system to analyze a situation of a real factory (1000) to build a virtual factory (2100) in which a progress situation of a work performed from a first portion (P1) to a second portion (P2) is displayed, the method comprising:

    when a product (331) is at the first portion (P1) on one or more facilities (311, 312, 313, 314, 315) used to produce the product (331) in the real factory (1000), outputting a first signal by a first monitoring device (110, 111) monitoring the first portion (P1) from a first location outside of the one or more facilities (311, 312, 313, 314, 315), wherein the first signal includes information about an image of the first portion (P1) taken from the first location when the product (331) is at the first portion (P1), wherein the first signal is from a first monitoring device configured to recognize the product;
    when the product is at the second portion (P2) on the one or more facilities (311, 312, 313, 314, 315) different from the first portion (P1), output-

ting a second signal by a second monitoring device (110, 111) monitoring the second portion (P2) from a second location outside of the one or more facilities (311, 312, 313, 314, 315), wherein the second signal includes information about an image of the second portion (P2) taken from the second location when the product (331) is at the second portion (P2), wherein the second signal is from a second monitoring device configured to recognize the product;
calculating a time difference between a time when the product (331) is at the first portion (P1) and a time by a data processing module, when the product (331) is at the second portion (P2), based on the first signal and the second signal;
analyzing a progress situation of a first work performed from the first portion (P1) to the second portion (P2) based on the time difference by the computing system; and
the method being **characterized by** predicting a progress situation of a second work based on the time difference by the computing system, wherein the second work is performed from the first portion (P1) to the second portion (P2) after the first work is performed.

4. The method of claim 3, further comprising: when the first portion (P1) and the second portion (P2) is at one facility (311, 312, 313, 314, 315) of the one or more facilities (311, 312, 313, 314, 315), analyzing an operation state of the one facility (311, 312, 313, 314, 315) based on the time difference by the computing system.

5. The method of claim 4, wherein the time difference is a processing time of the one facility (311, 312, 313, 314, 315),
further comprising:

calculating a mean time to repair, MTTR, and a mean time between failures, MTBF, of the one facility (311, 312, 313, 314, 315) based on the processing time by the computing system,
wherein the analyzing of the operation state of the one facility (311, 312, 313, 314, 315) includes analyzing the operation state of the one facility (311, 312, 313, 314, 315) based on the processing time, the mean time to repair, and the mean time between failures by the computing system.

6. The method of claim 3, further comprising: when the product (331) is produced through a process, wherein a process is a series of works that are performed to produce one product, which starts from a first facility (311, 312, 313, 314, 315) of the one or more facilities (311, 312, 313, 314, 315) and is completed at a second facility (311, 312, 313, 314, 315) of the one or more facilities (311, 312, 313, 314, 315), when the first portion (P1) is on the first facility (311, 312, 313, 314, 315), and when the second portion (P2) is on the second facility (311, 312, 313, 314, 315), analyzing the progress situation of the process based on the time difference by the computing system.

Patentansprüche

1. Rechensystem zum Bau einer virtuellen Fabrik (2100), Folgendes umfassend:

eine Datenbank (320), die konfiguriert ist, um Modellierungsdaten zu speichern;
ein Datenanalysemodul (360); und
ein virtuelles Fabrikbaumodul (340), wobei das virtuelle Fabrikbaumodul (340) zu Folgendem konfiguriert ist:
Bauen der virtuellen Fabrik (2100), wobei eine Fortschrittssituation einer ersten Arbeit, die von einem ersten Abschnitt (P1) bis zu einem zweiten Abschnitt (P2) durchgeführt wird, angezeigt wird, auf der Grundlage der Modellierungsdaten und einer zeitlichen Differenz zwischen einer Ausgabezeit eines ersten Signals und einer Ausgabezeit eines zweiten Signals, der auf der Grundlage von Folgendem berechnet wird:

der ersten Signalausgabe, wenn sich ein Produkt (331) an dem ersten Abschnitt (P1) an einer oder mehreren Anlagen (311, 312, 313, 314, 315) befindet, die von einer ersten Position außerhalb der einen oder der mehreren Anlagen (311, 312, 313, 314, 315) überwacht werden, die in einer realen Fabrik (1000) verwendet werden, wobei das erste Signal von einer ersten Überwachungsvorrichtung ausgegeben wird, die konfiguriert ist, um das Produkt zu erkennen, und wobei das erste Signal Informationen über ein Bild des ersten Abschnitts (P1) einschließt, das von der ersten Position aufgenommen wurde, wenn sich das Produkt (331) an dem ersten Abschnitt (P1) befindet, und
der zweiten Signalausgabe, wenn sich das Produkt (331) an dem zweiten Abschnitt (P2) an der einen oder den mehreren Anlagen (311, 312, 313, 314, 315) befindet, die von einer zweiten Position außerhalb der einen oder der mehreren Anlagen (311, 312, 313, 314, 315) überwacht werden, wobei das zweite Signal von einer zweiten Überwachungsvorrichtung ausgegeben wird, die konfiguriert ist, um das Produkt zu erkennen, und wobei das zweite Signal In-

formationen über ein Bild des zweiten Abschnitts (P2) einschließt, das von der zweiten Position aufgenommen wurde, wenn sich das Produkt (331) an dem zweiten Abschnitt (P2) befindet,
wobei die erste Position von der zweiten Position beabstandet ist,
wobei der erste Abschnitt (P1) von dem zweiten Abschnitt (P2) beabstandet ist,
wobei das Datenanalysemodul (360) konfiguriert ist, um die Fortschrittssituation der ersten Arbeit auf der Grundlage der zeitlichen Differenz zu analysieren; und
wobei das Computersystem **dadurch gekennzeichnet ist, dass** es eine Fortschrittssituation einer zweiten Arbeit auf der Grundlage der zeitlichen Differenz vorhersagt, wobei die zweite Arbeit von dem ersten Abschnitt (P1) bis zu dem zweiten Abschnitt (P2) durchgeführt wird, nachdem die erste Arbeit durchgeführt wurde.

2. Rechensystem nach Anspruch 1, wobei das Modul (340) zum Bau der virtuellen Fabrik konfiguriert ist, um die virtuelle Fabrik (2100) zu bauen, auf die eine Situation der realen Fabrik (1000) reflektiert wird, auf der Grundlage von Daten, die von der realen Fabrik (1000) gesammelt wurden, und den Modellierungsdaten.

3. Verfahren zum Verwenden eines Rechensystems zum Analysieren einer Situation einer realen Fabrik (1000), um eine virtuelle Fabrik (2100) zu bauen, wobei eine Fortschrittssituation einer durchgeführten Arbeit von einem ersten Abschnitt (P1) bis zu einem zweiten Abschnitt (P2) angezeigt wird, wobei das Verfahren Folgendes umfasst:

wenn sich ein Produkt (331) an dem ersten Abschnitt (P1) an einer oder mehreren Anlagen (311, 312, 313, 314, 315) befindet, die zur Herstellung des Produkts (331) in der realen Fabrik (1000) verwendet werden, Ausgeben eines ersten Signals durch eine erste Überwachungsvorrichtung (110, 111), die den ersten Abschnitt (P1) von einer ersten Position außerhalb der einen oder der mehreren Anlagen (311, 312, 313, 314, 315) überwacht, wobei das erste Signal Informationen über ein Bild des ersten Abschnitts (P1) einschließt, das von der ersten Position aufgenommen wurde, wenn sich das Produkt (331) an dem ersten Abschnitt (P1) befindet, wobei das erste Signal von einer ersten Überwachungsvorrichtung stammt, die konfiguriert ist, um das Produkt zu erkennen,
wenn sich das Produkt an dem zweiten Abschnitt (P2) in der einen oder den mehreren Anlagen (311, 312, 313, 314, 315) befindet, die sich von dem ersten Abschnitt (P1) unterscheiden, Ausgeben eines zweiten Signals durch eine zweite Überwachungsvorrichtung (110, 111), die den zweiten Abschnitt (P2) von einer zweiten Position außerhalb der einen oder der mehreren Anlagen (311, 312, 313, 314, 315) überwacht, wobei das zweite Signal Informationen über ein Bild des zweiten Abschnitts (P2) einschließt, das von der zweiten Position aufgenommen wurde, wenn sich das Produkt (331) an dem zweiten Abschnitt (P2) befindet, wobei das zweite Signal von einer zweiten Überwachungsvorrichtung stammt, die konfiguriert ist, das Produkt zu erkennen,
Berechnen einer zeitlichen Differenz zwischen einem Zeitpunkt, an dem sich das Produkt (331) an dem ersten Abschnitt (P1) befindet, und einem Zeitpunkt durch ein Datenverarbeitungsmodul, an dem sich das Produkt (331) an dem zweiten Abschnitt (P2) befindet, auf der Grundlage des ersten Signals und des zweiten Signals,
Analysieren einer Fortschrittssituation einer ersten Arbeit, die von dem ersten Abschnitt (P1) bis zu dem zweiten Abschnitt (P2) durchgeführt wird, auf der Grundlage der zeitlichen Differenz durch das Rechensystem; und
wobei das Verfahren **gekennzeichnet ist durch** Vorhersagen einer Fortschrittssituation einer zweiten Arbeit auf der Grundlage der zeitlichen Differenz durch das Rechensystem, wobei die zweite Arbeit von dem ersten Abschnitt (P1) bis zu dem zweiten Abschnitt (P2) durchgeführt wird, nachdem die erste Arbeit durchgeführt wurde.

4. Verfahren nach Anspruch 3, ferner Folgendes umfassend:
wenn sich der erste Abschnitt (P1) und der zweite Abschnitt (P2) an einer Anlage (311, 312, 313, 314, 315) der einen oder mehreren Anlagen (311, 312, 313, 314, 315) befinden, Analysieren eines Betriebszustands der einen Anlage (311, 312, 313, 314, 315) auf der Grundlage der zeitlichen Differenz durch das Rechensystem.

5. Verfahren nach Anspruch 4, wobei die zeitliche Differenz eine Verarbeitungszeit der einen Anlage (311, 312, 313, 314, 315) ist, ferner Folgendes umfassend:

Berechnen einer mittleren Zeit bis zur Reparatur, MTTR, und einer mittleren Zeit zwischen Ausfällen, MTBF, der einen Anlage (311, 312, 313, 314, 315) auf der Grundlage der Verarbeitungszeit, durch das Rechensystem,
wobei das Analysieren des Betriebszustands der einen Anlage (311, 312, 313, 314, 315) das

Analysieren des Betriebszustands der einen Anlage (311, 312, 313, 314, 315) auf der Grundlage der Verarbeitungszeit, der mittleren Zeit bis zur Reparatur und der mittleren Zeit zwischen Ausfällen, durch das Rechensystem einschließt.

6. Verfahren nach Anspruch 3, ferner Folgendes umfassend:
wenn das Produkt (331) durch einen Vorgang hergestellt wird, wobei ein Vorgang eine Reihe von Arbeiten ist, die durchgeführt werden, um ein Produkt herzustellen, der von einer ersten Anlage (311, 312, 313, 314, 315) der einen oder der mehreren Anlagen (311, 312, 313, 314, 315) startet und in einer zweiten Anlage (311, 312, 313, 314, 315) der einen oder der mehreren Anlagen (311, 312, 313, 314, 315) abgeschlossen wird, wenn sich der erste Abschnitt (P1) an der ersten Anlage (311, 312, 313, 314, 315) befindet, und wenn sich der zweite Abschnitt (P2) an der zweiten Anlage (311, 312, 313, 314, 315) befindet, Analysieren der Fortschrittssituation des Vorgangs auf der Grundlage der zeitlichen Differenz durch das Rechensystem.

Revendications

1. Système informatique permettant de construire une usine virtuelle (2100), comprenant :

une base de données (320) configurée pour stocker des données de modélisation ;
un module d'analyse de données (360) ; et
un module de construction d'usine virtuelle (340), dans lequel le module de construction d'usine virtuelle (340) est configuré pour :
construire l'usine virtuelle (2100) dans laquelle une situation de progression d'un premier travail réalisé d'une première partie (P1) à une deuxième partie (P2) est affichée, sur la base des données de modélisation et d'une différence temporelle entre un temps de sortie d'un premier signal et un temps de sortie d'un deuxième signal, qui est calculé sur la base de :

la première émission de signal lorsqu'un produit (331) est au niveau de la première partie (P1) sur une ou plusieurs installations (311, 312, 313, 314, 315) surveillées à partir d'un premier emplacement en dehors des une ou plusieurs installations (311, 312, 313, 314, 315) utilisées dans une usine réelle (1000), dans lequel le premier signal est émis à partir d'un premier dispositif de surveillance configuré pour reconnaître le produit et dans lequel le premier signal inclut des informations concernant une image de la première partie (P1) prise à partir du premier emplacement lorsque le produit (331) est au niveau de la première partie (P1), et la deuxième émission de signal lorsque le produit (331) est au niveau de la deuxième partie (P2) sur les une ou plusieurs installations (311, 312, 313, 314, 315) surveillées à partir d'un deuxième emplacement en dehors des une ou plusieurs installations (311, 312, 313, 314, 315), dans lequel le deuxième signal est émis à partir d'un deuxième dispositif de surveillance configuré pour reconnaître le produit et dans lequel le signal inclut des informations concernant une image de la deuxième partie (P2) prises à partir du deuxième emplacement lorsque le produit (331) est au niveau de la deuxième partie (P2),

dans lequel le premier emplacement est espacé du deuxième emplacement,
dans lequel la première partie (P1) est espacée de la deuxième partie (P2) ;
dans lequel le module d'analyse de données (360) est configuré pour analyser la situation de progression du premier travail sur la base de la différence temporelle ; et
dans lequel le système informatique est caractérisé pour prédire une situation de progression d'un deuxième travail sur la base de la différence temporelle, dans lequel le deuxième travail est réalisé de la première partie (P1) à la deuxième partie (P2) après la réalisation du premier travail.

2. Système informatique selon la revendication 1, dans lequel le module de construction de l'usine virtuelle (340) est configuré pour construire l'usine virtuelle (2100) sur laquelle une situation de l'usine réelle (1000) est reflétée, sur la base de données récoltées de l'usine réelle (1000) et des données de modélisation.

3. Procédé d'utilisation d'un système informatique pour analyser une situation d'une usine réelle (1000) pour construire une usine virtuelle (2100) dans lequel une situation de progression d'un travail réalisé d'une première partie (P1) à une deuxième partie (P2) est affichée, le procédé comprenant :

lorsqu'un produit (331) est au niveau de la première partie (P1) sur une ou plusieurs installations (311, 312, 313, 314, 315) utilisées pour produire le produit (331) dans l'usine réelle (1000), l'émission d'un premier signal par un premier dispositif de surveillance (110, 111) surveillant la première partie (P1) d'un premier emplacement en dehors de la ou des installations (311, 312, 313, 314, 315), dans lequel le premier signal inclut des informations concernant une image de la première partie (P1) prise à partir du premier emplacement lorsque le produit (331) est au niveau de la première partie (P1), dans lequel le premier signal provient d'un premier dispositif de surveillance configuré pour reconnaître le produit ;

lorsque le produit est au niveau de la deuxième partie (P2) sur la ou les installations (311, 312, 313, 314, 315) différente de la première partie (P1), l'émission d'un deuxième signal par un deuxième dispositif de surveillance (110, 111) surveillant la deuxième partie (P2) depuis un deuxième emplacement en dehors de la ou des installations (311, 312, 313, 314, 315), dans lequel le deuxième signal inclut des informations concernant une image de la deuxième partie (P2) prise à partir du deuxième emplacement quand le produit (331) est au niveau de la deuxième partie (P2), dans lequel le deuxième signal provient d'un deuxième dispositif de surveillance configuré pour reconnaître le produit ;

le calcul d'une différence temporelle entre un moment où le produit (331) est au niveau de la première partie (P1) et un moment par un module de traitement de données, quand le produit (331) est au niveau de la deuxième partie (P2) sur la base du premier signal et du deuxième signal ;

l'analyse d'une situation de progression d'un premier travail réalisé de la première partie (P1) à la deuxième partie (P2) sur la base de la différence temporelle par le système informatique ; et

le procédé étant **caractérisé par** la prédiction d'une situation de progression d'un deuxième travail sur la base de la différence temporelle par le système informatique, dans lequel le deuxième travail est réalisé de la première partie (P1) à la deuxième partie (P2) une fois que le premier travail est réalisé.

4. Procédé selon la revendication 3, comprenant en outre :
lorsque la première partie (P1) et la deuxième partie (P2) sont au niveau d'une installation (311, 312, 313, 314, 315) des une ou plusieurs installations (311, 312, 313, 314, 315), l'analyse d'un état de fonctionnement de l'une installation (311, 312, 313, 314, 315) sur la base de la différence temporelle par le système informatique.

5. Procédé selon la revendication 4, dans lequel la différence temporelle est un temps de traitement de l'une installation (311, 312, 313, 314, 315), comprenant en outre :

le calcul d'un temps moyen de réparation, MTTR, et d'un temps moyen entre les pannes, MTBF, de l'une installation (311, 312, 313, 314, 315) sur la base du temps de traitement, par le système informatique,

dans lequel l'analyse de l'état de fonctionnement de l'une installation (311, 312, 313, 314, 315) inclut l'analyse de l'état de fonctionnement de l'une installation (311, 312, 313, 314, 315) sur la base du temps de traitement, du temps moyen de réparation et du temps moyen entre les pannes par le système informatique.

6. Procédé selon la revendication 3, comprenant en outre :
lorsque le produit (331) est produit par le biais d'un procédé, dans lequel un procédé est une série de travaux qui sont réalisés pour produire un produit, qui débute depuis une première installation (311, 312, 313, 314, 315) des une ou plusieurs installations (311, 312, 313, 314, 315) et s'achève au niveau d'une deuxième installation (311, 312, 313, 314, 315) des une ou plusieurs installations (311, 312, 313, 314, 315), quand la première partie (P1) est sur la première installation (311, 312, 313, 314, 315), et quand la deuxième partie (P2) est sur la deuxième installation (311, 312, 313, 314, 315), l'analyse de la situation de progression du procédé sur la base de la différence temporelle par le système informatique.

FIG. 1

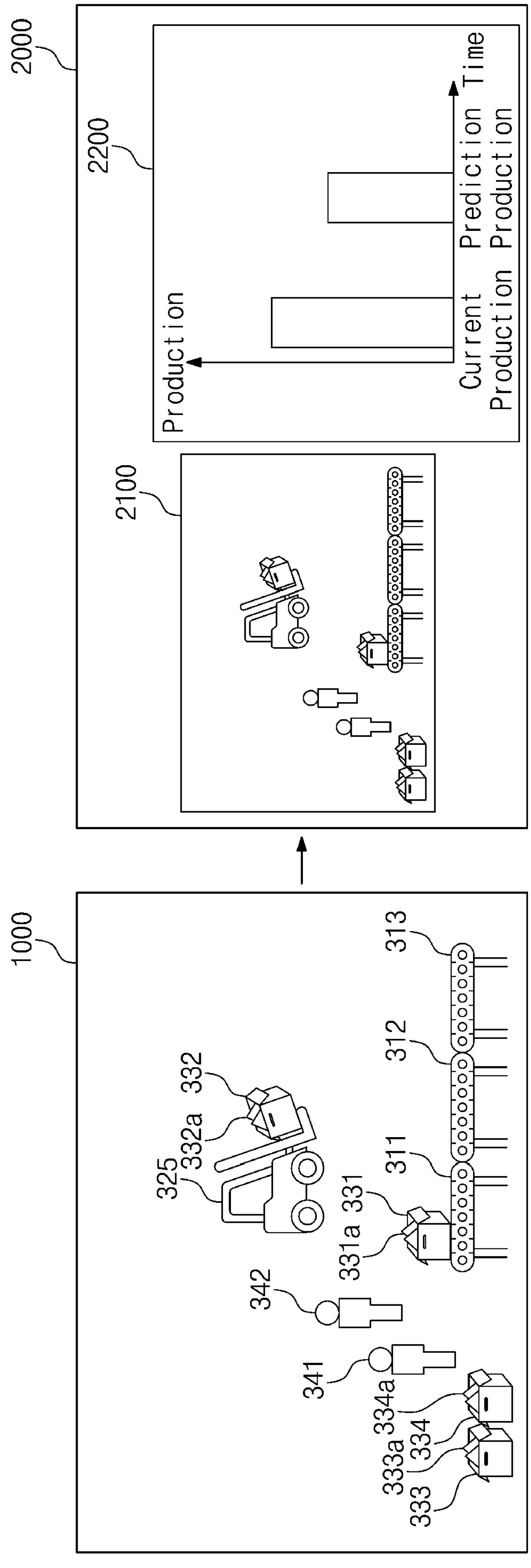

1000
2000
2100
2200
Production
Time
Current Production
Prediction Production
311
312
313
325
331
331a
332
332a
333
333a
334
334a
341
342

FIG. 2

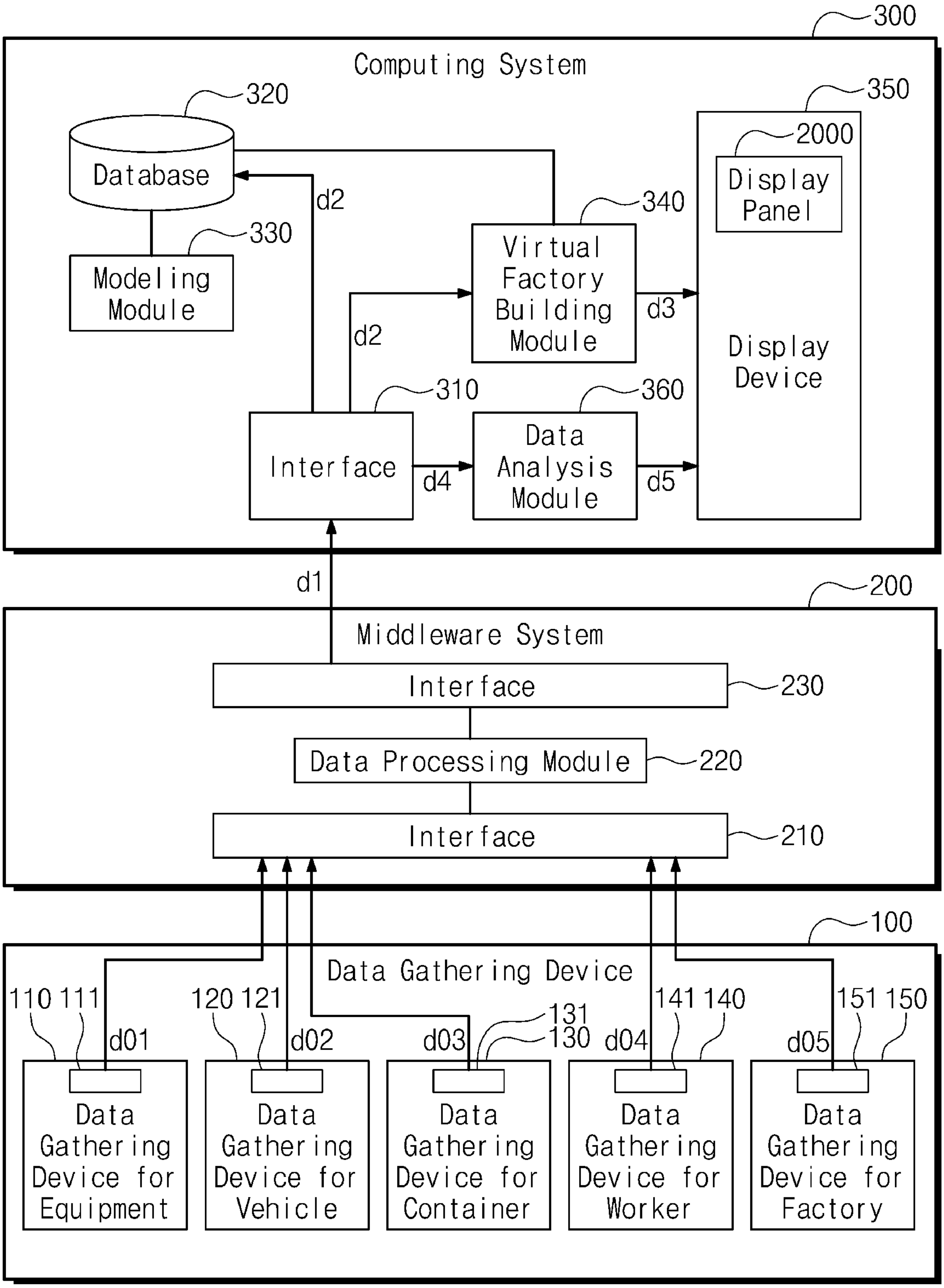

300
Computing System
320
Database
d2
330
Modeling Module
340
Virtual Factory Building Module
d3
350
2000
Display Panel
Display Device
d2
310
Interface
d4
360
Data Analysis Module
d5
d1
200
Middleware System
Interface
230
Data Processing Module
220
Interface
210
100
Data Gathering Device
110 111
d01
120 121
d02
d03
131
130
d04
141 140
151 150
d05
Data Gathering Device for Equipment
Data Gathering Device for Vehicle
Data Gathering Device for Container
Data Gathering Device for Worker
Data Gathering Device for Factory

FIG. 3

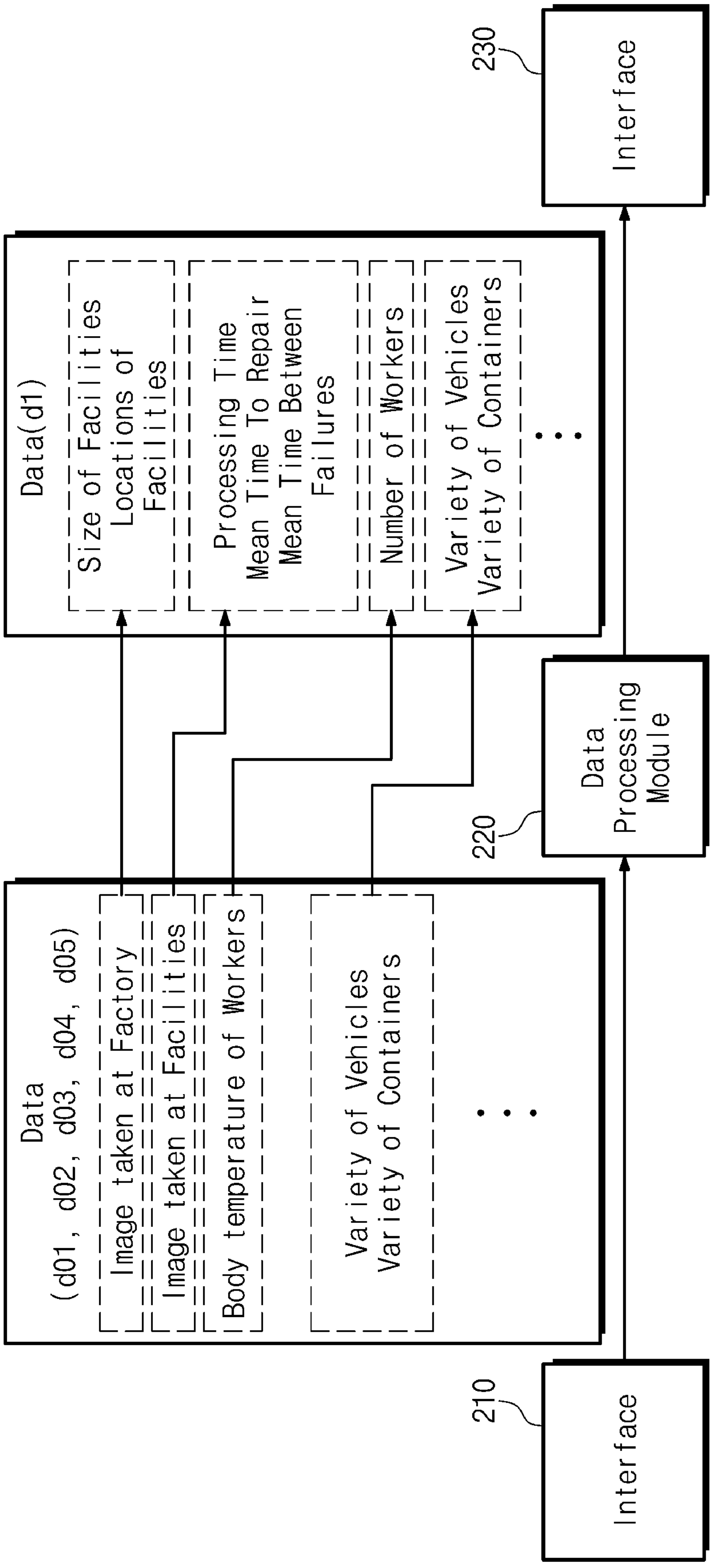

Interface
210
Data
(d01, d02, d03, d04, d05)
Image taken at Factory
Image taken at Facilities
Body temperature of Workers
Variety of Vehicles
Variety of Containers
...
220
Data Processing Module
Data(d1)
Size of Facilities
Locations of Facilities
Processing Time
Mean Time To Repair
Mean Time Between Failures
Number of Workers
Variety of Vehicles
Variety of Containers
...
230
Interface

FIG. 4

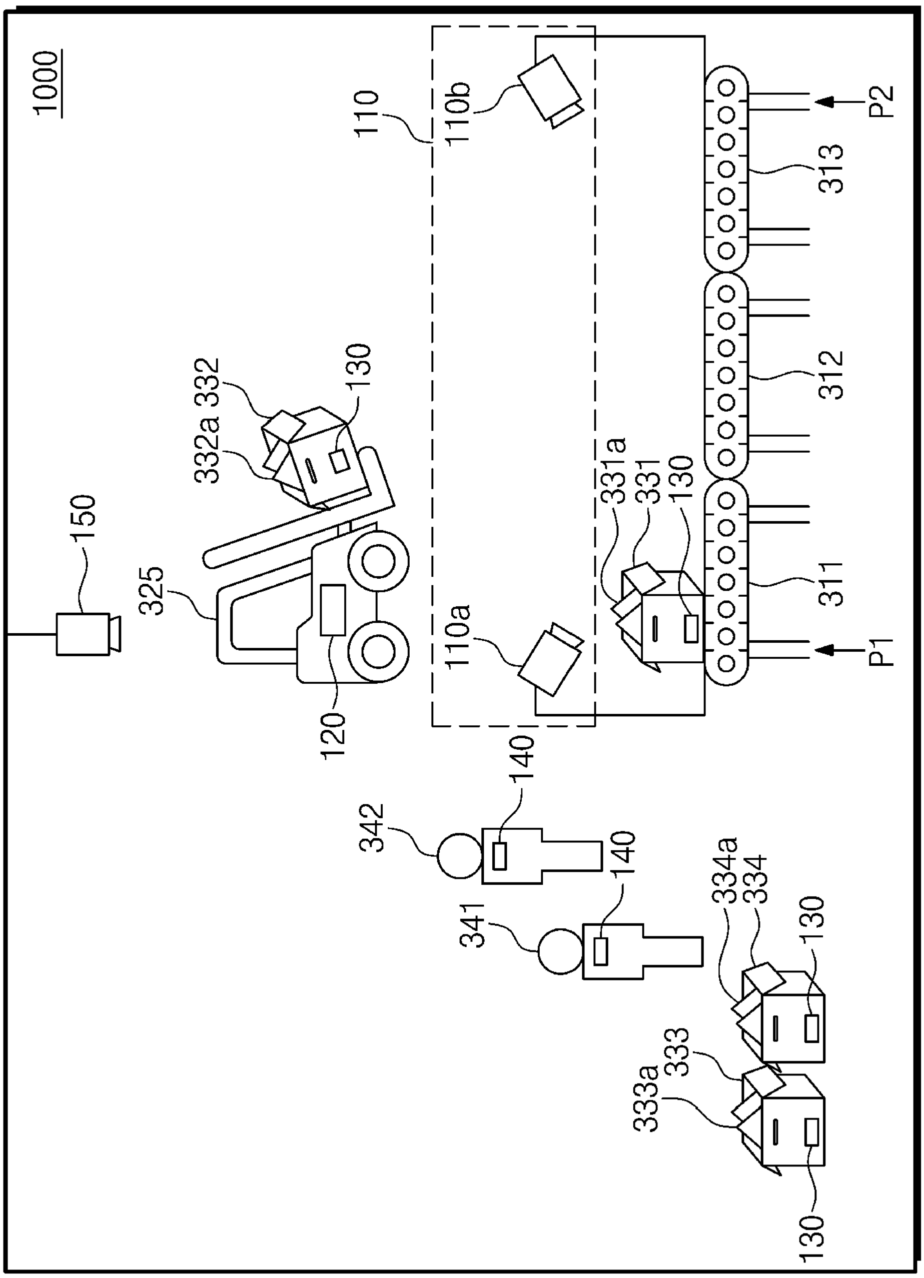

1000
110
110a
110b
120
130
140
150
311
312
313
325
331
331a
332
332a
333
333a
334
334a
341
342
P1
P2

FIG. 5

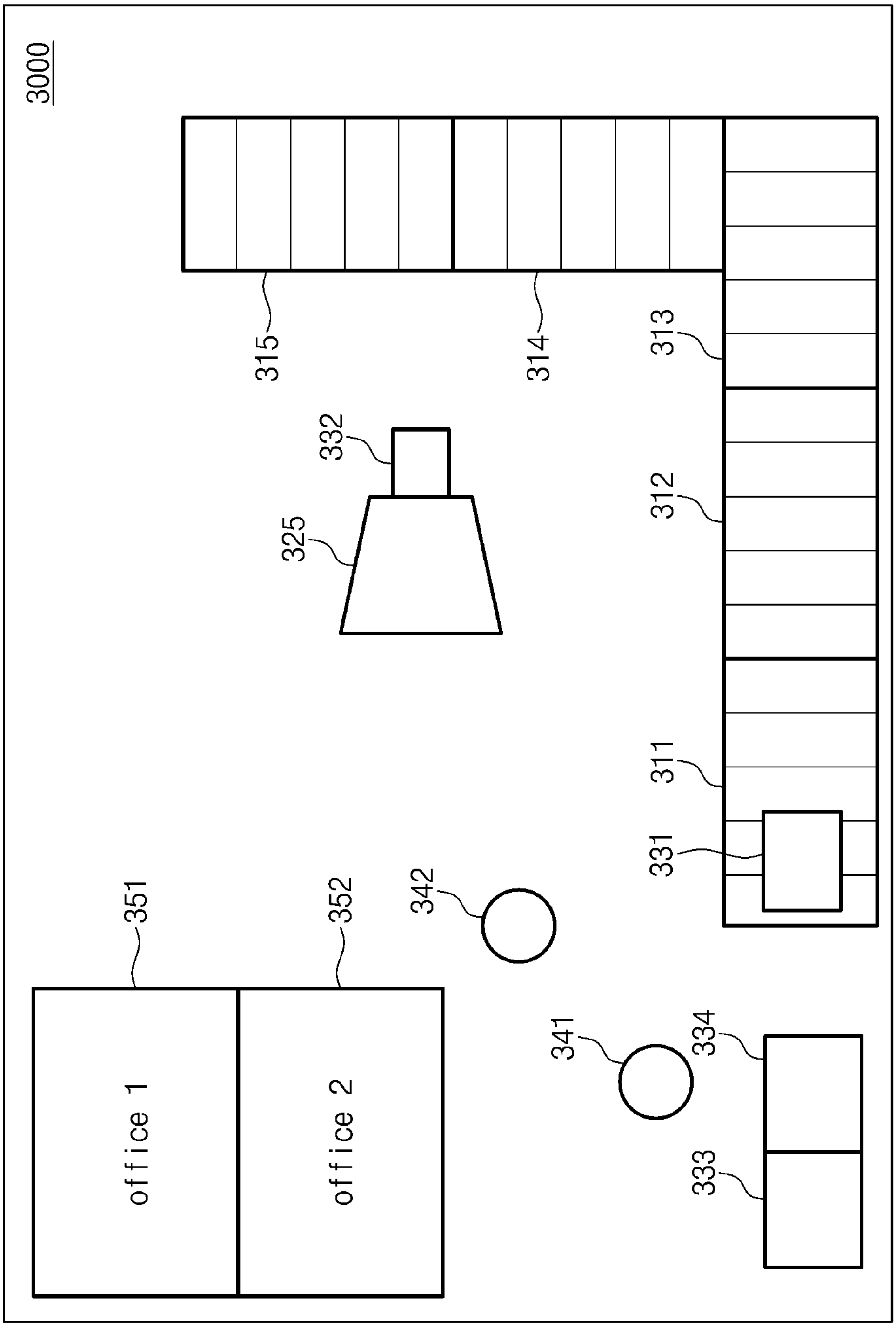

3000
315
314
313
332
325
312
311
331
351
352
342
341
334
333
office 1
office 2

FIG. 6

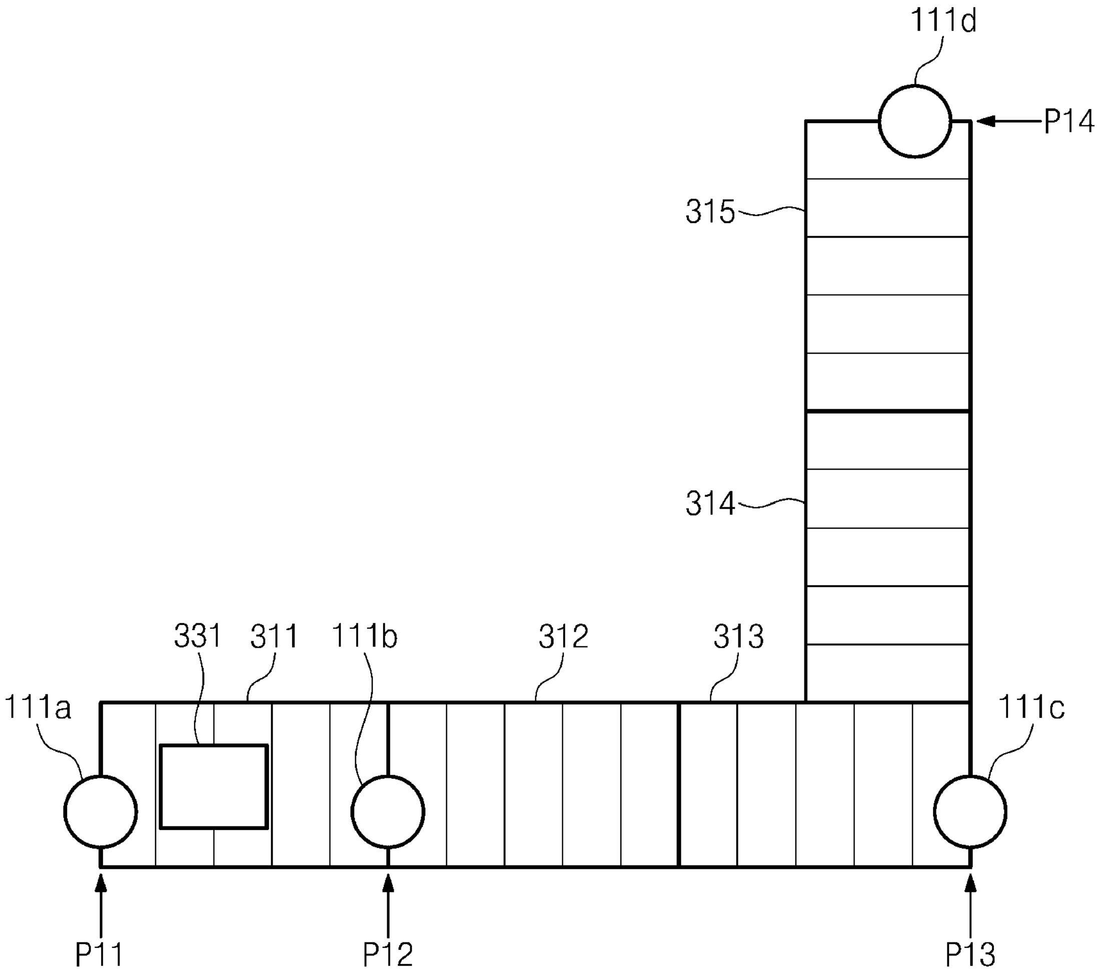


FIG. 7

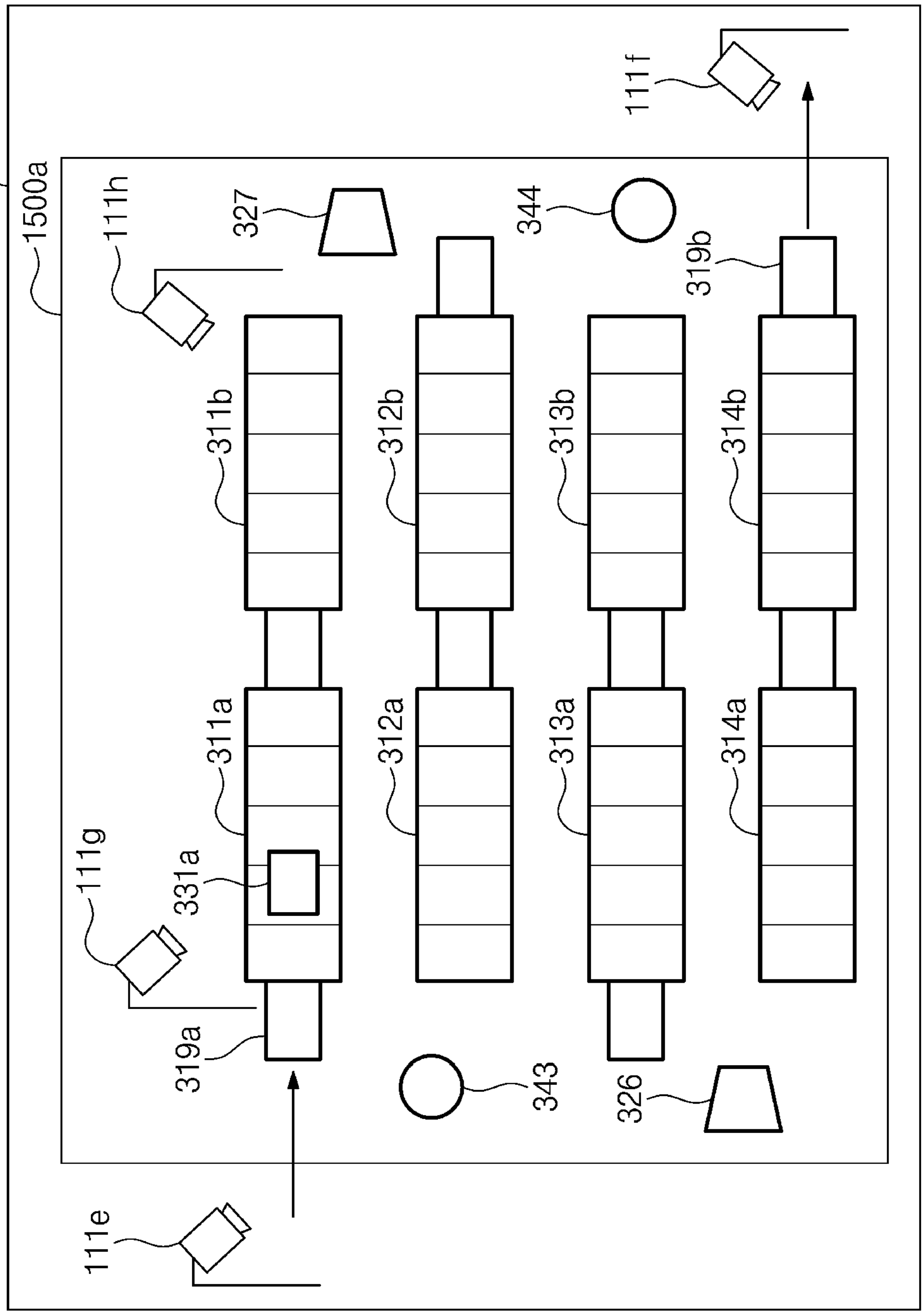
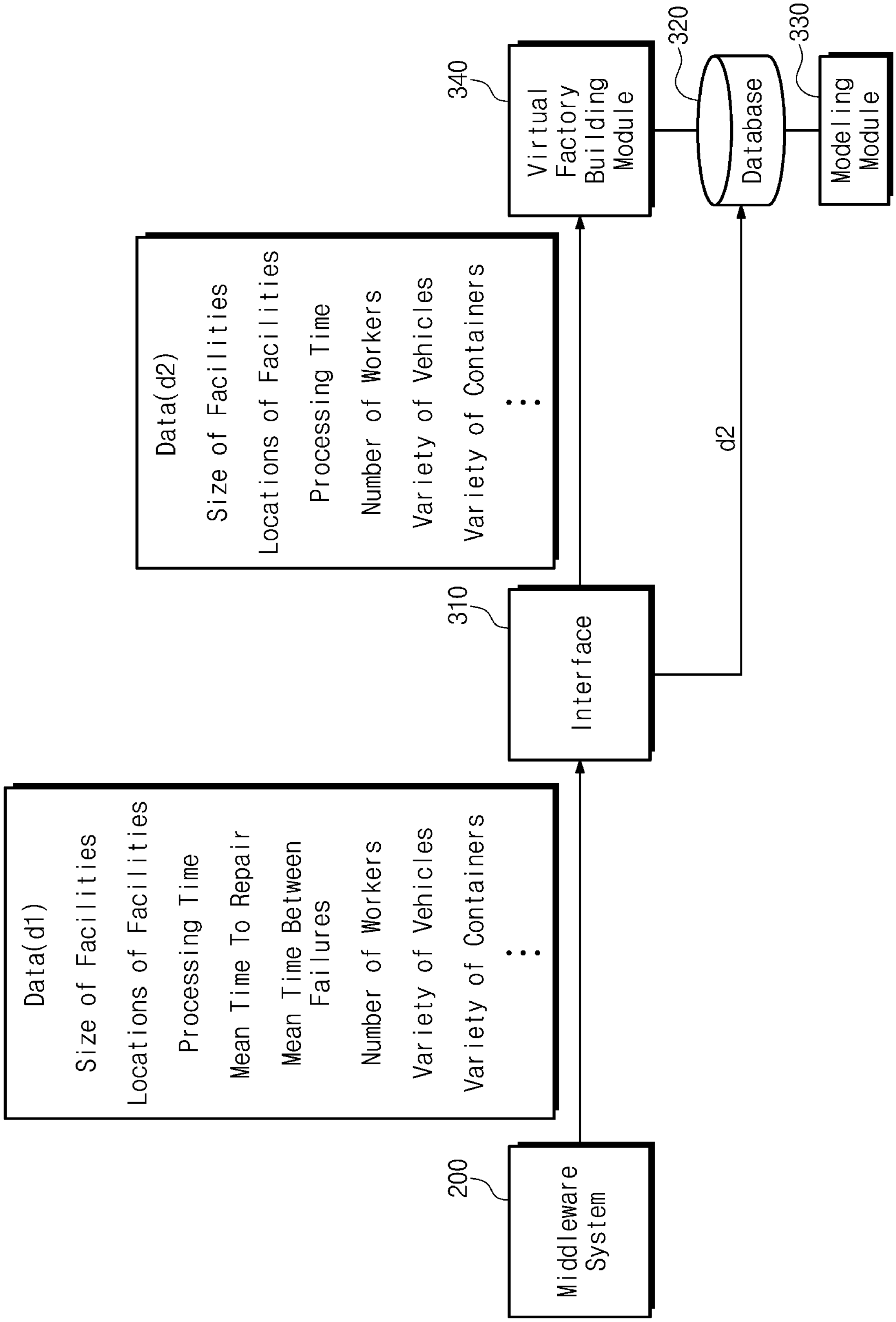

1000a
1500a
111h
327
344
111f
319b
311b
312b
313b
314b
311a
312a
313a
314a
111g
331a
319a
343
326
111e

FIG. 8



Middleware System
200
Data(d1)
Size of Facilities
Locations of Facilities
Processing Time
Mean Time To Repair
Mean Time Between Failures
Number of Workers
Variety of Vehicles
Variety of Containers
...
Interface
310
Data(d2)
Size of Facilities
Locations of Facilities
Processing Time
Number of Workers
Variety of Vehicles
Variety of Containers
...
d2
Virtual Factory Building Module
340
Database
320
Modeling Module
330

FIG. 9

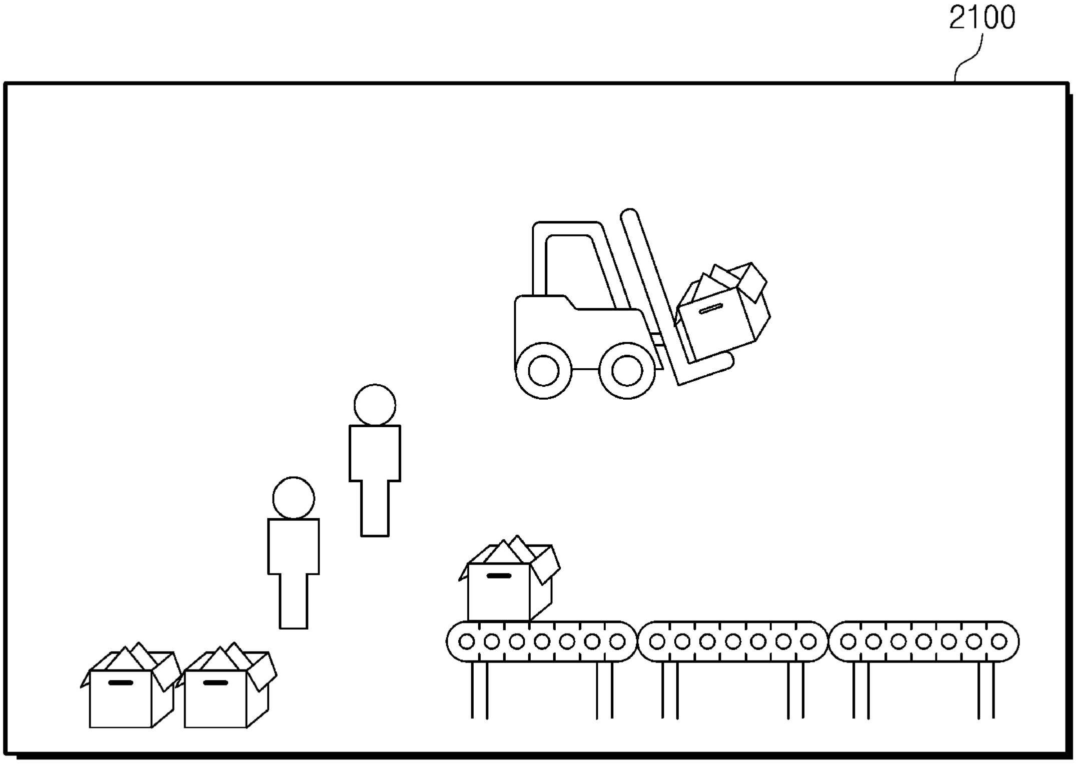


FIG. 10

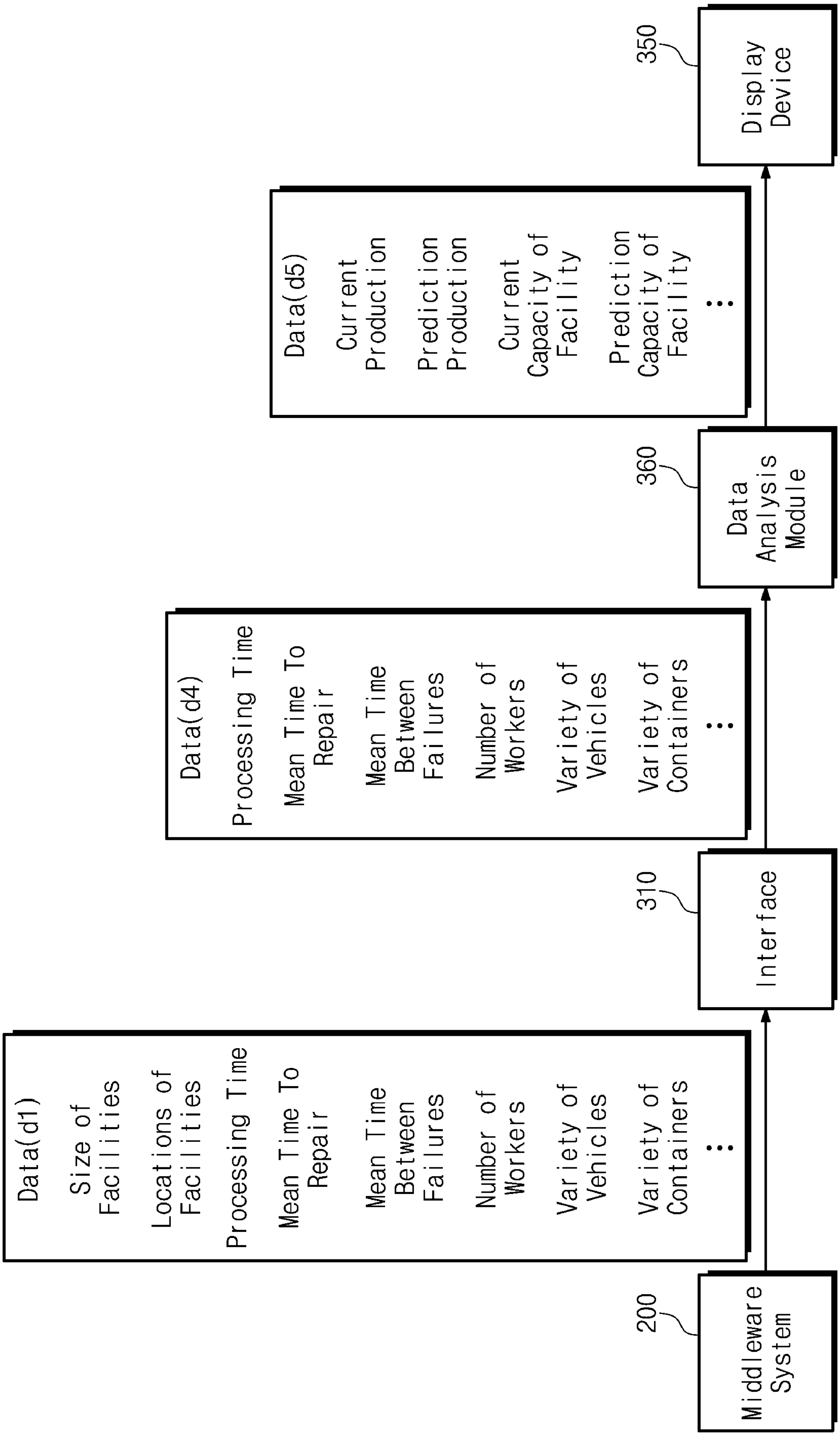

200
Middleware System
Data(d1)
Size of Facilities
Locations of Facilities
Processing Time
Mean Time To Repair
Mean Time Between Failures
Number of Workers
Variety of Vehicles
Variety of Containers
...
310
Interface
Data(d4)
Processing Time
Mean Time To Repair
Mean Time Between Failures
Number of Workers
Variety of Vehicles
Variety of Containers
...
360
Data Analysis Module
Data(d5)
Current Production
Prediction Production
Current Capacity of Facility
Prediction Capacity of Facility
...
350
Display Device

FIG. 11

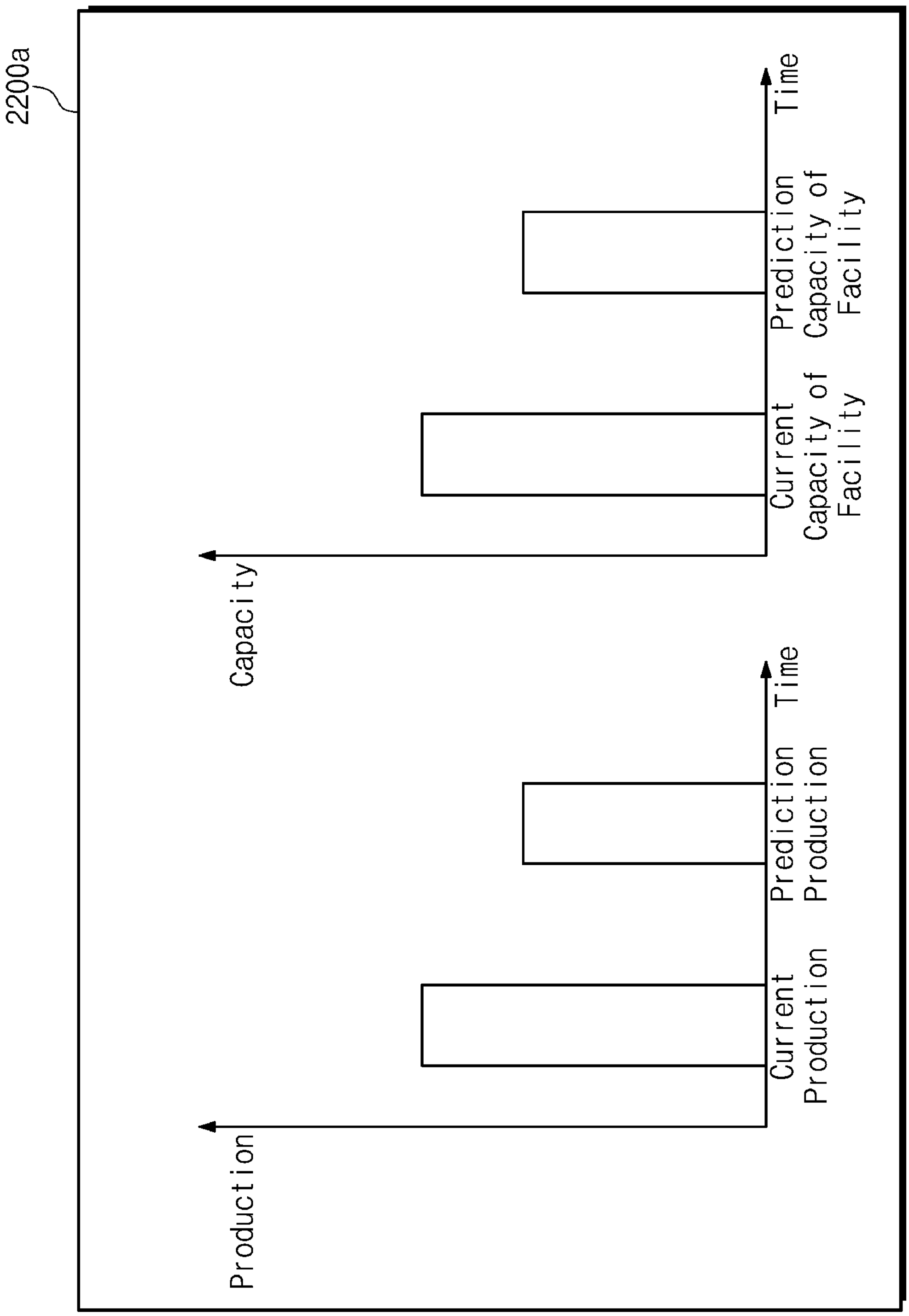

2200a
Production
Current Production
Prediction Production
Time
Capacity
Current Capacity of Facility
Prediction Capacity of Facility
Time

FIG. 12

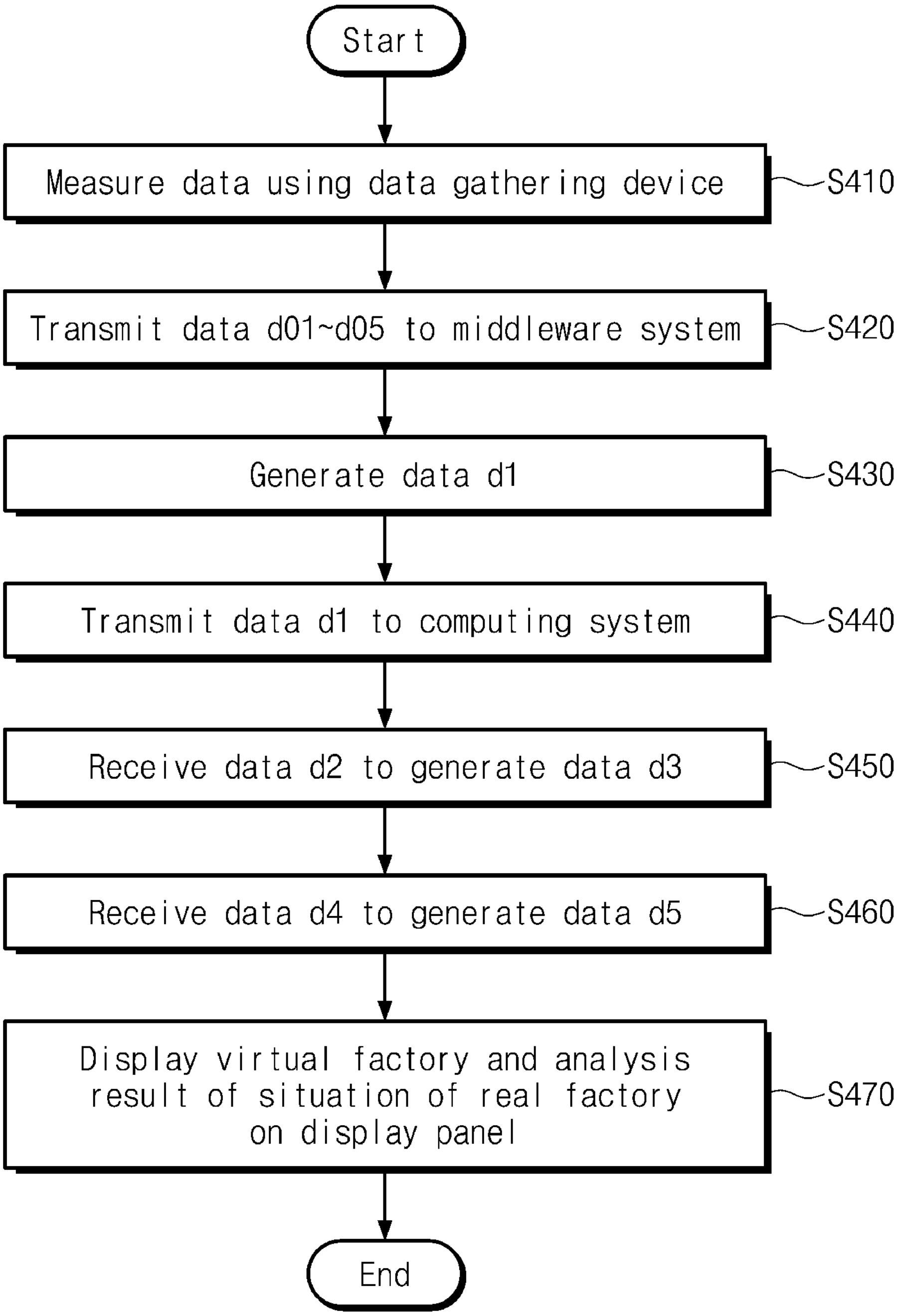
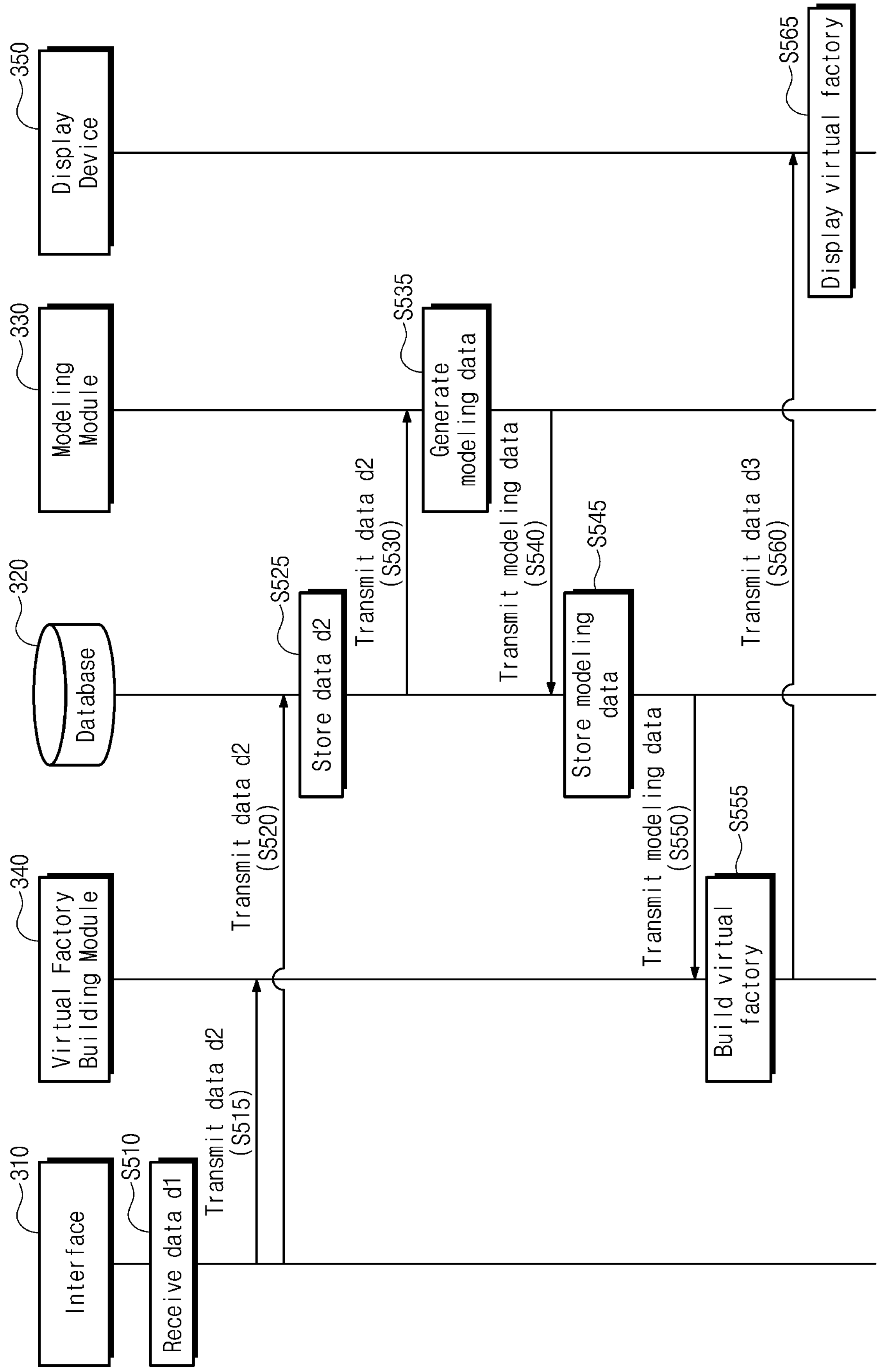

Start
Measure data using data gathering device
S410
Transmit data d01~d05 to middleware system
S420
Generate data d1
S430
Transmit data d1 to computing system
S440
Receive data d2 to generate data d3
S450
Receive data d4 to generate data d5
S460
Display virtual factory and analysis result of situation of real factory on display panel
S470
End

FIG. 13



310
Interface
S510
Receive data d1
Transmit data d2 (S515)
340
Virtual Factory Building Module
Transmit data d2 (S520)
320
Database
S525
Store data d2
Transmit data d2 (S530)
330
Modeling Module
S535
Generate modeling data
Transmit modeling data (S540)
S545
Store modeling data
Transmit modeling data (S550)
S555
Build virtual factory
Transmit data d3 (S560)
350
Display Device
S565
Display virtual factory

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 2755096 A1 **[0004]**
- WO 2008116282 A1 **[0005]**