(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
7 March 2013 (07.03.2013)

WIPO | PCT

(10) International Publication Number
WO 2013/029658 Al

(51) International Patent Classification:
B25J 13/00 (2006.01) *B25J 13/06* (2006.01)

(21) International Application Number:
PCT/EP20 11/064887

(22) International Filing Date:
30 August 201 1 (30.08.201 1)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant *(for all designated States except US):* **ABB TECHNOLOGY AG** [CH/CH]; Affolternstrasse 44, CH-8050 Zurich (CH).

(72) Inventors; and
(75) Inventors/Applicants *(for US only):* **SJÖBERG, Ralph** [SE/SE]; Egilsvagen 76, Sweden, S-723 55 Vasteras (SE). **MYHR, Mats** [SE/SE]; Gideonsbergsgatan 15E, S-722 25 Vasteras (SE). **NYLÉN, Olov** [SE/SE]; Packisvagen 9, S-722 31 Vasteras (SE).

(74) Agent: **SAVELA, Reino;** ABB AB, Intellectual Property, Ingenjor Baaths Gata 11, S-721 83 Vasteras (SE).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available):* AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available):* ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,

[Continued on nextpage]

WO 2013/029658 A1

(54) Title: ENABLING DEVICE TRANSFERRING ROBOT CONTROL SIGNALS

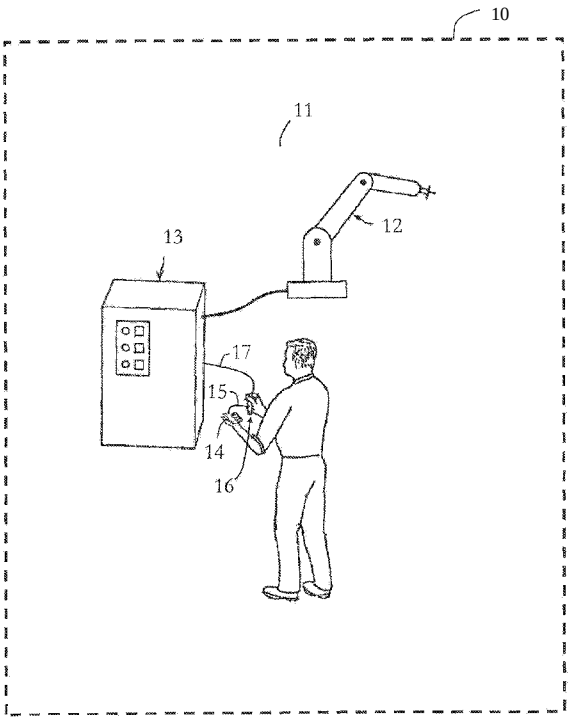

Figure 2

(57) Abstract: The present invention relates to an industrial robot system (11) comprising a robot that comprises a manipulator (12) and a robot controller (13) arranged to control the manipulator, and an enabling device (16) arranged to be connected via a first wire (17) to the robot controller, which upon activation is arranged to enable manual operation of the manipulator. The enabling device is further arranged to be connected to, and receive robot control signals from, an operator control device (14) via which the robot is arranged to be manually operated, and to transfer the received robot control signals to the robot controller via the first wire. The enabling device and the operator control device are separate devices each comprised in a respective individual housing.

TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published :

— *with international search report (Art. 21(3))*

ENABLING DEVICE TRANSFERRING ROBOT CONTROL SIGNALS

TECHNICAL FIELD

The invention relates to an industrial robot system and a method of controlling an industrial robot.

BACKGROUND

An industrial robot is comprised of a robot controller and a manipulator and is programmed to carry out work along a predetermined operating path. In order to program or teach the robot the work, the manipulator is manipulated to positions along the desired operating path via the robot controller. These positions are stored as instructions in a memory in the robot controller. Other information, such as desired robot movement velocity, may also be stored in the memory. During operation of the robot, the program instructions are executed, thereby making the robot operate as desired.

The person controlling the robot is denoted an operator or user. An industrial robot can be operated in different operation modes. For example, when the robot is put in manual operation mode, the robot is controlled by means of a portable operator control device, generally denoted a Teach Pendant Unit (TPU). The TPU is used for manually controlling the robot, for example to teach or program the manipulator to follow an operating path. The TPU may also be used for monitoring the robot program, changing certain variables in the program and starting, stopping and editing the program.

In practice, one or more manipulators are located in a designated (enclosed) area referred to as a robot cell, and one or more corresponding robot controllers are located in, or in connection to, the robot cell and communicates with the respective manipulator via wire. The TPU normally comprises operator control means and a visual display unit. The operator control means usually is a joystick, a jog dial, a ball, a set of buttons or any combination of these such that a designated manipulator can be controlled.

Manipulators are typically heavy and bulky devices which move very fast, and great measures of safety must be taken for an operator to be able to control a manipulator within the robot cell to avoid any risk of injury. Therefore, the TPU further comprises

an enabling device which contains an on-button, an off-button and an emergency-button. For the robot controller to be able to control a given manipulator, the operator must push the on-button such that power is provided to the manipulator. Operating the off-button shuts the power down of the manipulator that the operator controls, while a push of the emergency button shuts down all manipulators in the cell. Any person moving into the robot cell must for safety reasons hold the enabling device in his or her hand.

Hence, an operator wishing to control a robot must for control and safety reasons have access to both the operator control means and the enabling device. Therefore, these functional entities are combined into one single device in the form of a TPU which is connected to the robot controller in order to control a designated manipulator.

Now, prior art TPUs are associated with the drawback that they are specific-purpose controllers manufactured exclusively for controlling a particular type, or particular family of robots. This drawback has as a consequence that prior art TPUs become complex and expensive.

SUMMARY

An object of the present invention is to solve or at least mitigate these problems in the art.

This object is achieved in a first aspect of the present invention by an industrial robot system comprising a robot that comprises a manipulator and a robot controller arranged to control the manipulator, and an enabling device arranged to be connected via a first wire to the robot controller, which upon activation is arranged to enable manual operation of the robot. The enabling device is further arranged to be connected to, and receive robot control signals from, an operator control device via which the robot is arranged to be manually operated, and to transfer the received robot control signals to the robot controller via the wire. The enabling device and the operator control device are separate devices each comprised in a respective individual housing.

The object is achieved in a second aspect of the present invention by a method of controlling an industrial robot comprising a manipulator and a robot controller arranged to control the manipulator, the method comprising the steps of sending enabling signals

via a first wire from an enabling device to the robot controller, which enabling signals enable manual operation of the manipulator; and receiving robot control signals at the enabling device and transferring the robot control signals to the robot controEer for manual operation of the manipulator

By arranging the operator control device and enabling device into two separate devices each comprised in a respective individual housing and having them communicate with each other, it is possible to use less complex hardware for robot control. The enabling device will be located at the robot controller and connected to the robot controller via wire. In order to have an operator control the robot via the operator control device, the enabling device must be activated, typically by pushing and holding an enable button on the enabling device. As previously mentioned, the enabling device basically contains an on-button, an off-button and an emergency-button. Thus, the enabling device in practice comprises a couple of switches and some push buttons. Consequently, the enabling device in itself is a fairly non-complex and inexpensive device. However, with the present invention, the problem in the art of utilizing the special-purpose TPU is overcome. Instead, an operator control device connected to the enabling device is used for controlling the robot and particularly for controlling movement of the manipulator.

In an embodiment of the present invention, the enabling device is arranged to be connected via wire to the operator control device. The enabling device and the operator control device are arranged with an appropriate interface for interconnection such as for example universal serial bus (USB). Possibly, adapting cables and/ or connectors may have to be used for connecting the two devices.

In another embodiment of the present invention, the enabling device is arranged to be wirelessSy connected to the operator control device. This is advantageous since an operator is given more room for manoeuvre and a cable can be avoided.

In yet another embodiment of the present invention, the wireless communication between the operator control device and the enabling device is effected by means of short range communication technology, such as for example Bluetooth or infrared. Since the operator at all times is required to hold the enabling device in her one hand in order to push and hold the enabling button to enable control of the robot, while actually controlling movement of the manipulator with the operator control device placed in her

other hand, it is highly advantageous to carry out the wireless communication between the enabling device and the operator control device with short range communication technology. Advantages brought about by this particular embodiment is that less operator control device output power is required, and further that the risk of causing disturbance and interference with other robots is decreased.

In a further embodiment of the present invention, the operator control device is handheld. Since the operator will typically operate the enabling device with her one hand and the operator control device with the other, it is advantageous to design the operator control device to be small and light-weight such that the operator easily can hold and manoeuvre the device.

In yet a further embodiment of the present invention, the operator control device is a general purpose device, such as e.g. a personal digital assistant (PDA), a smart phone or the like, equipped with appropriate software for controlling the robot. By using a general purpose device, it is possible to provide relatively inexpensive robot control in that available and readily accessible hardware in the form of for instance a smart phone is utilized. In the smart phone, an appropriate control program is downloaded, and the robot is controlled via the smart phone display, buttons and wireless Bluetooth interface or a wired interface such as USB.

In another embodiment of the present invention, the enabling device is handheld. Similar to the previously mentioned embodiment where the operator control device is handheld, it is advantageous to design the enabling device to be small and light-weight such that the operator easily can hold and manoeuvre the enabling device.

In still another embodiment of the present invention, one or both of the enabling device and the operator control device are arranged with an indicator for indicating wireless communication between the enabling device and the operator control device. Advantageously, since the enabling device and the operator control device are closely separated when in operation, there is no need to initiate a tedious and complex procedure for ensuring that a given operator control device (among potentially many) actually is associated with the correct enabling device. With the present invention, the operator knows that by holding the operator control device close to a designated enabling device, the associating procedure is carried through and the operator can be

assured that she actually is communicating with the intended robot. Further advantageously, one or more indicators can be used for indicating that the wireless communication is activated, i.e. for indicating when a wireless interface has been set-up between the enabling device and the operator control device.

Further features of, and advantages with, the present invention will become apparent when studying the appended claims and the following description. Those skilled in the art realize that different features of the present invention can be combined to create embodiments other than those described in the following.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is now described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 shows a prior art industrial robot system;

Figure 2 shows an embodiment of an industrial robot system according to the present invention; and

Figure 3 shows another embodiment of an industrial robot system according to the present invention.

DETAILED DESCRIPTION

The invention will now be described more fully hereinafter with reference to the accompanying drawings, in which certain embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided by way of example so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art.

Figure 1 shows a prior art industrial robot system 1 comprising a manipulator 2, a robot controller 3 for controlling the manipulator, and a portable operator control device 4 referred to as a TPU for manually operating the manipulator. The TPU communicates with the robot controller via a cable 5. The TPU typically comprises a display 6 and control means 7 for manually operating the manipulator, in this case illustrated in the form of a joystick. The TPU further comprises an enabling device that comprises an

enabling button or handle 9 which must be pushed and held by the operator such that the robot can be controlled. Once the operator releases the enabling handle, the robot cannot be controlled by the TPU. Thus, the enabling handle practically constitutes an on-button which continuously must be activated for control to be possible. The enabling device further comprises an off-button and an emergency-button. Operating the off-button shuts the power down of the particular manipulator that the operator controls, while a push of the emergency button shuts down all manipulators in a cell 10, in case a number of robots are located in the same cell. Any person moving into the robot cell must for safety reasons hold the enabling device in his or her hand.

Figure 2 shows an embodiment of an industrial robot system 11 according to the present invention. The industrial robot system 11 comprises a manipulator 12, a robot controller 13 for controlling the manipulator, an enabling device 16 which upon activation is arranged to enable manual operation of the robot, and a portable operator control device 14 for manually operating the manipulator. As can be seen, the enabling device and the operator control device are separate devices each comprised in a respective individual housing. In this particular embodiment, the operator control device is a smart phone comprising a touch-screen that operator manipulates to control the robot. When manipulating the smart phone 14, control signals are sent via a second wire 15 to the enabling device 16 which transfers the control signals to the robot controller via a first wire 17 such that the manipulator is controlled in an intended manner. Again, the enabling device comprises an enabling button which must be pushed and held by the operator such that the robot can be controlled. Once the operator releases the enabling button, the robot cannot be controlled by the operator control device 14. The enabling device further comprises an off-button and an emergency-button. Operating the off-button shuts the power down of the particular manipulator that the operator controls, while a push of the emergency button shuts down all manipulators in a cell 10, in case a number of robots are located in the same cell. Any person moving into the robot cell must for safety reasons hold the enabling device in his or her hand.

Figure 3 shows a further embodiment of an industrial robot system 11 according to the present invention. The industrial robot system 11 comprises a manipulator 12, a robot controller 13 for controlling the manipulator, an enabling device 16 which upon

activation is arranged to enable manual operation of the robot, and a portable operator control device 14 for manually operating the manipulator. As can be seen, the enabling device and the operator control device are separate devices each comprised in a respective individual housing, In this particular embodiment, the operator control device is a smart phone comprising a touch-screen that operator manipulates to control the robot. When manipulating the smart phone 14, control signals are sent via wireless interface 18 using e.g. Bluetooth to the enabling device 16 which transfers the control signals to the robot controller via the first wire 17 such that the manipulator is controlled in an intended manner. Again, the enabling device comprises an enabling button which must be pushed and held by the operator such that the robot can be controlled. Once the operator releases the enabling button, the robot cannot be controlled by the operator control device 14. The enabling device further comprises an off-button and an emergency-button. Operating the off-button shuts the power down of the particular manipulator that the operator controls, while a push of the emergency button shuts down all manipulators in a cell 10, in case a number of robots are located in the same cell. Any person moving into the robot cell must for safety reasons hold the enabling device in bis or her hand.

Advantageously, in an embodiment of the present invention, the enabling device and the operator control device being arranged in two individual and separate housings can be attached together by suitable mechanical fastening means which is substantially rigid to enable the handling of the two devices as a single unit yet enabling fast detaching when need arises. For example, the fastening means may comprise a rack arranged to receive the two devices. Or, alternatively, the enabling device may comprise a docking station arranged to physically receive the operator control device and to simultaneously operatively connect the operator control device to the enabling device. This facilitates handling of the enabling device and the operator control device.

Even though the invention has been described with reference to specific exemplifying embodiments thereof, many different alterations, modifications and the like will become apparent for those skilled in the art. The described embodiments are therefore not intended to limit the scope of the invention, as defined by the appended claims.

CLAIMS

1. An industfial robot system (11) comprising:
a robot comprising a manipulator (12) and a robot controller (13) arranged to control said manipulator; and
an enabling device (16) arranged to be connected via a first wire (17) to the robot controller, which upon activation is arranged to enable manual operation of the manipulator, and further being arranged to be connected to, and receive robot control signals from, an operator control device (14) via which the manipulator is arranged to be manually operated, and to transfer the received robot control signals to the robot controller via the first wire,
characterized in that the enabling device and the operator control device are separate devices each comprised in a respective individual housing.

2. The industrial robot system (11) according to claim 1, wherein the enabling device is arranged to be connected via a second wire (15) to the operator control device.

3. The industrial robot system (11) according to claim 1, wherein the enabling device is arranged to be wirelessly connected (18) to the operator control device.

4. The industrial robot system (11) according to claim 3, wherein the wireless connection (18) between the operator control device (14) and the enabling device (16) is effected by means of using a short-range communication technology.

5. The industrial robot system (11) according to any one of the preceding claims, further comprising said operator control device (14).

6. The industrial robot system (11) according to claim 5, wherein the operator control device (14) is handheld.

7. The industrial robot system (11) according to claims 5 or 6, wherein the operator control device (14) is a general purpose device.

8. The industrial robot system (11) according to claim 7, wherein the operator control device (14) is a personal digital assistant or a smart phone.

9. The industrial robot system (11) according to any one of the preceding claims, wherein the enabling device (16) is handheld.

10. The industrial robot system (11) according to claim 3, wherein one or both of the enabling device (16) and the operator control device (14) are arranged with an indicator for indicating wireless connection (15) between the enabling device and the operator control device.

11. The industrial robot system (11) according to any one of the preceding claims, the industrial robot system further comprising fastening means for attaching the enabling device and the operator control device rigidly together for enabling the handling of the two devices as a single unit.

12. A method of controlling an industrial robot comprising a manipulator (12) and a robot controller (13) arranged to control said manipulator, the method comprising the steps of:

sending enabling signals via a first wire (17) from an enabling device (16) to the robot controller, which enabling signals enable manual operation of the manipulator; and

receiving robot control signals at the enabling device and transferring the robot control signals to the robot controller for manual operation of the manipulator.

13. The method of controlling an industrial robot according to claim 12, the enabling device (16) receiving robot control signals from an operator control device (14), wherein the enabling device and the operator control device are separate devices each comprised in a respective individual housing.

14. The method of controlling an industrial robot according to claims 12 or 13, wherein the enabling device receives the robot control signals via a second wire (15).

15. The method of controlling an industrial robot according to claim 12 or 13, wherein the robot control signals are received via wireless communication (18).

16. The method of controlling an industrial robot according to claim 15, wherein the wireless communication (18) is effected by means of using a short-range communication technology.

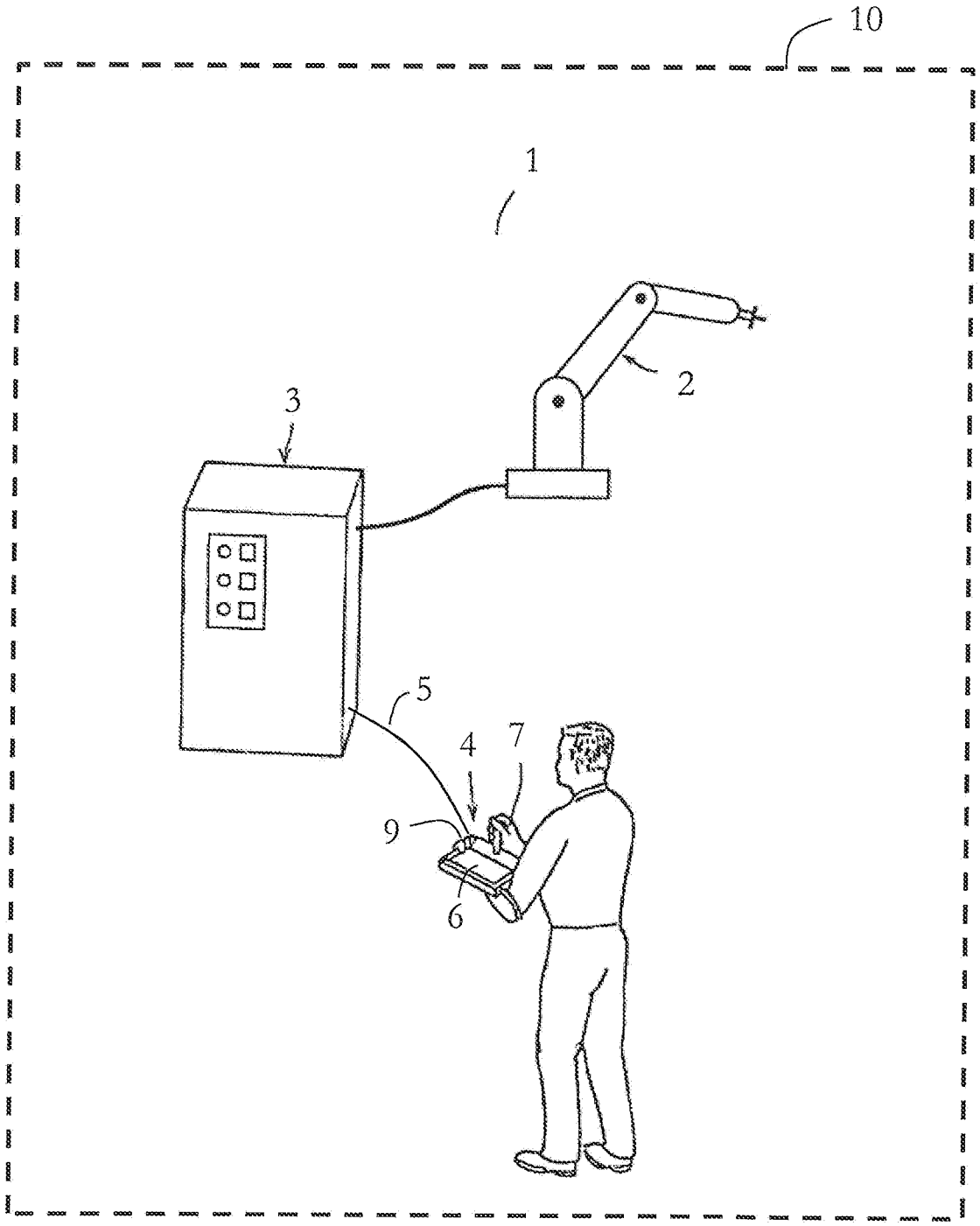

Figure 1

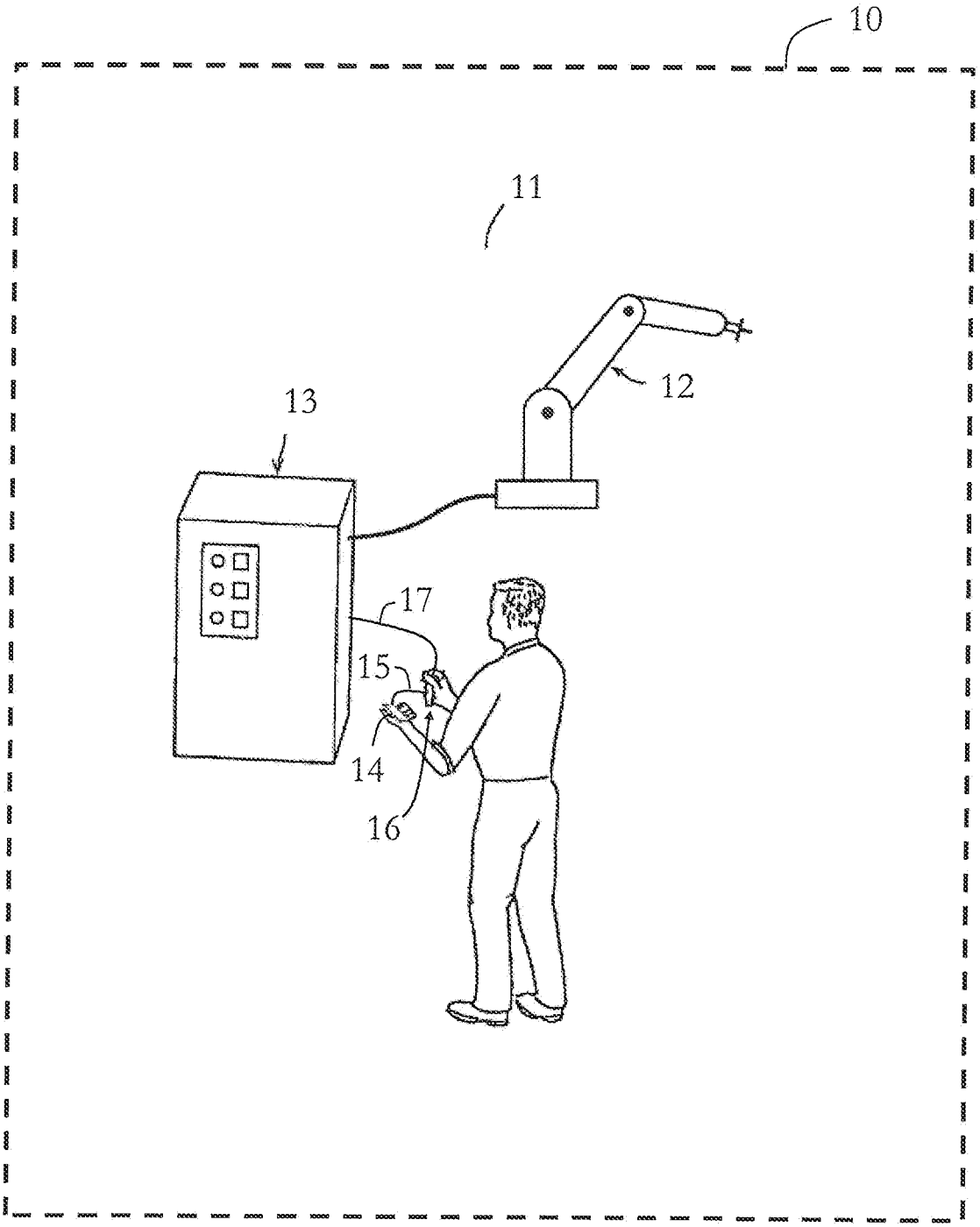

Figure 2

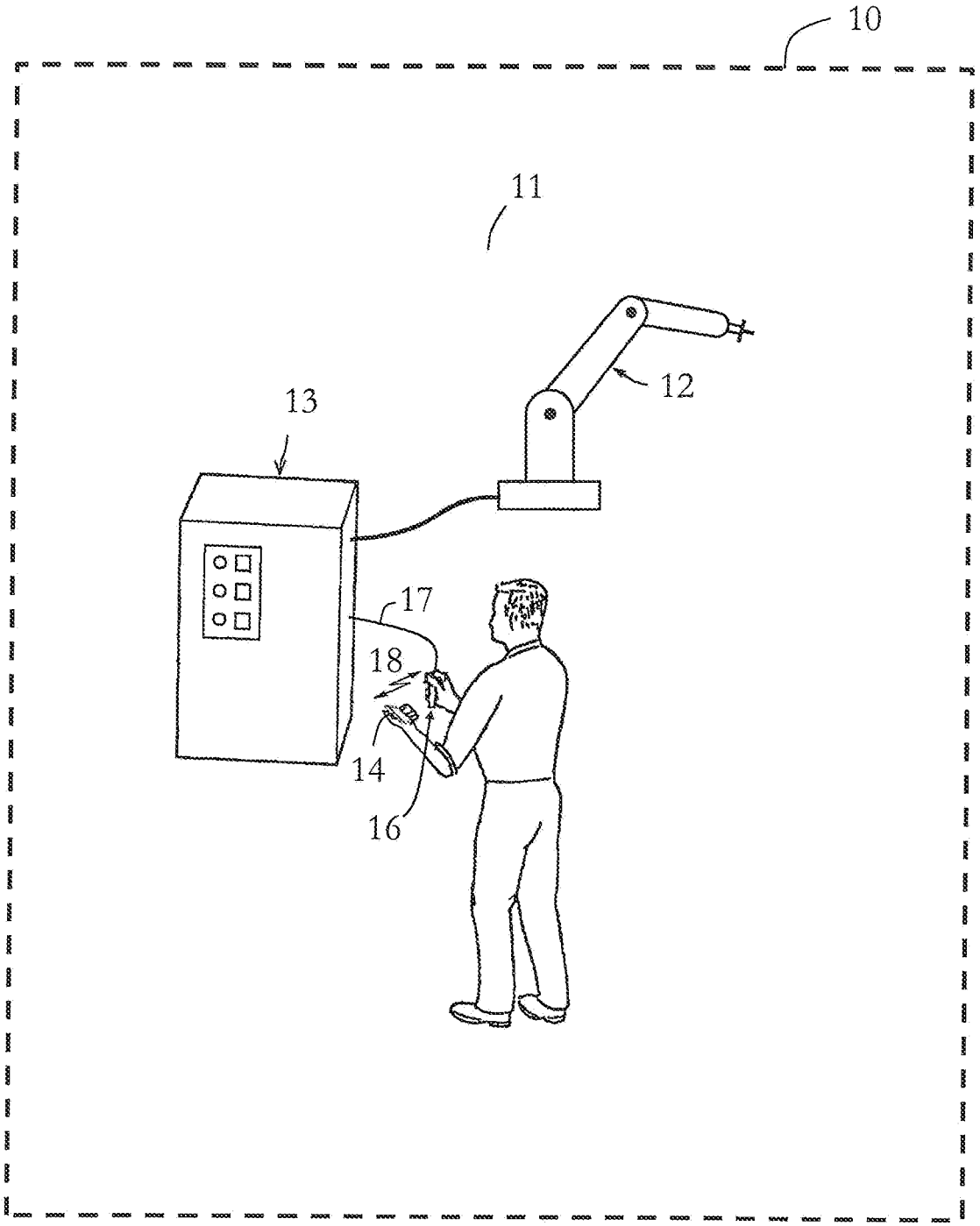

Figure 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/064887

A. CLASSIFICATION OF SUBJECT MATTER
INV. B25J13/00 B25J13/06
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)
B25J

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

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2 194 434 Al (COMAU SPA [IT]) 9 June 2010 (2010-06-09) the whol e document	1-16
X	EP 1 782 928 Al (ABB AB [SE]) 9 May 2007 (2007-05-09)	12
A	the whol e document	1-11 , 13-16
X	Wo 2006/049554 Al (ABB AB [SE] ; SJ0EBERG RALPH [SE]) 11 May 2006 (2006-05-11)	12
A	the whol e document	1-11 , 13-16
A	EP 1 728 601 Al (ABB AB [SE]) 6 December 2006 (2006-12-06) the whol e document	1-16

-/-- ·

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" documentwhich may throw doubts on priority claim(s) orwhich is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 June 2012	04/07/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Mi ngri no, Al essandra

1

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/064887

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1 719 588 Al (ABB RESEARCH LTD [CH]) 8 November 2006 (2006-11-08) the whol e document	1-16

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2011/064887

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2194434 A1	09-06-2010	EP 2194434 A1	09-06-2010
		JP 2010149273 A	08-07-2010
		US 2010145520 A1	10-06-2010
EP 1782928 A1	09-05-2007	AT 394206 T	15-05-2008
		EP 1782928 A1	09-05-2007
WO 2006049554 A1	11-05-2006	AT 469737 T	15-06-2010
		CN 101052498 A	10-10-2007
		EP 1817141 A1	15-08-2007
		US 2008125908 A1	29-05-2008
		WO 2006049554 A1	11-05-2006
EP 1728601 A1	06-12-2006	CN 101184590 A	21-05-2008
		EP 1728601 A1	06-12-2006
		US 2009128079 A1	21-05-2009
		WO 2006128784 A2	07-12-2006
EP 1719588 A1	08-11-2006	CN 101171105 A	30-04-2008
		EP 1719588 A1	08-11-2006
		EP 1890845 A1	27-02-2008
		US 2009212731 A1	27-08-2009
		WO 2006117363 A1	09-11-2006