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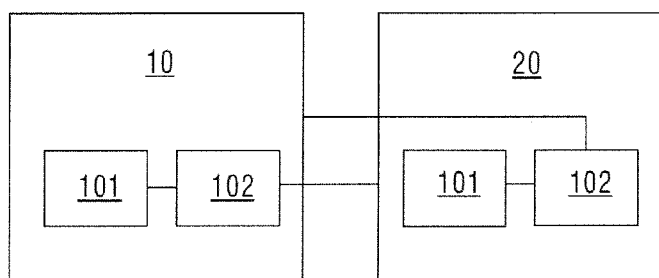


Fig. 1

(57) **Abstract:** The present invention provides a production system and a method for controlling same. The production system comprises at least two industrial devices, wherein the industrial devices comprise a quality of service (QoS) evaluation unit for acquiring a quality of service parameter of the industrial devices, and when the quality of service parameter of the industrial devices does not satisfy a pre-set threshold value, sending an optimization request to a production system model (PSM) unit of the industrial devices, wherein the optimization request contains the quality of service parameter; and a production system model (PSM) unit for receiving the optimization request, estimating an optimization working state and/or an optimization working parameter of each industrial device according to the quality of service parameter, a pre-set production system model and/or a pre-set production system optimization form, and sending the optimization working state and/or the optimization working parameter of each industrial device to each corresponding industrial device. The quality of service thus ensures the whole working process of the production system to be smooth, improves production efficiency and ensures the security performance of the production system.



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Description

PRODUCTION SYSTEM AND METHOD FOR CONTROLLING SAME

TECHNICAL FIELD

The present invention relates to industrial production automation techniques, and in particular to a production system and a method for controlling same.

BACKGROUND ART

With the improvement of the intelligent level of manufacturing industry, the existing production system is constituted by numerous distributed automatic industrial devices integrated themselves with a server, and through the server, these industrial devices can communicate with other industrial devices, products with an electronic tag, enterprise resource planning ("ERP" for short), manufacturing execution system ("MES" for short) and the like in the production system so as to provide a systematic and automatic production service.

However, during the practical production, there still exist problems that the operating efficiency of an execution system of the industrial device is low and the working process flow of the whole production system runs slowly which are caused when a plurality of tasks requests arrive simultaneously, or a plan task is changed temporarily and an operating abnormality or fault occurs to the industrial device, and in severe cases, the operating efficiency of all lines of the production system is caused to reduce sharply and even paralyse, thereby raising production security.

SUMMARY OF THE INVENTION

In order to solve the problems mentioned in the background art that the processing efficiency of the execution system of the industrial device is not high with regard to the cases that a plurality of tasks are concurrent, or a plan task is changed temporarily and an operating abnormality or fault occurs to the

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industrial device and the like, and slow working process running easily occurs to the production system and production security is caused, and the like, the present invention provides a production system and a method for controlling same, in which an optimization working state and/or an optimization working parameter of an industrial device generating each procedure of the production system are estimated by performing quality of service ("QoS" for short) estimation on the quality of service of each industrial device in the production system, according to an estimated quality of service parameter and based on a pre-set production system model ("PSM" for short) or a pre-set production system optimization form, so as to ensure the whole working process of the production system to be smooth, improves production efficiency and ensures the security performance of the production system.

The present invention provides a production system, comprising at least two industrial devices, wherein the industrial devices comprise a quality of service (QoS) evaluation unit and a production system model (PSM) unit, wherein

the quality of service (QoS) evaluation unit is used for acquiring a quality of service parameter of the industrial devices, wherein the quality of service parameter is used for measuring an instruction execution situation of the industrial devices and/or the working performance of the industrial devices, and when the quality of service parameter of the industrial devices does not satisfy a pre-set threshold value, sending an optimization request to the production system model (PSM) unit of the industrial devices, wherein the optimization request contains the quality of service parameter; and

the production system model (PSM) unit is used for receiving the optimization request, estimating an optimization working state and/or an optimization working parameter of each industrial device according to the quality of service parameter, a pre-set production system model and a pre-set production system optimization form, or according to the

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quality of service parameter and a pre-set production system model, or according to the quality of service parameter and a pre-set production system optimization form, and sending the optimization working state and/or the optimization working parameter of each industrial device to each corresponding industrial device, wherein the pre-set production system model comprises a model of each industrial device constituting the production system, and the pre-set production system optimization form comprises a quality of service optimization strategy of each industrial device constituting the production system.

The present invention further provides a method for controlling a production system, comprising:

a quality of service (QoS) evaluation unit of a first industrial device acquiring a quality of service parameter of the first industrial device, wherein the quality of service parameter is used for measuring an instruction execution situation of the first industrial device and/or the working performance of the first industrial device, and when the quality of service parameter of the industrial device does not satisfy a pre-set threshold value, sending an optimization request to a production system model (PSM) unit of the first industrial device, wherein the optimization request contains the quality of service parameter; and

the production system model (PSM) unit of the first industrial device receiving the optimization request, estimating an optimization working state and/or an optimization working parameter of the first industrial device and various second industrial devices according to the quality of service parameter, a pre-set production system model and a pre-set production system optimization form, or according to the quality of service parameter and a pre-set production system model, or according to the quality of service parameter and a pre-set production system optimization form, and sending the optimization working state and/or the optimization working parameter to the first industrial device and each of the second

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industrial devices, wherein the pre-set production system model comprises a model of the first industrial device and each of the second industrial devices constituting the production system, and the pre-set production system optimization form comprises a quality of service optimization strategy of the first industrial device and each of the second industrial devices constituting the production system.

The present invention further provides a method for controlling a production system, comprising:

a quality of service (QoS) evaluation unit of a first industrial device acquiring a quality of service parameter of the first industrial device, wherein the quality of service parameter is used for measuring an instruction execution situation of the first industrial device and/or the working performance of the first industrial device, and when the quality of service parameter does not satisfy a pre-set threshold value, sending an optimization request to a production system model (PSM) unit of the first industrial device and various second industrial devices, wherein the optimization request contains the quality of service parameter, so that the production system model (PSM) unit of the first industrial device and various second industrial devices estimates an optimization working state and/or an optimization working parameter of the respective industrial devices according to at least one of a pre-set production system model, a pre-set respective industrial device model, a pre-set production system optimization form and a pre-set respective industrial device optimization form, and the quality of service parameter, and sends the optimization working state and/or the optimization working parameter to the respective industrial devices, wherein the pre-set production system model comprises a model of the first industrial device and each of the second industrial devices constituting the production system, and the pre-set production system optimization form comprises a quality of service optimization strategy of the first industrial device and each of the second industrial devices constituting the

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production system. By means of the production system and the method for controlling same provided in the present invention, an optimization working state and/or an optimization working parameter of an industrial device generating each procedure of the production system are estimated by performing quality of service (QoS) estimation on the quality of service of each industrial device in the production system, according to an estimated quality of service parameter and based on a pre-set production system model (PSM) or a pre-set production system optimization form, so as to ensure the whole working process of the production system to be smooth, improves production efficiency and ensures the security performance of the production system.

BRIEF DESCRIPTION OF THE DRAWINGS

The embodiments of the present invention will be described in detail below with reference to the accompanying drawings, in which:

Fig. 1 is a structural diagram of Embodiment I of a production system of the present invention;

Fig. 2 is a structural diagram of Embodiment II of a production system of the present invention;

Fig. 3 is a structural diagram of Embodiment III of a production system of the present invention;

Fig. 4 is a flowchart of Embodiment I of a method for controlling a production system of the present invention;

Fig. 5 is a flowchart of Embodiment II of a method for controlling a production system of the present invention; and

Fig. 6 is a flowchart of Embodiment I of another method for controlling a production system of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

To make the objectives, technical solutions, and advantages of the embodiments of the present invention more comprehensible, the following clearly and completely describes the technical solutions in the embodiments of the present

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invention with reference to the embodiments of the present invention. It should be noted that in the drawings, similar or like elements all use like reference numerals.

Fig. 1 is a structural diagram of Embodiment I of a production system of the present invention. As shown in Fig. 1, the production system of the present embodiment comprises: at least two industrial devices 10-20, wherein the industrial devices 10-20 comprise: a quality of service (QoS) evaluation unit 101 and a production system model (PSM) unit 102, wherein the quality of service (QoS) evaluation unit 101 is used for acquiring a quality of service parameter of the industrial devices 10-20, wherein the quality of service parameter is used for measuring an instruction execution situation of the industrial devices 10-20 and/or the working performance of the industrial devices 10-20, and when the quality of service parameter of the industrial devices 10-20 does not satisfy a pre-set threshold value, sending an optimization request to a production system model (PSM) unit 102 of the industrial devices 10-20, wherein the optimization request contains the quality of service parameter; and the production system model (PSM) unit 102 is used for receiving the optimization request, estimating an optimization working state and/or an optimization working parameter of each of the industrial devices 10-20 according to the quality of service parameter, a pre-set production system model and a pre-set production system optimization form, or according to the quality of service parameter and a pre-set production system model, or according to the quality of service parameter and a pre-set production system optimization form, and sending the optimization working state and/or the optimization working parameter of each of the industrial devices 10-20 to each of the corresponding industrial devices 10-20, wherein the pre-set production system model comprises a model of each industrial device constituting the production system, and the pre-set production system optimization form comprises a quality of service optimization

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strategy of each industrial device constituting the production system.

Specifically, the production system comprises at least two industrial devices 10-20, wherein the industrial devices 10-20, respectively serving as a network node, perform communication via a network interface, and the industrial devices 10-20 may be any device, such as computers, electrical motors, robots and numerical control machine tools, which is required in an industrial production line. The industrial devices 10-20 receive a task instruction sent by a management-layer server, a product, a real-time instruction control platform and the like, wherein if the task instruction comes from a product, by attaching an electronic tag to the product, the industrial devices 10-20 can identify the task instruction by scanning the electronic tag on the product when the product flows through the industrial devices 10-20. The quality of service (QoS) evaluation unit 101 can monitor the industrial devices 10-20 in real time to obtain the quality of service parameter of the industrial devices 10-20, wherein the quality of service mainly reflects the instruction execution situation of the industrial devices 10-20, and/or the working performance of the industrial devices 10-20; can comprise: the load condition, the device performance and the like of the industrial devices 10-20; if a plurality of task instructions arrive simultaneously, or the task instructions are changed temporarily, relatively high load is caused; or due to the cases of a performance fault (such as sharp dropping of the rotation speed of an electrical motor, robot program error and so on) of the industrial devices 10-20, delay of the working process, overstocking of products on the production line and the like, the quality of service of the industrial devices 10-20 is further caused to reduce and cannot satisfy the pre-set threshold value. For example: cases such as when the load condition exceeds a pre-set load threshold value, and/or when the device performance is lower than the pre-set device performance threshold value. The pre-set threshold value can be provided with different pre-set threshold value

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indicators by engineering technicians according to the specific indicators, such as the type and performance of the industrial device and the working process flow and performance. For example, the industrial device 10 is an electrical motor. When the rotation speed of the electrical motor does not satisfy a pre-set rotation speed threshold value, the quality of service (QoS) evaluation unit 101 monitors that the quality of service of the industrial device 10 is reduced and cannot satisfy the pre-set rotation speed threshold value of the electrical motor, and then sends an optimization request to the production system model (PSM) unit 102; the optimization request contains: a quality of service parameter; and the specific representation form of the quality of service parameter is provided according to indicators, such as the type and performance of the industrial devices 10-20 and the working process flow requirements of the production line, for example, when the current rotation speed of the electrical motor does not satisfy the pre-set rotation speed, the quality of service parameter can contain a current rotation speed value of the electrical motor, and can further contain a task processing time estimation value of the electrical motor. For example: an execution time t_{exe} , a waiting time t_{wait} , a transmission time t_{trans} , data size, transmission speed and the like, wherein the execution time t_{exe} refers to the time of the process when the task instruction is executed, the waiting time t_{wait} refers to the time required to wait when the task instruction is executed in a task instruction queue, and the transmission time t_{trans} refers to the transmission time of the task instruction arriving at the industrial devices 10-20; and the QoS evaluation unit 101 calculates a delay time t_{delay} of task processing, $t_{delay} = t_{wait} + t_{exe} + t_{trans}$ wherein $t_{trans} = \text{data size} / \text{transmission speed}$, if t_{delay} exceeds a pre-set time threshold value, it is indicated that the industrial devices 10-20 do not process the task instruction in time, then the above-mentioned time delay value can also serve as the quality of service (QoS) parameter

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and combine the rotation speed value of the electrical motor together to constitute the quality of service parameter of the current industrial devices for optimizing the quality of service of the industrial devices. It should be noted that the above-mentioned quality of service parameter being the delay time or the rotation speed of the electrical motor is merely used as an example. The present invention does not limit the quality of service parameter, which can be any quality of service estimation parameter representing the device performance of the industrial devices 10-20 and the working process flow performance. The quality of service (QoS) evaluation unit 101 acquires the quality of service parameter of the industrial devices 10-20, and in the acquisition process, the industrial devices 10-20 can be either actively monitored by the quality of service (QoS) evaluation unit 101 so as to obtain the quality of service parameter, or the industrial devices 10-20 can report various quality of service parameters thereof to the quality of service (QoS) evaluation unit 101. The present embodiment does not limit the specific acquisition method. When the acquired quality of service parameters do not satisfy the pre-set threshold value, an optimization request is sent to the production system model (PSM) unit 102, and the production system model (PSM) unit 102 pre-stores a pre-set overall model of the production system, and/or the pre-set optimization form of the production system. If estimation is performed according to the pre-set production system model and the quality of service parameter provided by the QoS, the quality of service parameter is substituted in the pre-set production system model to calculate the optimization working state and/or the optimization working parameter of each of the industrial devices 10-20, wherein the working state is such as shut-down, standby, operating, forward rotation and reverse rotation; and the working parameter is such as a time parameter, a speed parameter, a priority parameter and voltage and current parameters. The above-mentioned working state and working parameter are merely used as an example, and the

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present invention does not limit the working state and working parameter specifically, which can be determined by engineering technicians according to the specific working condition. If estimation is performed according to the pre-set production system optimization form and the quality of service parameter provided by the QoS, the production system model (PSM) unit 102 stores form files, such as a configuration file, process data, a working logic file and operating time data, of each industrial device of the production system, in which a correlation between the quality of service parameter and each indicator in these form files is recorded, for example: when the quality of service parameter of a certain industrial device shows that the operating time delays for two seconds, using a table lookup method to correspondingly find a solution in the form files, the working state: increasing the rotation speed of the electrical motor; and the working parameter: increasing the rotation speed to a certain rotation speed value or a rotation speed range. Accordingly, an experimental form constituted by using experimental data completes the adjustment on the industrial devices. Since it is unnecessary for the solution based on the pre-set production system optimization form to perform real-time calculation according to the quality of service parameter and the pre-set production system model, the time consumption of model calculation can be reduced greatly, the working state and/or the working parameter of the industrial devices 10-20 can be adjusted more quickly, so that the case that the quality of service of the industrial device is reduced can be processed in time and efficiently. Certainly, these three, i.e. the pre-set production system model, the pre-set production system optimization form and the quality of service parameter, can also be combined to jointly obtain the optimized strategy. Finally, the optimization working state and/or the optimization working parameter corresponding to each of the industrial devices 10-20 are generated according to the working state and the working parameter, and the optimized working state and/or the optimized working parameter are sent

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to each of the industrial devices 10-20, so that the industrial devices 10-20 adjust the working process or adjust an operation parameter and the like of the industrial devices 10-20 according to the optimized working state and/or working parameter.

By means of the production system of the present embodiment, an optimization working state and/or an optimization working parameter of an industrial device generating each procedure of the production system are estimated by performing quality of service (QoS) estimation on the quality of service of each industrial device in the production system, according to an estimated quality of service parameter and based on a pre-set production system model (PSM) or a pre-set production system optimization form, so as to ensure the whole working process of the production system to be smooth, improves production efficiency and ensures the security performance of the production system.

Fig. 2 is a structural diagram of Embodiment II of a production system of the present invention. As shown in Fig. 2, on the basis of Embodiment I mentioned above, the production system further comprises an integrated server 103, wherein the integrated server 103 is used for: receiving a task instruction to be executed by the industrial devices 10-20, and performing statistical analysis on the received task instruction, so as to obtain the load condition of the industrial devices 10-20; and/or receiving an operating parameter fed back by the industrial devices 10-20; and generating a quality of service parameter of the industrial devices 10-20 according to the load condition and/or the operating parameter of the industrial devices 10-20, wherein the quality of service (QoS) evaluation unit 101 is specifically used for monitoring the integrated server 103 and acquiring the quality of service parameter of the industrial devices 10-20 from the integrated server 103.

Specifically, the integrated server 103 receives the task instruction sent to the industrial devices 10-20 via a network communication interface, can perform operations, such as queue

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management, priority ranking and occupied resource analysis, on the task instruction, and performs comprehensive analysis by combining the processing capability thereof and the processing capability of the industrial devices so as to estimate the current load condition of the industrial devices 10-20, for example, the current industrial devices 10-20 are in a full load working state, or in an idle state, etc. Furthermore, the integrated server 103 can further learn the current working state of the industrial devices 10-20 in time by receiving the operating parameter fed back by various sensor elements of the industrial devices 10-20, so as to find whether a fault occurs to or an abnormality exists in the industrial devices 10-20 in time. The integrated server 103 performs comprehensive analysis again according to the load condition and/or the operating parameter of the industrial devices 10-20 to obtain the quality of service parameter of the industrial devices 10-20; for example, with regard to each instruction in the task instruction queue, how long is the delay time individually required to wait. Accordingly, the quality of service (QoS) evaluation unit 101 acquires, by monitoring the integrated server 103, execution capability information about the integrated server 103, such as the execution capability of a central processing unit, which indirectly reflects the quality of service of the industrial devices 10-20. The quality of service (QoS) evaluation unit 101 acquires the quality of service parameter of the industrial devices 10-20 from the integrated server 103, and then estimates the quality of service parameter of the industrial devices 10-20 according to the pre-set threshold value. The working process and time of the quality of service (QoS) evaluation unit 101 directly acquiring the quality of service parameter from the industrial devices 10-20 can be greatly saved, and the processing efficiency is improved.

Further, at least one of the quality of service (QoS) evaluation unit 101 and the production system model (PSM) unit 102 is integrated into the integrated server 103. The quality

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of service (QoS) evaluation unit 101 and the production system model (PSM) unit 102 can be integrated with the integrated server 103 into one piece, and can also be arranged as separate bodies.

Fig. 3 is a structural diagram of Embodiment III of a production system of the present invention. As shown in Fig. 3, on the basis of the above-mentioned embodiment, the industrial devices 10-20 further comprise: a permission control unit 104 for verifying an access right of a task instruction, and if the verification is passed, sending a permission instruction to the integrated server 103 so that the industrial devices 10-20 execute the task instruction; and the permission control unit 104 further for receiving the optimization working state and/or the optimization working parameter sent by the production system model (PSM) unit 102 so as to update access right data of the industrial devices 10-20.

Specifically, the verification of the access right comprises: identity verification of an initiator of the task instruction, such as whether an IP address of the initiator is legal, and whether the category of the task to be executed by the initiator is matched, and further comprises: an attribute right of the industrial devices 10-20 allowed to access, such as allowing to access one or more of read or write function of the industrial devices 10-20. The verification performed on the access right of the task instruction by the permission control unit 104 greatly reduces the possibility of maliciously accessing the industrial devices 10-20, and ensures the security of the production system; meanwhile, eligibility screening is performed on the task instruction before the task instruction arrives at the industrial devices 10-20 by the permission control unit 104 so as to merely enable the eligible task instruction to enter the instruction execution queue of the integrated server 103, which can accelerate the task instruction processing efficiency of the integrated server 103. In addition, the permission control unit 104 is further used for receiving the optimization working state and/or the

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optimization working parameter sent by the production system model (PSM) unit 102, and the permission control unit 104 updates the access right data of the corresponding industrial devices 10-20 according to the optimization working state and/or the optimization working parameter. For example, the industrial device 10 is a robot arm, and the access right data thereof originally does not comprise pasting a bar code label on a product; however, since the number of awaiting products in the production line is overstocked, and the optimization working state and/or the optimization working parameter can indicate to open the function of the robot arm pasting the bar code label, the permission control unit 104 updates the access right data of the robot arm according to the newly added function.

Further, the production system further comprises: an engineering data unit 30 for storing a configuration file of each of the industrial devices 10-20, so that the production system model (PSM) unit 102 acquires the configuration file corresponding to each of the industrial devices 10-20 constituting the production system from the engineering data unit 30 so as to form the pre-set production system model, and is further used for storing a quality of service optimization strategy of each of the industrial devices 10-20, so that the production system model (PSM) unit 102 acquires the quality of service optimization strategy corresponding to each of the industrial devices 10-20 constituting the production system from the engineering data unit 30 so as to form the pre-set production system optimization form.

Specifically, the engineering data unit 30 can be a configuration platform developed by engineering technicians for use, which has the complete configuration development file, data, production system optimization strategy form of the production system and the like, wherein the production system is composed by numerous industrial devices 10-20 with different combination forms; if a current production system is composed by ten industrial devices 10-20, and then due to the production

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task demand, the production system is changed into twenty industrial devices 10-20, the production system model (PSM) unit 102 of each of the industrial devices 10-20 can acquire the configuration file and the quality of service optimization strategy corresponding to each of the industrial devices 10-20 constituting the current production system from the engineering data unit 30 so as to form the pre-set production system model and the pre-set production system optimization form of the current production system. That is to say, the engineering data unit 30 provides diversified modeling requirements of the production system, which can enable the production system to possess better flexibility and plasticity.

Fig. 4 is a flowchart of Embodiment I of a method for controlling a production system of the present invention, as shown in Fig. 4, comprising:

in step 101, a quality of service (QoS) evaluation unit of a first industrial device acquiring a quality of service parameter of the first industrial device, wherein the quality of service parameter is used for measuring an instruction execution situation of the first industrial device and/or the working performance of the first industrial device, and when the quality of service parameter of the industrial device does not satisfy a pre-set threshold value, sending an optimization request to a production system model (PSM) unit of the first industrial device, wherein the optimization request contains the quality of service parameter; and

in step 102, the production system model (PSM) unit of the first industrial device receiving the optimization request, estimating an optimization working state and/or an optimization working parameter of the first industrial device and various second industrial devices according to the quality of service parameter, a pre-set production system model and a pre-set production system optimization form, or according to the quality of service parameter and a pre-set production system model, or according to the quality of service parameter and a pre-set production system optimization form, and sending the

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optimization working state and/or the optimization working parameter to the first industrial device and each of the second industrial devices, wherein the pre-set production system model comprises a model of the first industrial device and each of the second industrial devices constituting the production system, and the pre-set production system optimization form comprises a quality of service optimization strategy of the first industrial device and each of the second industrial devices constituting the production system.

The method of the present embodiment may be implemented by using the technical solution of Embodiment I of the production system shown in Fig. 1, and the implementation principles and technical effects are similar and will not be described herein.

By means of the method for controlling a production system of the present embodiment, an optimization working state and/or an optimization working parameter of an industrial device generating each procedure of the production system are estimated by performing quality of service (QoS) estimation on the quality of service of each industrial device in the production system, according to an estimated quality of service parameter and based on a pre-set production system model (PSM) or a pre-set production system optimization form, so as to ensure the whole working process of the production system to be smooth, improves production efficiency and ensures the security performance of the production system.

Fig. 5 is a flowchart of Embodiment II of a method for controlling a production system of the present invention, and as shown in Fig. 5, on the basis of Embodiment I shown in Fig. 4 above, the method comprises:

in step 201, a permission control unit of the first industrial device verifying an access right of a task instruction received by the first industrial device, and if the verification is passed, sending a permission instruction to an integrated server of the first industrial device, so that the first industrial device executes the task instruction; and

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in step 202, the integrated server of the first industrial device receiving the task instruction to be executed by the first industrial device, and performing statistical analysis on the received task instruction, so as to obtain the load condition of the first industrial device; and/or receiving an operating parameter fed back by the first industrial device; and generating the quality of service parameter of the first industrial device according to the load condition and/or the operating parameter of the first industrial device;

in step 203, the quality of service (QoS) evaluation unit of the first industrial device monitoring the integrated server of the first industrial device, and acquiring the quality of service parameter of the first industrial device from the integrated server of the first industrial device, wherein the quality of service parameter is used for measuring an instruction execution situation of the first industrial device and/or the working performance of the first industrial device;

in step 204, when the quality of service parameter of the industrial device does not satisfy a pre-set threshold value, the quality of service (QoS) evaluation unit of the first industrial device sending the optimization request to a production system model (PSM) unit of the first industrial device, wherein the optimization request contains the quality of service parameter;

in step 205, the production system model (PSM) unit of the first industrial device receiving the optimization request, estimating an optimization working state and/or an optimization working parameter of the first industrial device and various second industrial devices according to the quality of service parameter, a pre-set production system model and a pre-set production system optimization form, or according to the quality of service parameter and a pre-set production system model, or according to the quality of service parameter and a pre-set production system optimization form, wherein the pre-set production system model comprises a model of the first industrial device and each of second industrial devices

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constituting the production system, and the pre-set production system optimization form comprises a quality of service optimization strategy of the first industrial device and each of the second industrial devices constituting the production system;

in step 206, the production system model (PSM) unit of the first industrial device sending the optimization working state and/or the optimization working parameter to the first industrial device and each of the second industrial devices; and

in step 207, the production system model (PSM) unit of the first industrial device sending the optimization working state and/or the optimization working parameter to a permission control unit of the first industrial device and each of the second industrial devices, so that the permission control unit of the first industrial device and each of the second industrial devices updates access right data of respective industrial devices.

There is no necessary sequential relationship between step 206 and step 207, and it can be set by a person skilled in the art at his/her will according to actual working conditions.

Further, the method further comprises: the production system model (PSM) unit of the first industrial device acquiring the pre-set production system model and/or the pre-set production system optimization form from an engineering data unit, wherein the engineering data unit is used for storing a configuration file of the first industrial device and each of the second industrial devices, so that the production system model (PSM) unit acquires the configuration file corresponding to each of the industrial devices constituting the production system from the engineering data unit so as to form the pre-set production system model, and is further used for storing a quality of service optimization strategy of the first industrial device and each of the second industrial devices, so that the production system model (PSM) unit acquires the quality of service optimization strategy

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corresponding to each of the industrial devices constituting the production system from the engineering data unit so as to form the pre-set production system optimization form. This step can be performed in any step before step 205.

The method of the present embodiment may be implemented by using the technical solutions of the embodiments of the production system shown in Figs. 1 to 3, and the implementation principles and technical effects are similar and will not be described herein.

Fig. 6 is a flowchart of Embodiment I of another method for controlling a production system of the present invention, as shown in Fig. 6, comprising:

in step 301, a quality of service (QoS) evaluation unit of a first industrial device acquires a quality of service parameter of the first industrial device, wherein the quality of service parameter is used for measuring an instruction execution situation of the first industrial device and/or the working performance of the first industrial device.

In step 302, when the quality of service parameter does not satisfy a pre-set threshold value, an optimization request is sent to a production system model (PSM) unit of the first industrial device and various second industrial devices, wherein the optimization request contains the quality of service parameter, so that the production system model (PSM) unit of the first industrial device and various second industrial devices estimates an optimization working state and/or an optimization working parameter of the respective industrial devices according to at least one of a pre-set production system model, a pre-set respective industrial device model, a pre-set production system optimization form and a pre-set respective industrial device optimization form, and the quality of service parameter.

In this step, different from step 204 of the above-mentioned embodiment, the quality of service (QoS) evaluation unit not only sends the optimization request to the PSM unit of the first industrial device, but also sends the optimization

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request to the production system model (PSM) unit of various second industrial devices. That is to say, when finding that there is a case that the first industrial device has a relatively poor quality of service, the QoS evaluation unit reports the current situation of the quality of service parameter of the first industrial device to all the industrial devices on the production system in time. With a pre-warning function, any one of the industrial devices in the production system learns the reason in advance why the performance of the first industrial device is reduced and takes precautions in advance, thereby further ensuring the security performance of the production system. In addition, all the industrial devices, i.e. the first industrial device and various second industrial devices, that constitute the production system estimate the working state and working parameter of respective industrial devices according to the overall production system model in the production system model (PSM) unit thereof or the model of respective industrial devices. Or, the first industrial device and various second industrial devices estimate the working state and working parameter of respective industrial devices according to the overall production system optimization form in the production system model (PSM) unit thereof or the optimization form of respective industrial devices. Or, the two methods of the optimization form and the model are combined. It should be noted that each industrial device model is contained in a production system model, and each industrial device can perform calculation to obtain an optimization working state and/or an optimization working parameter of respective industrial devices according to either an overall model of the production system or an individual model thereof.

In step 303, the optimization working state and/or the optimization working parameter are sent to respective industrial devices; the pre-set production system model comprises a model of the first industrial device and each of second industrial devices constituting the production system; and the pre-set production system optimization form comprises a

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quality of service optimization strategy of the first industrial device and each of the second industrial devices constituting the production system.

The method for controlling a production system of the present embodiment pre-warns, by performing quality of service ("QoS") estimation on the quality of service of each industrial device in the production system, and reporting the condition of the industrial device with bad QoS estimation to other industrial devices on the production system in time, each industrial device to make estimation based on a pre-set model, or a pre-set optimization form to generate a respective optimization working state and/or optimization working parameter, and take precautions in advance, so as to further ensure the fluency of the working process of the whole production system, improve the production efficiency and ensure the security performance of the production system.

Finally, it should be noted that various embodiments above are merely provided for describing the technical solutions of the present invention, rather than limiting the present invention; although the present invention is described in detail with reference to the foregoing embodiments, persons of ordinary skill in the art should understand that they can still make modifications to the technical solutions described in the foregoing embodiments, or make equivalent substitutions to some or all of the technical features thereof; however, these modifications and substitutions do not make corresponding technical solutions depart from the scope of the technical solutions of various embodiments of the present invention.

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Claims

1. A production system, comprising at least two industrial devices, characterized in that the industrial devices comprise a quality of service (QoS) evaluation unit and a production system model (PSM) unit, wherein

the quality of service (QoS) evaluation unit is used for acquiring a quality of service parameter of the industrial devices, wherein the quality of service parameter is used for measuring an instruction execution situation of the industrial devices and/or the working performance of the industrial devices, and when the quality of service parameter of the industrial devices does not satisfy a pre-set threshold value, sending an optimization request to the production system model (PSM) unit of the industrial devices, wherein the optimization request contains the quality of service parameter; and

the production system model (PSM) unit is used for receiving the optimization request, estimating an optimization working state and/or an optimization working parameter of each industrial device according to the quality of service parameter, a pre-set production system model and a pre-set production system optimization form, or according to the quality of service parameter and a pre-set production system model, or according to the quality of service parameter and a pre-set production system optimization form, and sending the optimization working state and/or the optimization working parameter of each industrial device to each corresponding industrial device, wherein the pre-set production system model comprises a model of each industrial device constituting the production system, and the pre-set production system optimization form comprises a quality of service optimization strategy of each industrial device constituting the production system.

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2. The production system according to claim 1, characterized in that the production system further comprises an integrated server,

wherein the integrated server is used for receiving a task instruction to be executed by the industrial devices, and performing statistical analysis on the received task instruction, so as to obtain the load condition of the industrial devices; and/or receiving an operating parameter fed back by the industrial devices; and generating the quality of service parameter of the industrial devices according to the load condition and/or the operating parameter of the industrial devices,

wherein the quality of service (QoS) evaluation unit is specifically used for monitoring the integrated server and acquiring the quality of service parameter of the industrial devices from the integrated server.

3. The production system according to claim 2, characterized in that at least one of the quality of service (QoS) evaluation unit and the production system model (PSM) unit is integrated in the integrated server.

4. The production system according to either of claims 2 and 3, characterized in that the industrial devices further comprise:

a permission control unit for verifying an access right of the task instruction received by the industrial devices, and if the verification is passed, sending a permission instruction to the integrated server, so that the industrial devices execute the task instruction; and

the permission control unit further for receiving the optimization working state and/or the optimization working parameter sent by the production system model (PSM) unit so as to update access right data of the industrial devices.

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5. The production system according to any one of claims 1 to 3, characterized in that the system further comprises:

an engineering data unit for storing a configuration file of each of the industrial devices, so that the production system model (PSM) unit acquires the configuration file corresponding to each of the industrial devices constituting the production system from the engineering data unit so as to form the pre-set production system model, and further for storing the quality of service optimization strategy of each of the industrial devices, so that the production system model (PSM) unit acquires the quality of service optimization strategy corresponding to each of the industrial devices constituting the production system from the engineering data unit so as to form the pre-set production system optimization form.

6. A method for controlling a production system, characterized in that the method comprises:

a quality of service (QoS) evaluation unit of a first industrial device acquiring a quality of service parameter of the first industrial device, wherein the quality of service parameter is used for measuring an instruction execution situation of the first industrial device and/or the working performance of the first industrial device, and when the quality of service parameter of the industrial device does not satisfy a pre-set threshold value, sending an optimization request to a production system model (PSM) unit of the first industrial device, wherein the optimization request contains the quality of service parameter;

the production system model (PSM) unit of the first industrial device receiving the optimization request, estimating an optimization working state and/or an optimization working parameter of the first industrial device and various second industrial devices according to the quality of service parameter, a pre-set production system model and a pre-set production system optimization form, or according to the

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quality of service parameter and a pre-set production system model, or according to the quality of service parameter and a pre-set production system optimization form, and sending the optimization working state and/or the optimization working parameter to the first industrial device and each of the second industrial devices, wherein the pre-set production system model comprises a model of the first industrial device and each of the second industrial devices constituting the production system, and the pre-set production system optimization form comprises a quality of service optimization strategy of the first industrial device and each of the second industrial devices constituting the production system.

7. The method according to claim 6, characterized in that before the quality of service (QoS) evaluation unit of the first industrial device acquiring the quality of service parameter of the first industrial device, the method further comprises:

an integrated server of the first industrial device receiving a task instruction to be executed by the first industrial device, and performing statistical analysis on the received task instruction, so as to obtain the load condition of the first industrial device; and/or receiving an operating parameter fed back by the first industrial device; and generating the quality of service parameter of the first industrial device according to the load condition and/or the operating parameter of the first industrial device; and

accordingly, the quality of service (QoS) evaluation unit of the first industrial device acquiring the quality of service parameter of the first industrial device comprises: the quality of service (QoS) evaluation unit of the first industrial device monitoring the integrated server of the first industrial device, and acquiring the quality of service parameter of the first industrial device from the integrated server of the first industrial device.

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8. The method according to claim 7, characterized in that before the integrated server of the first industrial device receiving the task instruction to be executed by the first industrial device, the method further comprises:

a permission control unit of the first industrial device verifying an access right of the task instruction received by the first industrial device, and if the verification is passed, sending a permission instruction to the integrated server of the first industrial device, so that the first industrial device executes the task instruction; and

accordingly, after estimating the optimization working state and/or the optimization working parameter of the first industrial device and various second industrial devices, the method further comprises:

the production system model (PSM) unit of the first industrial device sending the optimization working state and/or the optimization working parameter to the permission control unit of the first industrial device and each of the second industrial devices, so that the permission control unit of the first industrial device and each of the second industrial devices updates access right data of respective industrial devices.

9. The method according to any one of claims 6 to 8, characterized in that before estimating the optimization working state and/or the optimization working parameter of the first industrial device and various second industrial devices, the method further comprises:

the production system model (PSM) unit of the first industrial device acquiring the pre-set production system model and/or the pre-set production system optimization form from an engineering data unit, wherein the engineering data unit is used for storing a configuration file of the first industrial device and each of the second industrial devices, so that the production system model (PSM) unit acquires the configuration file corresponding to each of the industrial devices

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constituting the production system from the engineering data unit so as to form the pre-set production system model, and is further used for storing the quality of service optimization strategy of the first industrial device and each of the second industrial devices, so that the production system model (PSM) unit acquires the quality of service optimization strategy corresponding to each of the industrial devices constituting the production system from the engineering data unit so as to form the pre-set production system optimization form.

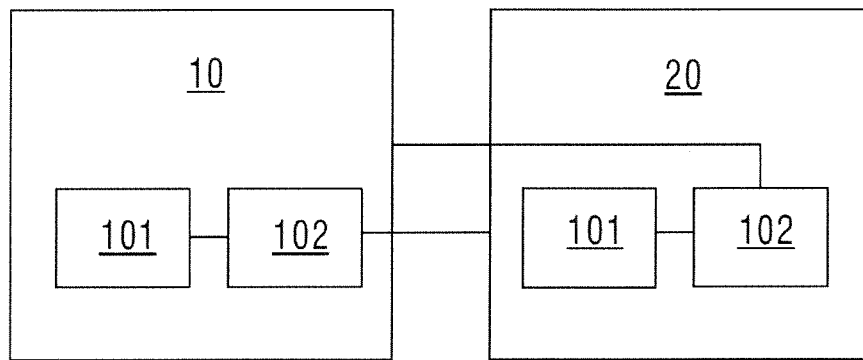
10. A method for controlling a production system, characterized in that the method comprises:

a quality of service (QoS) evaluation unit of a first industrial device acquiring a quality of service parameter of the first industrial device, wherein the quality of service parameter is used for measuring an instruction execution situation of the first industrial device and/or the working performance of the first industrial device, and when the quality of service parameter does not satisfy a pre-set threshold value, sending an optimization request to a production system model (PSM) unit of the first industrial device and various second industrial devices, wherein the optimization request contains the quality of service parameter, so that the production system model (PSM) unit of the first industrial device and various second industrial devices estimates an optimization working state and/or an optimization working parameter of the respective industrial devices according to at least one of a pre-set production system model, a pre-set respective industrial device model, a pre-set production system optimization form and a pre-set respective industrial device optimization form, and the quality of service parameter, and sends the optimization working state and/or the optimization working parameter to the respective industrial devices, wherein the pre-set production system model comprises a model of the first industrial device and each of the second industrial devices constituting the production system, and the

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pre-set production system optimization form comprises a quality of service optimization strategy of the first industrial device and each of the second industrial devices constituting the production system.

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*Fig. 1*

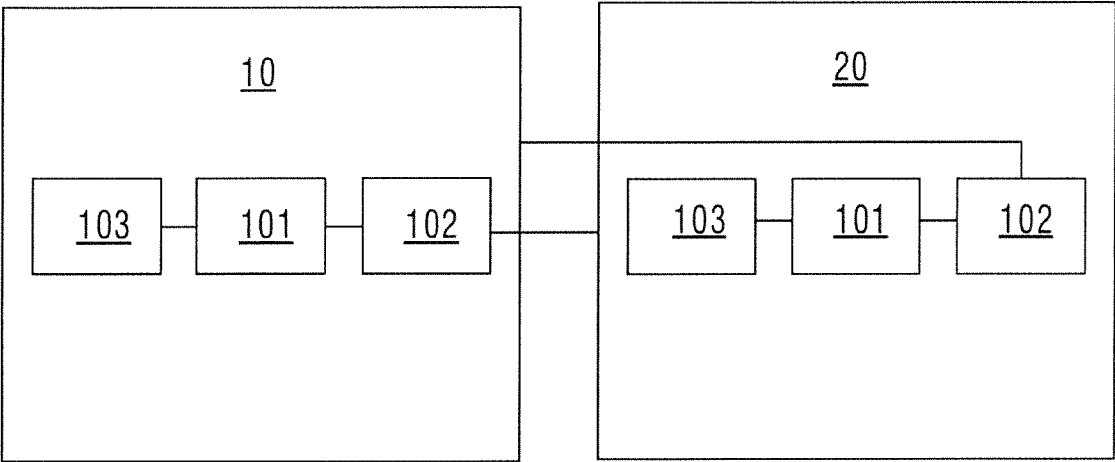


Fig. 2

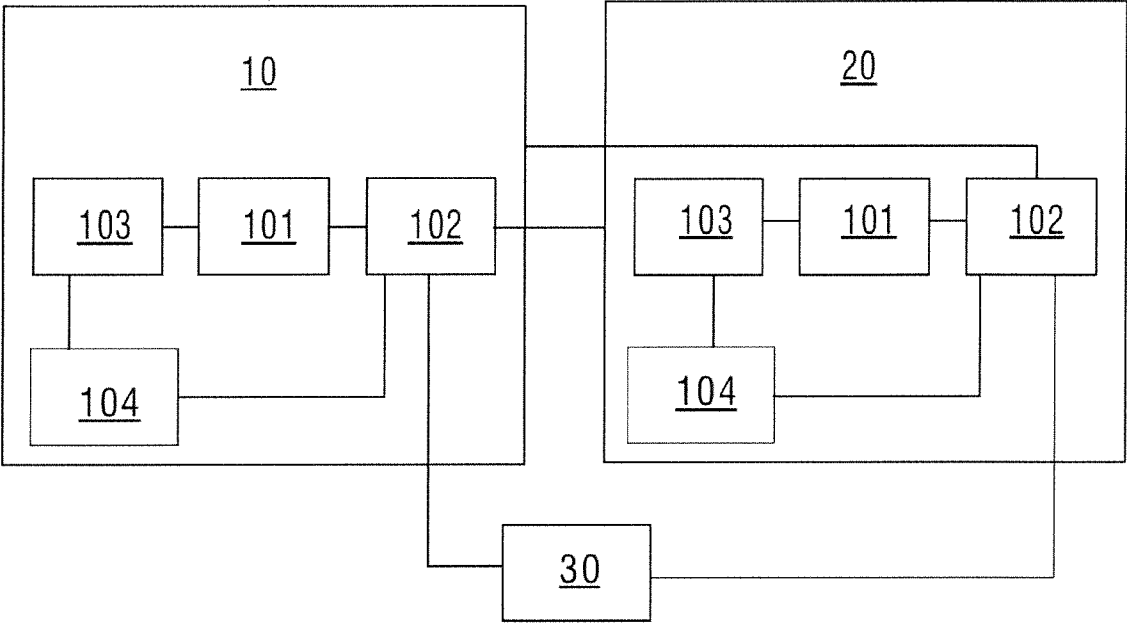
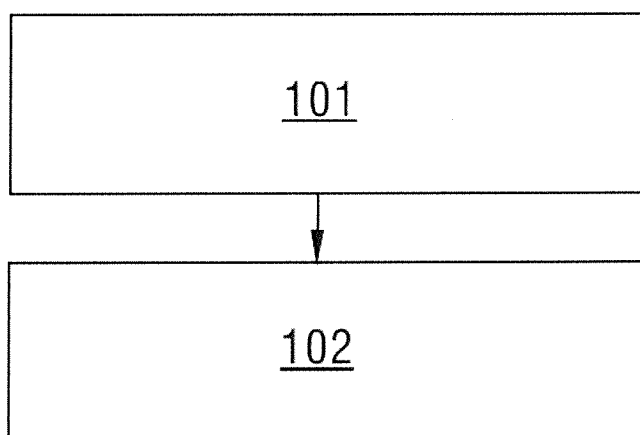
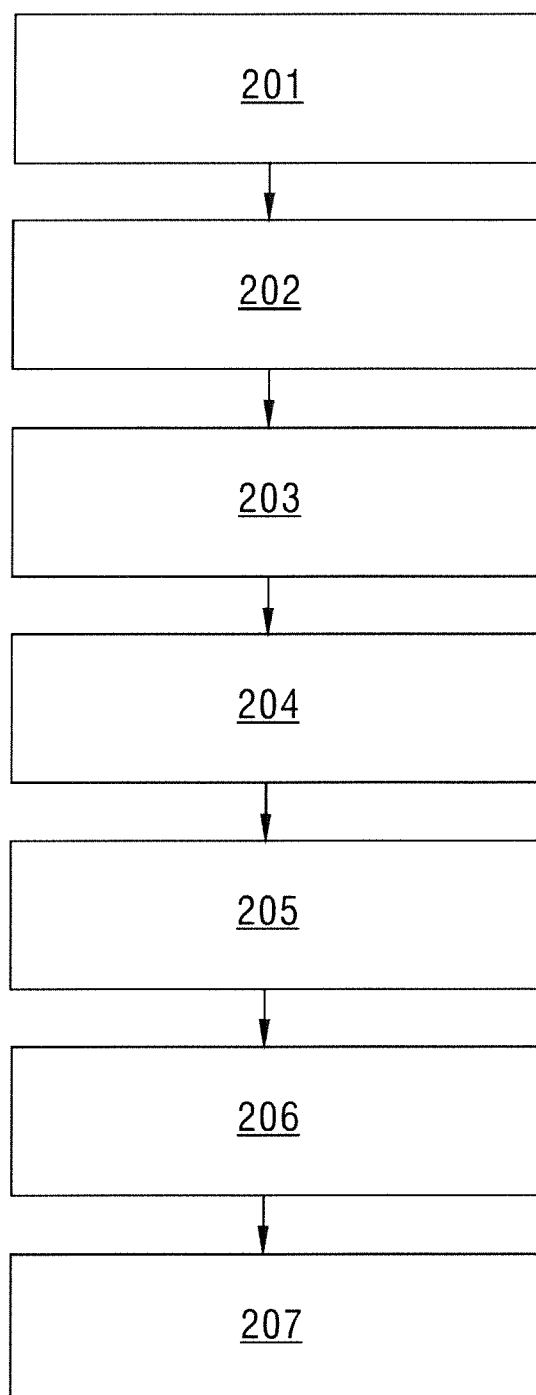


Fig. 3

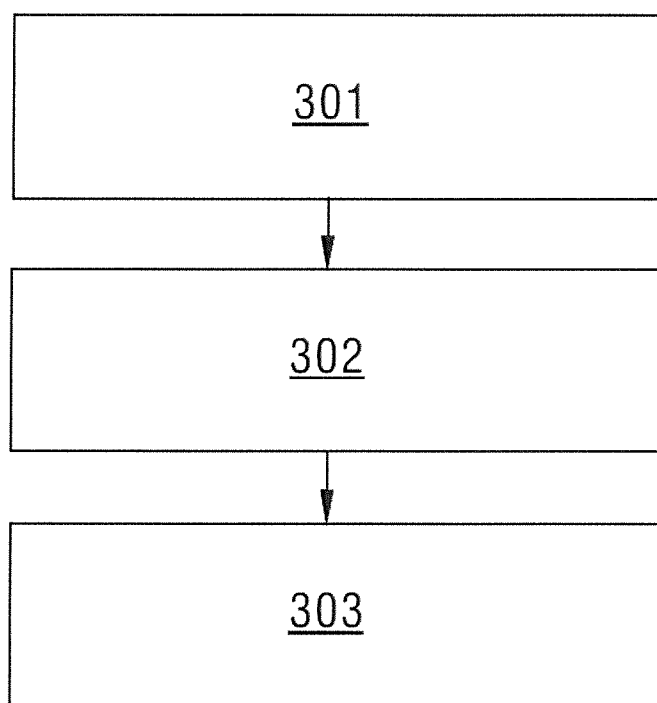
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*Fig. 4*

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*Fig. 5*

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*Fig. 6*

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/054980

A. CLASSIFICATION OF SUBJECT MATTER
INV. G05B19/418 G05B23/02
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	paragraph [0001] paragraph [0135] - paragraph [0137] paragraph [0113] - paragraph [0129] figures 43,47-51	4,5,8,9
X	----- WO 2014/044298 A1 (SIEMENS AG [DE]) 27 March 2014 (2014-03-27)	1-3,5-7, 9,10
Y	page 1, lines 6-19 page 3, line 17 - page 4, line 34 page 5, line 24 - page 6, line 29 page 6, line 37 - page 9, line 10 page 9, line 13 - page 11, line 5 page 11, line 17 - page 12, line 12 page 12, line 14 - page 13, line 20 figures 1-4 ----- -/-	5,9



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Date of the actual completion of the international search

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Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/054980

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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International application No

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