FLEXIBLE WORKSTATION AND MESSAGE TRANSMITTING METHOD THEREOF

BACKGROUND

Technical Field

The disclosure is related to a workstation, particularly related to a flexible workstation and a message transmitting method thereof.

Description of Related Art

The automated production line is generally disposed with multiple workstations for implementing different applications.

However, the related-art workstations are not standardized and modularized, thereby not being capable of rapid modification with respect to different applications. As a result, the dedicated workstation needs to be purchased for the related-art automated production line with respect to the required application, and the production line arrangement cost is increased.

Also, when the application is changed, the exclusive workstation needs to be removed and new workstation needs to be purchased, and thus cost increasing.

Further, in the related-art automated production line, the message transmitting method of master-slave manner (demand/response) is mainly adopted. As a result, every time the workstation is added, deleted or changed, the software configuration of the management equipment needs to be modified substantially, such as changing the dispatching targets of all kinds of control commands of the management equipment. The disadvantage makes the user need to spend huge time to get the workstation to offline or online every time the workstation is changed (the application is changed).

Additionally, most of the related-art automated production machine equipment are produced by customized design. Therefore, when the production line needs to change design, the former machines are generally inapplicable. Moreover, during the testing procedure of the

new production line, if the design needs to be changed, the machine is not capable of being modifying easily. As a result, the procedure of designing and arranging the production line may be time-consuming and high cost. Further, the highly customized machine may not be capable of being flexibly adjusted with respect to the change of the following manufacturing craft and process. Moreover, in the machine equipment of the related-art automated production line, the general fundamental functions, such as power, data signal, compressed air, etc., required for the electric control panel are respectively provided by individual wire, thereby causing complicated wiring and time-consuming and laborious assembly/disassembly. Further, when the electric control panel malfunctions, the complicated wiring may cause extended time in debugging schedule and directly influence the production capacity of the factory.

In view of this, the inventors have devoted themselves to the aforementioned related art, researched intensively try to solve the aforementioned problems.

SUMMARY OF THE DISCLOSURE

The object of the disclosure is to provide an electric control panel, an automation work station, a flexible workstation and a message transmitting method thereof, which may make the workstation be standardized and modularized through the standardized integrated connecting interface, and rapidly set the receiving message types according to the application of the workstation.

In some embodiments, an automation work station includes a control box and an electric control panel. The electric control panel includes a wiring box and an integrated external socket. The wiring box is accommodated in the control box and includes a pressure chamber and multiple docking sockets. The docking sockets includes a pipeline socket, a network socket and a power socket, which communicates with the pressure chamber. The integrated external socket is disposed in the wiring box and includes multiple connecting ports corresponding to the docking sockets. The connecting ports includes a pipeline port communicating with the pressure chamber.

In some embodiments, an electric control panel includes a wiring box and an integrated external socket. The wiring box is accommodated in the control box and includes a pressure chamber and multiple docking sockets. The docking sockets includes a pipeline socket, a network socket and a power socket, which communicates with the pressure chamber. The integrated external socket is disposed in the wiring box and includes multiple connecting ports corresponding to the docking sockets. The connecting ports includes a pipeline port communicating with the pressure chamber.

In some embodiments, a flexible workstation includes a first function station, a second function station, a robot station and a control equipment. The first function station includes a first function equipment. The second function station includes a second function equipment. The robot station is configured to operate the first function equipment of the first function station to implement a first combinational application when connecting to the first function station through cable, and operate the second function equipment of the second function station to implement a second combinational application when connecting to the second function station through cable. The control equipment is connected to the robot station through cable, and configured to subscribe a first topic corresponding to the first combinational application, when the robot station is connected to the first function station, to receive a first message published to all subscribers of the first topic, and to control the robot station or the first function station to implement the first combinational application based on the first message. The control equipment is configured to subscribe a second topic corresponding to the second combinational application, when the robot station is connected to the second function station, to receive a second message published to all subscribers of the second topic, and to control the robot station or the second function station to implement the second combinational application based on the second message.

In some embodiments, a message transmitting method of the flexible workstation includes:

a) setting the flexible workstation to subscribe a first topic, wherein the first topic is

corresponding to a first combinational application of a function station and a robot station of the flexible workstation; b) publishing a first message of the first topic to all subscribers of the first topic through a management equipment; c) executing an action based on the first message when the flexible workstation receives the first message; and d) subscribing a second topic based on a second combinational application when the flexible workstation is changed to be the second combinational application.

The disclosure provides a design for a standardized electric control panel, which includes the serial connection interface of the pressure, network and power. Therefore, the function equipment may be rapidly combined in series and easily to be maintained.

The disclosure may rapidly change the application of the workstation to decrease the changing cost and reduce the setup time before being online.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an architecture diagram of the message transmitting network in accordance with some embodiments.

FIG. 2 is an architecture diagram of the automated production line in accordance with some embodiments.

FIG. 3 is an architecture diagram of the flexible workstation in accordance with some embodiments.

FIG. 4 is an architecture diagram of the processor in accordance with some embodiments.

FIG. 5 is a schematic diagram of the integrated external socket in accordance with some embodiments.

FIG. 6 is a schematic diagram of the flexible workstation in accordance with some embodiments.

FIG. 7 is a schematic diagram of the automated production line in accordance with some embodiments.

FIG. 8 is a schematic diagram of the message transmitting in accordance with some embodiments.

FIG. 9 is a schematic diagram of the process editing interface in accordance with some embodiments.

FIG. 10 is a flowchart of the message transmitting method in accordance with some embodiments.

FIG. 11 is a flowchart of changing the combinational application in accordance with some embodiments.

FIG. 12 is a sequence diagram of registration and subscription in accordance with some embodiments.

FIG. 13 is a flowchart of executing action in accordance with some embodiments.

FIG. 14 is a flowchart of changing workstation in accordance with some embodiments.

FIG. 15 is a flowchart of standardizing connection in accordance with some embodiments.

FIG. 16 is a flowchart of editing and publishing the process in accordance with some embodiments.

FIG. 17 is a stereogram of the automation work station in accordance with some embodiments.

FIG. 18 is a schematic diagram of the wiring box of the automation work station in accordance with some embodiments.

FIG. 19 is a schematic diagram of the wiring box of the automation work station in accordance with some embodiments.

FIG. 20 is a schematic diagram of the using state of the automation work station of the disclosure in accordance with some embodiments.

DETAILED DESCRIPTION

The technical contents of this disclosure will become apparent with the detailed description of embodiments accompanied with the illustration of related drawings as follows. It is intended that the embodiments and drawings disclosed herein are to be considered illustrative rather than restrictive.

The disclosure provides a modularized flexible workstation and a message transmitting method thereof.

The flexible workstation of the disclosure includes a robot station and a function station, which are being modularized. According to the required application (the after-mentioned combinational application) of the automated production line, the disclosure may be used to select the combination of the robot station and the function station which may achieve the combinational application, and rapidly assemble the selected robot station and the function station to be the flexible workstation for the combinational application.

Moreover, when the combinational application is changed, in order to make the flexible workstation be offline/online from/to the automated production line, the disclosure provides a message transmitting method applied for the flexible workstation.

Please refer to FIG. 1, which is an architecture diagram of the message transmitting network in accordance with some embodiments. In the disclosure, the automated production line may include a management node 10 and multiple nodes (two nodes 11, 12 are used as an example in FIG. 1). The nodes 11, 12 are in charge of different applications for the automated production line respectively.

Taking the automated production line of circuit board as an example, the nodes may be configured to respectively execute different applications, such as loading blank board, printing solder paste, inspecting solder paste, mounting small component, mounting large component, inspecting component, welding, inspecting welding, unloading, testing, cutting board etc.

Further, the management node 10 and all nodes 11, 12 are connected with each other through the network 13. The network 13 may be, for example, local area network, industrial ethernet, Wi-Fi network, the other wired/wireless network, or the combination thereof, here is not intended to be limiting.

The publishing/subscribing mechanism of the disclosure is described hereafter.

In the disclosure, each node is configured to only receive the message belonging to the subscription topic without receiving the message not belonging to the subscription topic. The message may be, for example, the control signal, data signal, or response signal, etc., here is not intended to be limiting.

For example, the node 12 may be configured to subscribe the first topic. Thus, when the other nodes publish the first message of the first topic, the first message is sent to all subscribers (including the node 12) of the first topic. Further, when the other nodes publish the second message of the second topic, the node 12 does not receive the second message since the node 12 does not subscribe the second topic.

In the disclosure, when new application needs to be added to the automated production line and new node also needs to be added accordingly, the new node only needs to be registered to the management node 10 and subscribes one or multiple topics required for the new application, and thus the communication configuration of the new node may be completed rapidly without changing the configurations of the other nodes (such as nodes 11, 12).

For example, the new node may be configured to subscribe the first topic. Thus, when the other nodes publish the first message of the first topic, the first message is sent to all subscribers (including the new node) of the first topic without changing the configurations of the other nodes 10-12.

The disclosure may rapidly complete the configuration for the network communication without interfering the other nodes' s operations, when the node goes online/offline, through the aforementioned publishing/subscribing mechanism.

Please refer to FIG. 1 and FIG. 2, FIG. 2 is an architecture diagram of the automated production line in accordance with some embodiments. The management node 10 in FIG. 1 may be, for example, the management equipment 20, and each node 11, 12 may be, for example, the flexible workstation 21. The network 23 is the same as or similar to the network 13, the description is omitted here for brevity.

The automated production line may include the management equipment 20 and multiple flexible workstations 21 connected through the network 23. The flexible workstations 23 are used to respectively implement different combinational applications. Further, the management equipment 20 and each flexible workstation21 may transmit messages therebetween through the aforementioned publishing/subscribing mechanism.

In some embodiments, the automated production line may include the user computer 22, for example general purpose computer, such as personal computer, tablet computer, laptop, etc., connected to the network 23. The user computer 22 is used to provide the process editing interface 220. The process editing interface 220 may be, for example, graphic user interface (GUI), and provide creating/editing function of the automated process.

Specifically, the user may operate the process editing interface 220 to rapidly establish corresponding process based on the combinational application of the designated flexible workstation 21, and publish the process to the flexible workstation 21 to execute.

Comparing to compile program code directly, the disclosure may hugely reduce the threshold, cost and time of developing/maintaining automated control program.

In some embodiments, the user computer 22 may be configured to execute the robot operating system 410 shown in FIG. 4, generate and display the process editing interface 220 through the robot operating system 410, and accept the user's operation through the process editing interface 220 to edit the process.

Please refer to FIG. 1 to FIG. 3, FIG. 3 is an architecture diagram of the flexible workstation in accordance with some embodiments.

The flexible workstation 21 of the embodiment may include one or multiple robot stations (in FIG. 3, using one robot station 31 as an example) and one or multiple function stations (in FIG. 3, using three function stations 32-34 as an example). The robot station 31 and the function stations 32-34 may be connected serially through the integrated cables 350-352 to implement resource sharing and transmitting, such as network, power, air pressure, etc., to achieve the purpose of replacing different cables used in the related art for transmission. Therefore, the amount of the cables may be effectively reduced, and assembling/disassembling time may also be reduced.

Further, the robot station 31 and function stations 32-34 may be the after-mentioned automation work station. In other words, the flexible workstation 21 may be obtained by connecting multiple after-mentioned automation work stations.

Each robot station 31 may include a control box 310, a robotic arm 311 and a wiring box 312 electrically connected to one another. The robot station 31 is used to operate the connected function station 32-34 to implement the corresponding combinational application.

The control box 310 is used to control the robot station 31. Specifically, the control box 310 may be configured to receive power and network signal (for example, control signal) through the wiring box 312, and control the gesture of the robotic am 311 based on the network signal.

The robotic arm 311 may be configured to move in multi-degree-of-freedom, and execute processing to the function stations 32-34. For example, operating the function equipment 32 (for example, the tools such as welding gun, fixture, screwing machine, etc.) of the function station 32 to execute the actions such as welding, inserting, screwing, etc. The robotic arm 311 may be the four-axis robotic arm, six-axis robotic arm, etc., here is not intended to be limiting.

It is worth mentioning that the robotic arm 311 being adopted may be determined based on the demand (for example, the demand with respect to the degree of freedom) of the function equipment 321 to be operated.

Each function station 32-34 (in FIG. 3, using the function station 32 as an example) may include the control box 320, the function equipment 321 and the wiring box 322 electrically connected to one another.

The control box 320 is used to control the function station 32. Specifically, the control box 320 may be configured to receive power and network signal (for example, control signal) through the wiring box 322, and control the function equipment 321 based on the network signal.

The function equipment 321 is used to provide different application tools for the robotic arm 311 of the robotic station 31 to use, such as a laser welding tool, an inserting tool, a screwing tool, a labelling tool, a dispensing tool or a fixture, etc.

Therefore, the robotic arm 311 of the robotic station 31 may implement different combinational applications through mixing different function stations 32-34, such as a laser welding application, an automatic inserting application, an automatic screwing application, an automatic labelling application, an automatic dispensing application or an automatic gripping application, etc.

Further, each wiring box 312, 322 is disposed in a standardized electric control panel and used for integrating multiple connecting ports of the workstation to be a single integrated external socket. Through the simplification, the robot station 31 and function station 32-34 of the disclosure may be assembled/disassembled rapidly through the single integrated external socket. The disclosure may increase conversion speed with respect to the reduction of cable amount.

In some embodiments, the flexible workstation 21 may include the control equipment 30. The control equipment 30 may be disposed on the robot station 31 and connected with the robot station 31 through the network cable 353.

Additionally, the wiring box 312 of the robot station 31 and the wiring box of the function stations 32-34 may be connected serially through the integrated cables 350-352. The integrated cables 350-352 may include the network cable.

Therefore, when the control equipment 30 is connected to the network through the network interface 302, the robot station 31 and all function stations 32-34 connected to the control equipment 30 may also be connected to the network. The control equipment 30 may communicate externally by connecting to the network, and be used to control the flexible workstation 21, such as transmitting control signal to control the robotic arm 311 and/or function equipment 321. Further, the control equipment 30 is used as the node 11 or 12 to implement the message transmitting method of the flexible workstation of the disclosure.

In some embodiments, the control equipment 30 may include a processor 300, a storage 301 and a network interface 302 electrically connected to one another.

The processor 300 is, for example, System on a Chip (SoC), micro processing unit (MPU) or central processing unit (CPU), and is used to execute computation and program to control the control equipment 30.

The storage 301 is, for example, RAM, ROM, EEPROM, flash memory, the other memory or the combination thereof, and is used to store data.

The network interface 302 is, for example, ethernet card, and is used to connect the network 13, 23 and the other workstation (such as the robot station 31 and function stations 32-34).

Please refer to FIG. 1 to FIG. 4, FIG. 4 is an architecture diagram of the processor in accordance with some embodiments.

In some embodiments, the storage 301 of the control equipment 30 may include a non-transitory computer readable recording medium. The non-transitory computer readable recording medium is configured to store a computer program. The computer program records a computer executable code. When the processor 300 is configured to execute the code, all kinds of functions of the disclosure may be implemented.

Specifically, the computer program may include an operating system 400 (such as Windows, Linux, Unix, etc.), a robot operating system 410 (such as Robt OS) and a node

application 420. In the software architecture, the processor 300 may be configured to operate (or run) the operating system 400 on the system layer 40 to provide software/hardware resource management and distribution, and operate the robot operating system 410 on the intermediate layer 41. The robot operating system 410 is used as middleware to provide all kinds of auxiliary tools to assist development and management. For example, the process editing interface 220, node application 420, application program interface (API) or the other software tools executed on the application layer 42. The node application 420 is used to implement the distributed communication as shown in FIG. 1.

As a result, the disclosure may implement rapid development and maintenance of the automated functions.

Please refer to FIG. 6, which is a schematic diagram of the flexible workstation in accordance with some embodiments. With respect to the robot station, the embodiment provides the four-axis robot station 610 and six-axis robot station 611 as an example.

With respect to the function station, the embodiment provides the screwing function station 620 and dispensing function station 621 as an example.

The embodiment further provides a control equipment 600. The control equipment 600 is installed with the robot operating system 410.

When the automatic screwing application (combinational application) of relatively low requirement in degree-of-freedom is to be implemented, the user may install the control equipment 600 to the four-axis robot station 610, and connect the four-axis robot station 610 with the screwing function station 620 through the integrated cable. As a result, the flexible workstation 6 for implementing the automatic screwing application may be obtained.

When the automatic dispensing application (combinational application) of relatively high requirement in degree-of-freedom is to be implemented, the user may replace the four-axis robot station 610 by the six-axis robot station 611 with more degree-of-freedom, and replace

the screwing function station 620 by the dispensing function station 621. As a result, the flexible workstation 6 is changed to implement the automatic dispensing application.

Please refer to FIG. 7, which is a schematic diagram of the automated production line in accordance with some embodiments. In some embodiments, the automated production line 7 may include the transmitting equipment 71, 78, multiple flexible workstation 72-77 and the network switch 70 electrically connected with the aforementioned equipment.

The network switch 70 is configured to provide network communication environment for the management equipment (not shown in figures) to set up each transmitting equipment 71, 78 and each flexible workstation 72-77 to implement the work process of the designated application.

Taking the automated assembly of the computer product as an example, the transmitting equipment 71 is configured to provide the casing. The flexible workstation 72 is configured to dispose multiple computer components in the casing. The flexible workstation 73 is configured to screw some computer components to the casing. The flexible workstation 74 is configured to glue some computer components to the casing. The flexible workstation 75 is configured to flip the computer product to the checking surface. The flexible workstation 76 is configured to shoot the checking surface to visually check if the installation defect is existed through the computer. The flexible workstation 77 is configured to extract the defected computer product from the production line based on the checking result of the flexible workstation 76. The transmitting equipment 78 is configured to transmit the defectless computer product to the next production line or package area.

Please refer to FIG. 10, which is a flowchart of the message transmitting method in accordance with some embodiments. The message transmitting method in the embodiments of the disclosure may be implemented by the automated production line and flexible workstation in every embodiment.

The message transmitting method of the embodiments include the following steps.

The step S10: setting the flexible workstation to subscribe topic (the first topic). The topic is corresponding to the combinational application (the first combinational application) implemented by the present function station (the first function station) and robot station (the first robot station) of the flexible workstation.

The step S11: publishing message to all subscribers of the corresponding topic through the management equipment, for example, publishing message (the first message) of the first topic to all subscribers of the first topic or message (the second message) of the second topic to all subscribers of the second topic.

The step S12: determining, by the flexible workstation, whether message is received. Specifically, the flexible workstation only subscribes the first topic, thereby only receiving message of the first topic.

If the flexible workstation receives any message, the step S13 is being executed. The step S13: the flexible workstation executing actions based on the received message.

The step S14: determining whether the flexible workstation changes subscription.

When the flexible workstation needs to change subscribed topic with respect to the combinational application being changed (for example, changing to the second combinational application), the step S10 is being executed to subscribe new topic (such as the second topic) based on the changed combinational application.

When the flexible workstation does not receive any message in the step S12 or the flexible workstation does not change the subscription in the step S14, the step S15 is being executed. The step S15: determining, by the management equipment and flexible workstation, whether to terminate the execution, such as whether to complete all works, or whether the terminating signal is received, etc.

If terminating the execution is determined, the message transmitting method is terminated. If the execution is not terminated, the step S11 is re-executed.

The disclosure may rapidly change the application of the workstation to reduce the changing cost and reduce the setting time before online.

Please refer to FIG. 8, which is a schematic diagram of the message transmitting in accordance with some embodiments. FIG. 8 is the embodiment used for describing the message transmitting method of the flexible workstation.

The publisher (such as the management equipment) executes process control to respectively execute different processes; for example, collecting process 800, moving process 801, screwing process 802, etc.

Further, the publisher may create the corresponding topic with respect to different processes. The topic is, for example, collecting topic 810, moving topic 811, screwing topic 812, etc.

Moreover, the subscriber (the flexible workstation 820-821) may subscribe different topics based on the liable combinational application. For example, the flexible workstation 820 subscribes the collecting topic 810 and moving topic 811, and the flexible workstation 821 subscribes the moving topic 811 and screwing topic 812.

When the publisher executes the collecting process 800, the publisher may transmit the control message 83 to the collecting topic 810 to make the flexible workstation 820 subscribed the topic receive the message 83 and execute the collecting action based on the message 83.

When the publisher executes the moving process 801, the publisher may transmit the control message 84 to the moving topic 811 to make the flexible workstations 820, 821 subscribed the topic receive the message 84 and execute the moving action based on the message 84.

When the publisher executes the screwing process 802, the publisher may transmit the control message 85 to the screwing topic 812 to make the flexible workstation 821 subscribed the topic receive the message 85 and execute the screwing action based on the message 85.

As a result, the flexible workstation 820, 821 may be configured to rapidly set communication connection through subscribing/deleting subscription.

Please refer to FIG. 10 to FIG. 11, FIG. 11 is a flowchart of changing the combinational application in accordance with some embodiments.

The step S20: changing the present robot station and/or function station to the robot station and/or function station of different types to change the combinational application. For example, executing the steps in FIG. 15.

The step S21: executing subscription and message transmission based on the combinational application of the changed robot station and/or function station. For example, executing the steps in FIG. 10.

Please refer to FIG. 10 to FIG. 12, FIG. 12 is a sequence diagram of registration and subscription in accordance with some embodiments. In some embodiments, the publisher 1000 and the subscriber 1002 may be any one of the nodes 11, 12 (including any one of the flexible workstations in the disclosure), and the management node 1001 may be the management node 10.

First, the publisher 1000, management node 1001 and subscriber 1002 are connected to the same network (the step S300-S302).

The publisher 1000 may send a registering request to the management node 1001 (the step S303) and complete the registration after receiving the responded result of successful registration from the management node 1001 (the step S304). As a result, the management node 1001 may identify the publisher 1000.

After the registration is completed, the publisher 1000 may send a creating topic request to the management node 1001 (the step S305) and complete the establishment of one or multiple topics after receiving the responded result of successful processing from the management node 1001 (the step S306). As a result, the publisher 1000 may publish message with respect to the created topic.

On the other hand, the subscriber 1002 may send a registering request to the management node 1001 (the step S307) and complete the registration after receiving the responded result of successful registration from the management node 1001 (the step S308). As a result, the management node 1001 may identify the subscriber 1002.

After the registration is completed, the subscriber 1002 may send a subscribing request to the management node 1001 (the step S309) and complete the subscription to one or multiple topics after receiving the responded result of successful processing from the management node 1001 (the step S310). As a result, the subscriber 1002 may receive all messages of the subscribed topic through the network.

Afterward, when the publisher 1000 is configured to publish message (the step S311), the management node 1001 is configured to transmit message to all subscribers to the belonging topic according to which topic the message belongs to (the step S312).

Please refer to FIG. 10 to FIG. 13, FIG. 13 is a flowchart of executing action in accordance with some embodiments. In some embodiments, the flexible workstation may trigger different actions according to different received messages. Specifically, the method of the embodiment further includes the following steps.

The step S40: the flexible workstation being configured to respectively set multiple actions with respect to multiple messages.

The step S41: determining, by the flexible workstation, whether any subscribed message is received.

If the flexible workstation does not receive any message, the step S41 is re-executed to continuously detect.

If the flexible workstation receives the message, the step S42 is executed. The step S42: controlling, by the flexible workstation, the robot station and function station to execute the actions corresponding to the message.

For example, the moving message is corresponding to the moving action and may include the coordinate of the robotic arm. When the flexible workstation receives the moving message, the flexible workstation may control the robotic arm to move to the designated coordinate (for example, pose a gesture that the distal end moves to the coordinate) to cooperate with the function station.

In another example, the tin-providing message is corresponding to the tin-providing action and may include tin-providing amount and tin-providing coordinate. When the flexible workstation receives the tin-providing message, the flexible workstation may control the robotic arm to move to the designated tin-providing location and control the function station to squeeze the tin material of the tin-providing amount.

Please refer to FIG. 10 to FIG. 14, FIG. 14 is a flowchart of changing workstation in accordance with some embodiments. The flexible workstation may change the combinational application through the embodiment and rapidly go online after changing the combinational application. Specifically, the method of the embodiment further includes the following steps.

The step S50: controlling the flexible workstation to go offline from the network to stop receiving message of the original combinational application (the first combinational application).

The step S51: replacing the function station (the first function station, which may include the first function equipment) or robot station (the first robot station, which may include the first robotic arm) of the flexible workstation to another function station (the second function station, which may include the second function equipment with different types from the first function equipment) or another robot station (the second robot station, which may include the second robotic arm with different types from the first robotic arm). As a result, the replaced flexible workstation may be changed to implement new combinational application (the second combinational application) from the original combinational application (the first combinational application).

The step S52: setting the replaced flexible workstation to connect to the network.

The step S53: controlling the replaced flexible workstation to register to the management node. Further, after the registration is completed, the replaced flexible workstation may further subscribe the second topic corresponding to the second combinational application in the management node as described above to receive all messages of the second topic through the network.

Please refer to FIG. 1 to FIG. 5, FIG. 5 is a schematic diagram of the integrated external socket in accordance with some embodiments.

In some embodiments, the robot station 31 includes multiple connecting ports, for example, power connecting port 500 (220V AC), power connecting port 501 (220V DC), connecting port 502 (switch, such as network signal connecting port), connecting port 503 (air, such as air pressure connecting port).

The wiring box 312 may be configured to integrate multiple connecting ports as the integrated external socket 51. The integrated external socket 51 may include the power socket 510 (for example, power socket of 220V AC), network socket 511 (for example, ethernet socket) and air pressure socket 512.

Further, the function station 32 includes multiple connecting ports, for example, power connecting port 520 (220V AC), power connecting port 521 (24V DC), network power connecting port 522 (PoE, such as ethernet power supply), air pressure connecting port 523 (air, such as air pressure connecting port) and power connecting port 524 (48V DC).

The wiring box 312 may be configured to integrate multiple connecting ports as the integrated external socket 54. The integrated external socket 54 may include the power socket 540 (for example, power socket of 220V AC), network socket 541 (for example, ethernet socket) and air pressure socket 542.

The integrated cable 350 includes the cable body (for example, including the cables such as power cable, network cable and air pressure cable, etc.) and multiple sockets (for example,

two ends thereof are disposed with sockets such as power socket, network socket and air pressure socket, etc.). The socket is used for connecting the integrated external sockets 51, 54 to make the robot station 31 and function station 32 be able to share/transmit power, signal and air pressure.

Please refer to FIG. 10 to FIG. 15, FIG. 15 is a flowchart of standardizing connection in accordance with some embodiments. The method of the embodiment further includes the following steps for modifying the flexible workstation.

The step S60: connecting the integrated external socket 51 of the robot station 31 and the integrated external socket 54 of the function station 32 through the integrated cable 350 to assemble the flexible workstation 21.

The step S61: providing resource to the robot station 31 or function station 32 through the integrated cable 350. For example, providing air transmission, network transmission and/or power transmission.

The step S62: setting the control equipment 30 based on the combinational application of the robot station 31 and function station 32. For example, setting operation parameter or the other initialization configurations.

As a result, the disclosure may rapidly modify the flexible workstation.

The disclosure further provides the process editing interface based on the robot operating system. The user may rapidly edit the process to be executed by the flexible workstation through the process editing interface.

Please refer to FIG. 10 to FIG. 16, FIG. 16 is a flowchart of editing and publishing the process in accordance with some embodiments. The method of the disclosure further includes the following steps.

The step S70: providing the process editing interface 220 on the user computer 22 (installed with the robot operating system).

In some embodiments, the process editing interface 220 is configured to provide an action list of multiple actions.

The step S71: receiving the user's operation through the process editing interface 220 on the user computer 22 to edit the process. The process includes the executing sequence and executing condition of the actions.

In some embodiments, the step S71 may include the following steps S80-S83.

The step S80: creating the process on the user computer 22. The process may be defined with a starting point and a terminating point.

The step S81: accepting the user's dragging operation through the process editing interface 220 on the user computer 22 to add the actions to between the starting point and the terminating point.

The step S82: accepting the user's setting operation through the process editing interface 220 on the user computer 22 to set the executing sequence and executing condition of the actions.

The step S83: exporting the process being edited on the user computer 22.

In some embodiments, the user computer 22 may be configured to transform the process being edited to the computer executable code through the robot operating system and then export that.

The step S72: transmitting the process being edited to the flexible workstation 21 through the network 23 on the user computer 22 to set the flexible workstation 21 to execute the process.

In some embodiments, the flexible workstation 21 controls the robot station 31 and functions station 32 to execute the process through the robot operating system.

As a result, the disclosure may provide rapid and convenient editing process to the user.

Please refer to FIG. 9, which is a schematic diagram of the process editing interface in accordance with some embodiments. The process editing interface may include the process editing area (such as the left side in FIG. 9) and the action list (such as the right side in FIG. 9).

The process editing area is used to edit the process.

The data architecture of the process is described as below. In some embodiments, the process includes the starting point 900 (as the entering address of the process), the interrupting point 905 (used to interrupt the process when the exception or error occurs) and terminating point 906 (as the terminating address of the process). Further, multiple actions may be set between the starting point 900 and the terminating point 906. The actions are set to be with the executing sequence and executing condition and executed between the starting point 900 and the terminating point 906 based on the executing sequence and executing condition.

The user may drag any listed action 920-926 in the action list to place between the starting point 900 and terminating point 906 of the process (dragging operation) to be the process actions 901-904; for example, dragging the listed actions 920, 925, 926 and 922 to be the process actions 901-904 respectively.

The user may set the executing condition or sequence to the process actions 901-904 (setting operation). For example, setting conditions 910-912 (when the action is executed successfully, executing the next action continuously), setting conditions 913-916 (when the action is failed to be executed, interrupting the process).

After the process editing is completed, the user may publish the process to the flexible workstation to execute the corresponding combinational application.

Please refer to FIG. 17 to FIG. 20, one embodiment of the disclosure provides an automation work station, which includes a control box A100, an electric control panel and a function equipment A300. When the automation work station is the robot station, the function equipment A300 may be the robotic arm 311. When the automation work station is the function station, the function equipment A300 may be the function equipment 321.

The electric control panel is accommodated in the control box A100. The electric control panel includes a wiring box A200 and an integrated external socket A240. The wiring box A200 is accommodated in the control box A100 and includes multiple docking sockets. The function

equipment A300 is disposed on the control box A100 and connected to at least one of the docking sockets through the wiring box A200. The docking sockets at least includes a pipeline socket A231, a network socket A232 and a power socket A233. In some embodiments, the wiring box A200 is disposed with a wiring panel A210, and the docking sockets are disposed on the wiring panel A210. The control box A100 has a maintenance window A101, and the wiring panel A210 is disposed toward the maintenance window A101 to facilitate the user performing wiring operation through the maintenance window A101. Specifically, the function equipment A300 may include a robotic arm, a screwing tool, a laser welding tool, an inserting tool, a screwing tool, a labelling tool, a dispensing tool, a fixture, an optical path module, a laser source or a tin feeder, etc., here is not intended to be limiting. Further, the docking sockets are correspondingly connected different function equipment A300 according to the demand.

Please refer to FIG. 18 and FIG. 19, the wiring box A200 is further disposed with a pressure chamber A220. The pressure chamber A220 communicates with the pipeline socket A231 (as the aforementioned air pressure socket). A pressure regulator A511 is disposed between the pipeline socket A231 and pressure chamber A220. The pressure regulator A511 is used for regulating the pressure output by the pressure chamber A220, and may perform the regulation according to the pressure demand of different function equipment A300.

The integrated external socket A240 is disposed in the wiring box A200. The integrated external socket A240 is disposed on the wiring panel A210. The integrated external socket A240 includes multiple connecting ports corresponding to the docking sockets. Specifically, the connecting ports includes a pipeline port A241 (as the aforementioned air pressure connecting port) communicating with the pressure chamber A220, a network port A242 electrically connected to the network socket A232 and a power port A243 electrically connected to the power socket A233. Further, a switch valve A512 may be disposed between the pipeline port A241 and pressure chamber A220 for switching on/off the pressure connection.

In some embodiments, the integrated external socket A240 is disposed on the wiring panel A210 to facilitate wiring operation. The integrated external socket A240 is used for outputting or inputting of air pressure, network and power, the transmission direction is not limited in the disclosure. In some embodiments, two integrated external sockets A240 are arranged for outputting and inputting in the serial connection.

Please refer to FIG. 18 to FIG. 20, the automation work station of the disclosure further includes an integrated cable A400. The integrated cable A400 includes a cable body A410 and at least one socket A420. The socket A420 is used to dock with the integrated external socket A240. The socket A420 is disposed on one end of the cable body A410. Multiple connectors are disposed in the socket A420 corresponding to the connecting ports. The connectors include a pipeline connector A421 used for docking to the pipeline port A241, a network connector A422 used for docking to the network port A242 and a power connector A423 used for docking to the power port A243. The cable body A410 is disposed with a pipeline A411 connected to the pipeline connector A421, a network signal line A412 connected to the network connector A422 and a power line A412 connected to the power connector A423.

When two ends of the cable body A410 are disposed with the same sockets A420, the pipeline A411 is respectively connected to each pipeline connector A421 in each socket A420, the network signal line A412 is respectively connected to each network connector A422 in each socket A420, and the power line A412 is respectively connected to each power connector A423 in each socket A420. One of the socket A420 is inserted to external socket, another socket A420 is inserted to the integrated external socket A240 on the wiring box of another control box A100. Therefore, multiple function equipment A300 may be connected in series. For example, the robotic arm is connected to the electric screwdriver to assemble the screwing machine for assembling process, or the robotic arm, electric screwdriver, laser source, optical path module and tin feeder are connected to assemble the laser soldering machine. The connection and using manner of the integrated cable A400 are described hereafter.

When the socket A420 is only disposed on one end of the cable body A410 of the integrated cable A400, one end of the pipeline A411 is connected to the pipeline connector A421 and another end of the pipeline A411 is connected to a pressure source A10, one end of the network signal line A412 is connected to the network connector A422 and another end of the network signal line A412 is connected to a network device A20, and one end of the power line A413 is connected to the power connector A423 and another end of the power line A413 is connected to a power source A30. The compressed fluid required by the automation work station is input to the pressure chamber A220 and passes the pipeline socket A230 to output to the function equipment A300. In some embodiments, the pressure source A10 provides compressed air.

Please refer to FIG. 18 and FIG. 19, the connection and using manner of the pressure, network and power of the automation work station are described hereafter. The wiring box A200 is further disposed with a power switch A531, a power converter A532, an electric power measurer A533 and a network switch A521.

The pressure regulator A511 may be disposed with a pressure detector A513 electrically connected with the network switch A521, and be used for detecting the abnormal state of under pressure and output digital signal. Further, the pressure detector A513 may be disposed with a pressure meter to display pressure-providing.

The network switch A521 is electrically connected with the network socket A232 and the network port A242 of the integrated external socket A240. The network switch A521 is used for serially connecting the external object device to exchange data through signal transmission. The network switch A521 may be connected to different devices on the same network to transmit the data signal required for controlling the function equipment A300.

The power switch A531 is electrically connected with the power socket A233 and the network socket A232. The power switch A531 is used for controlling power input/output or switching different voltages. The power converter A532 is electrically connected with the power socket A233. The power converter A532 is used for converting the input AC power to

DC power for the required power of the function equipment A300 or the other components in the control box A100. The electric power measurer A533 is electrically connected with the power socket A233 to measure the power state provided to the function equipment A300. The electric power measurer A533 is electrically connected with the network switch A521 to output the detected information.

The disclosure provides a design for a standardized electric control panel, which includes the serial connection interface of the pressure, network and power. Therefore, the function equipment A300 may be rapidly combined in series and easily to be maintained. The automation work station of the disclosure further incorporates the electric power measurer A533 and pressure detector A513 with respect to the pressure, network and power line A413 to record the historic operating data of the function equipment A300 for a feedback modification to optimize the operation of the function equipment A300. The integrated cable A400 may be used to rapidly connect the fundamental functions of each control box A100 in series, thereby increasing the flexibility of serial connection and convenience of the function equipment A300. Therefore, the function equipment is easily to be replaced, thereby reducing the cost of changing the design of developing function equipment.

While this disclosure has been described by means of specific embodiments, numerous modifications and variations may be made thereto by those skilled in the art without departing from the scope and spirit of this disclosure set forth in the claims.

CLAIMS

1. A flexible workstation, comprising:

a first function station, comprising a first function equipment;

a second function station, comprising a second function equipment;

a robot station, configured to operate the first function equipment of the first function station to implement a first combinational application when connecting to the first function station through cable, and operate the second function equipment of the second function station to implement a second combinational application when connecting to the second function station through cable; and

a control equipment, connected to the robot station through cable, and configured to subscribe a first topic corresponding to the first combinational application, when the robot station is connected to the first function station, to receive a first message published to all subscribers of the first topic, and to control the robot station or the first function station to implement the first combinational application based on the first message;

wherein the control equipment is configured to subscribe a second topic corresponding to the second combinational application, when the robot station is connected to the second function station, to receive a second message published to all subscribers of the second topic, and to control the robot station or the second function station to implement the second combinational application based on the second message.

2. The flexible workstation according to claim 1, wherein the robot station comprises:

a robotic am, configured to move in multi-degree-of-freedom;

a wiring box, connected to the control equipment through cable, connected to the first function station or the second function station through cable, and configured to receive a power and a network signal; and

a control box, connected to the robotic am and the wiring box, and configured to control the robotic am to move to a coordinate to cooperate with the first function station or the second function station based on the coordinate of the first message or the second message being received.

3. The flexible workstation according to claim 1, wherein the first function station, the second function station and the robot station respectively comprise a wiring box, and the wiring box is configured to integrate multiple connecting ports to be an integrated external socket;

the integrated external socket of the robot station is connected to the integrated external socket of the first function station or the integrated external socket of the second function station through an integrated cable.

4. The flexible workstation according to claim 3, wherein the integrated external socket comprises a power socket, a network socket and an air-pressure socket;

the integrated cable comprises a power cable, a network cable and an air-pressure cable respectively disposed on two ends thereof.

5. The flexible workstation according to claim 1, wherein the control equipment is configured to control the flexible workstation to go offline from a network, and set the flexible workstation being changed to connect the network, when the robot station is connected to the second function station, to register the flexible workstation being changed to a management node, and subscribe the second topic corresponding to the second combinational application.

6. The flexible workstation according to claim 1, wherein the first function equipment is different from the second function equipment, the first function equipment and the second

function equipment respectively comprises a laser welding tool, an inserting tool, a screwing tool, a labelling tool, a dispensing tool or a fixture; and

the first combinational application or the second combinational application comprises a laser welding application, an automatic inserting application, an automatic screwing application, an automatic labelling application, an automatic dispensing application or an automatic gripping application.

7. The flexible workstation according to claim 1, wherein the control equipment comprises:

a network interface, configured to connect with a network and the robot station; and

a processor, configured to control the robot station, the first function station or the second function station based on the first message or the second message.

8. The flexible workstation according to claim 7, wherein the control equipment further comprises:

a storage, configured to store a robot operating system;

wherein the processor is configured to obtain a process, and execute the robot operating system to control the robot station, the first function station or the second function station to execute the process;

wherein the process comprises an executing sequence and an executing condition of multiple actions.

9. The flexible workstation according to claim 1, further comprising:

a robot operating system, installed in a user computer, and configured to control the user computer to display a process editing interface after being executed and accept an operation through the process editing interface to edit a process.

10. The flexible workstation according to claim 9, wherein the process comprises:

a starting point, configured to be an entering address of the process;

an interrupting point, configured to interrupt the process when an exception or an error occurs;

a terminating point, configured to be a terminating address of the process; and

multiple actions, set between the starting point and the terminating point, and selected from an action list provided from the process editing interface.

11. A message transmitting method of a flexible workstation, comprising steps of:

a) setting the flexible workstation to subscribe a first topic, wherein the first topic is corresponding to a first combinational application of a function station and a robot station of the flexible workstation;

b) publishing a first message of the first topic to all subscribers of the first topic through a management equipment;

c) executing an action based on the first message when the flexible workstation receives the first message; and

d) subscribing a second topic based on a second combinational application when the flexible workstation is changed to be the second combinational application.

12. The message transmitting method according to claim 11, wherein the a) further comprises steps of:

a1) setting the flexible workstation to connect to a network;

a2) registering the flexible workstation to a management node in the network; and

a3) controlling the flexible workstation to subscribe the first topic in the management node to receive all messages of the first topic through the network, after registration is completed.

13. The message transmitting method according to claim 11, wherein the c) further comprises steps of:

c1) respectively setting multiple actions with respect to multiple messages, wherein the messages comprise the first message; and

c2) controlling the robot station and the function station to execute the action corresponding to the first message, when the first message is received.

14. The message transmitting method according to claim 13, wherein the message comprises a coordinate of a robotic arm of the robot station;

the c2) further comprises a step of: controlling the robotic am to move to the coordinate to cooperate with the function station.

15. The message transmitting method according to claim 11, wherein the d) further comprises steps of:

d1) controlling the flexible workstation to go offline from a network;

d2) replacing the function station or the robot station to another function station or another robot station to make the flexible workstation change to the second combinational application from the first combinational application;

d3) setting the flexible workstation being changed to connect to the network;

d4) registering the flexible workstation being changed in a management node; and

d5) controlling the flexible workstation to subscribe the second topic corresponding to the second combinational application in the management node to receive all messages of the second topic through the network.

16. The message transmitting method according to claim 15, wherein the robot station comprises a robotic am in multi-degree-of-freedom;

the function station comprises a laser welding tool, an inserting tool, a screwing tool, a labelling tool, a dispensing tool or a fixture; and

the first combinational application comprises a laser welding application, an automatic inserting application, an automatic screwing application, an automatic labelling application, an automatic dispensing application or an automatic gripping application.

17. The message transmitting method according to claim 11, wherein the robot station comprises a wiring box, and the wiring box is configured to integrate multiple connecting ports of the robot station to be an integrated external socket;

The function station comprises a wiring box, and the wiring box is configured to integrate multiple connecting ports of the function station to be an integrated external socket;

before the a), the method further comprises s step of:

e) connecting the integrated external socket of the robot station with the integrated external socket of the function station through an integrated cable to be the flexible workstation.

18. The message transmitting method according to claim 17, further comprising a step of:

f) providing at least one of an air transmission, a network transmission and a power transmission to the robot station or the function station through the integrated cable.

19. The message transmitting method according to claim 11, further comprising steps of:

g1) providing a process editing interface on a user computer, and accepting an operation through the process editing interface to edit a process, wherein the process comprises an executing sequence and an executing condition of multiple actions; and

g2) transmitting the process to the flexible workstation through a network to set the flexible workstation to execute the process;

wherein editing the process comprises steps of:

g11) creating the process, wherein the process is defined with a starting point and a terminating point;

g12) providing an action list of the actions in the process editing interface;

g13) accepting a dragging operation through the process editing interface to add the actions to between the starting point and the terminating point; and

g14) accepting a setting operation through the process editing interface to set the executing sequence and the executing condition of the actions of the process.

20. The message transmitting method according to claim 19, wherein the flexible workstation comprises a control equipment, and the control equipment comprises a robot operating system;

the g2) comprises a step of:

g21) transmitting the process to the control equipment to control the robot station and the function station through the robot operating system to execute the process.