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(54) Title: 3D INK JET PRINTING SYSTEM AND METHOD

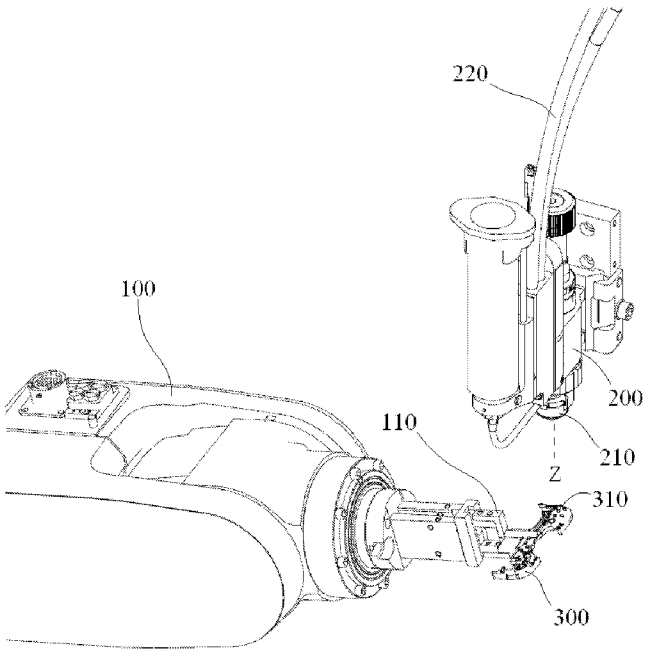


Fig.2

(57) Abstract: Disclosed are 3D ink jet printing system and method. The 3D ink jet printing system comprises: a multi-freedom robot configured to grip and move a product to be printed; and an inkjet print head configured to eject a conductive ink onto a surface of the product to be printed. The surface of the product comprises a 3D surface region, and the 3D ink jet printing system is configured to print out a first conductive pattern on the 3D surface region of the product. The robot is configured to adjust a position and a posture of the product during printing, so that the produce moves along a predetermined space path relative to the inkjet print head in a state where the inkjet print head is always substantially perpendicular to a currently printed target surface region of the product.

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3D INK JET PRINTING SYSTEM AND METHOD

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the benefit of Chinese Patent Application No.201410804634.2 filed on December 19, 2014 in the State Intellectual Property Office of China, the whole disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

Embodiments of the present invention relate to 3D ink jet printing system and method, and more particularly, relate to 3D ink jet printing system and method capable of printing out a conductive pattern on a complex surface of a product.

Description of the Related Art

In the electronics manufacturing industry, it often needs to print a conductive pattern on a surface of an electrical product, for example, print conductive traces on a circuit board. Generally, conductive ink (or referred as conductive adhesive or conductive paste) is ejected on the surface of the electrical product by using an ink jet print head, so as to form the conductive pattern on the surface of the electrical product.

In prior arts, an ink jet printing system generally comprises a horizontal moving mechanism and an ink jet print head mounted on the horizontal moving mechanism and moved together with the horizontal moving mechanism along an X-direction and a Y-direction, perpendicular to each other, in a horizontal plane.

In the prior arts, since the ink jet print head can only be moved along the X-direction and the Y-direction perpendicular to each other, the ink jet printing system is only adapted to print out a conductive pattern on a flat surface of the electrical product, and is not adapted to print out a conductive pattern on a complex surface, comprising a 3D surface region, of the electrical product.

SUMMARY OF THE INVENTION

The present invention has been made to overcome or alleviate at least one aspect of the above mentioned problems and disadvantages.

An object of the present invention is to provide 3D ink jet printing system and method capable of printing out a conductive pattern on a 3D surface of a product.

According to an aspect of the present invention, there is provided a 3D ink jet printing system, comprising: a multi-freedom robot configured to grip and move a product to be printed; and an ink jet print head configured to eject a conductive ink onto a surface of the product to be printed. The surface of the product comprises a 3D surface region, and the 3D ink jet printing system is configured to print out a first conductive pattern on the 3D surface region of the product; the robot is configured to adjust a position and a posture of the product during printing, so that the product moves along a predetermined space path relative to the ink jet print head in a state where the ink jet print head is always substantially perpendicular to a currently printed target surface region of the product.

According to an exemplary embodiment of the present invention, the ink jet print head is stationary during printing.

According to another exemplary embodiment of the present invention, the ink jet print head is movable in at least one of a first direction, a second direction and a third direction, which are perpendicular to each other.

According to another exemplary embodiment of the present invention, during printing, an angle between an axis of the ink jet printing head and a normal line of the currently printed target surface region of the product is in a range of 0~30 degrees.

According to another exemplary embodiment of the present invention,

the robot is movable in a first direction, a second direction and a third direction, which are perpendicular to each other; and the robot is rotatable about an axis in the first direction, an axis in the second direction and an axis in the third direction.

According to another exemplary embodiment of the present invention, the conductive ink is transmitted to the ink jet print head through a pipe from an ink supply device located far away from the ink jet print head.

According to another exemplary embodiment of the present invention, a gripper, adapted to directly grip the product, is mounted on an end effector of the robot.

According to another exemplary embodiment of the present invention, the 3D ink jet printing system further comprises a fixing device adapted to fix the product and connected to an end effector of the robot by a connection device.

According to another exemplary embodiment of the present invention, the first conductive pattern comprises a point, a curve or a 3D surface printed on the 3D surface region of the product.

According to another exemplary embodiment of the present invention, the robot is configured, during printing the first conductive pattern on the 3D surface region of the product, to adjust the posture of the product, so that an angle between a central axis of a nozzle of the ink jet printing head and a normal line of the 3D surface region is in a range of

0~30 degrees.

According to another exemplary embodiment of the present invention, the surface of the product further comprises a 2D surface region, and the 3D ink jet printing system is further configured to print out a second conductive pattern on the 2D surface region of the product.

According to another exemplary embodiment of the present invention, the second conductive pattern comprises a point, a straight line, a curve or a 2D plane printed on the 2D surface region of the product.

According to another exemplary embodiment of the present invention, an ink jetting frequency and/or an ink jetting flow rate of the ink jet print head is configured to match with a movement speed of the robot, so that the printed first conductive pattern and/or the printed second conductive pattern has an even thickness.

According to another exemplary embodiment of the present invention, the ink jet print head comprises ink jet print heads of different resolutions configured to print out conductive patterns with different sizes; and/or wherein the ink jet print head comprises ink jet print heads adapted to eject conductive inks of different materials.

According to an aspect of the present invention, there is provided a 3D ink jet printing method, comprising steps of:

S100: constructing an ideal 3D digital model of a product to be printed;

S200: obtaining parameters of a conductive pattern to be printed on a surface of the product based on the constructed ideal 3D digital model;

S300: planning a printing path for the conductive pattern based on the obtained parameters of the conductive pattern;

S400: calculating working parameters of a robot and an ink jet print head based on the panned printing path;

S500: manipulating the robot and the ink jet print head to print the conductive pattern based on the calculated working parameters; and

S600: monitoring a print quality of the conductive pattern printed on the surface of the product and adjusting the working parameters in real time, so that the print quality meets preset requirements,

wherein the surface of the product comprises a 3D surface region, and the conductive pattern comprises a first conductive pattern printed on the 3D surface region of the product, and

wherein the robot adjusts a position and a posture of the product during printing, so that the product moves along the panned printing path relative to the ink jet print head in a state where the ink jet print head is always substantially perpendicular to a currently printed target surface region of the product.

According to an exemplary embodiment of the present invention, the ink jet print head

is stationary during printing.

According to another exemplary embodiment of the present invention, the ink jet print head is movable in at least one of a first direction, a second direction and a third direction, which are perpendicular to each other.

According to another exemplary embodiment of the present invention, during printing, an angle between an axis of the ink jet printing head and a normal line of the currently printed target surface region of the product is in a range of 0~30 degrees.

According to another exemplary embodiment of the present invention, the parameters of the conductive pattern comprise a shape, a size, a position and an orientation of the conductive pattern.

According to another exemplary embodiment of the present invention, the working parameters of the robot comprise kinematic parameters and dynamic parameters of the robot; and the working parameters of the ink jet print head comprise an ink jetting frequency, an ink jetting flow rate, an ink temperature and an ink jet pressure.

According to another exemplary embodiment of the present invention, the step S600 comprises steps of:

S610: scanning the printed product with a 3D scanner and constructing an actual 3D digital model of the printed product;

S620: comparing the actual 3D digital model of the printed product and the ideal 3D digital model of the product; and

S630: determining whether or not a difference between the actual 3D digital model and the ideal 3D digital model is less than or equal to a preset threshold, and if not, adjusting the working parameters in real time until the difference becomes less than or equal to the preset threshold.

According to another exemplary embodiment of the present invention, the working parameters are adjusted by a closed loop feedback control algorithm until the print quality meets the preset requirements.

According to another exemplary embodiment of the present invention, the working parameters of the ink jet print head are controlled to match with the working parameters of the robot, so that the conductive pattern printed on the product has an even thickness.

According to another exemplary embodiment of the present invention, the robot is movable in a first direction, a second direction and a third direction, which are perpendicular to each other; and the robot is rotatable about an axis in the first direction, an axis in the second direction and an axis in the third direction.

According to another exemplary embodiment of the present invention, the first conductive pattern comprises a point, a curve or a 3D surface printed on the 3D surface region of the product.

According to another exemplary embodiment of the present invention, during printing

the first conductive pattern on the 3D surface region of the product, the robot adjusts the posture of the product, so that an angle between a central axis of a nozzle of the ink jet printing head and a normal line of the 3D surface region is in a range of 0~30 degrees.

According to another exemplary embodiment of the present invention, the surface of the product further comprises a 2D surface region, and the conductive pattern further comprises a second conductive pattern printed on the 2D surface region of the product.

According to another exemplary embodiment of the present invention, the second conductive pattern comprises a point, a straight line, a curve or a 2D plane printed on the 2D surface region of the product.

In the 3D ink jet printing system and method according to embodiments of the present invention, the multi-freedom robot grips the product and adjusts a position and a posture of the product during printing, so that the product moves along a predetermined space path relative to the ink jet print head in a state where the ink jet print head is always substantially perpendicular to a currently printed target surface region of the product. In this way, a conductive pattern can be printed on a 3D surface region of the product.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other features of the present invention will become more apparent by describing in detail exemplary embodiments thereof with reference to the accompanying drawings, in which:

Fig.1 is an illustrative perspective view of a 3D ink jet printing system according to an exemplary embodiment of the present invention; and

Fig.2 is a partially enlarged view of the 3D ink jet printing system shown in Fig.1.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

Exemplary embodiments of the present disclosure will be described hereinafter in detail with reference to the attached drawings, wherein the like reference numerals refer to the like elements. The present disclosure may, however, be embodied in many different forms and should not be construed as being limited to the embodiment set forth herein; rather, these embodiments are provided so that the present disclosure will be thorough and complete, and will fully convey the concept of the disclosure to those skilled in the art.

In the following detailed description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the disclosed embodiments. It will be apparent, however, that one or more embodiments may be practiced without these specific details. In other instances, well-known structures and devices are

schematically shown in order to simplify the drawing.

According to a general concept of the present invention, there is provided a 3D ink jet printing system, comprising: a multi-freedom robot configured to grip and move a product to be printed; and an ink jet print head configured to eject a conductive ink onto a surface of the product to be printed. The surface of the product comprises a 3D surface region, and the 3D ink jet printing system is adapted to print out a first conductive pattern on the 3D surface region of the product. The robot is configured to adjust a position and a posture of the product during printing, so that the product moves along a predetermined space path relative to the ink jet print head in a state where the ink jet print head is always substantially perpendicular to a currently printed target surface region of the product.

Fig.1 is an illustrative perspective view of a 3D ink jet printing system according to an exemplary embodiment of the present invention; and Fig.2 is a partially enlarged view of the 3D ink jet printing system shown in Fig.1.

In an exemplary embodiment of the present invention, there is disclosed a 3D ink jet printing system. As shown in Figs.1 and 2, the 3D ink jet printing system mainly comprises a multi-freedom robot 100 and an ink jet print head 200. The multi-freedom robot 100 is configured to grip and move a product 300 to be printed. The ink jet print head 200 is configured to eject a conductive ink onto a surface of the product 300 to be printed.

As clearly shown in Fig.2, in an embodiment, the surface of the product 300 comprises a 3D surface region 310, and the 3D ink jet printing system is adapted to print out a first conductive pattern on the 3D surface region 310 of the product 300.

In an embodiment, the robot 100 is configured to adjust a position and a posture of the product 300 during printing, so that the product 300 moves along a predetermined space path relative to the ink jet print head 200in a state where the ink jet print head 200 is always substantially perpendicular to a currently printed target surface region of the product 300. For example, in an embodiment, during printing, an angle between an axis Z of the ink jet printing head 200, in which the ink jet printing head 200 eject ink, and a normal line of the currently printed target surface region of the product 300 is in a range of 0~30 degrees. In another embodiment, an angle between the axis Z of the ink jet printing head 200 and the normal line of the currently printed target surface region of the product 300 is in a range of 0~10 degrees.

In one example, the ink jet print head 200 may be fixed on a stationary bracket (not shown). In this way, during printing, the ink jet print head 200 is stationary. But the present invention is not limited to this, the ink jet print head may be movable in at least one of a first direction, a second direction and a third direction, which are perpendicular to each other. In the latter case, during printing, the ink jet print head may be moved in at least one of the first direction, the second direction and the third direction.

As shown in Fig.1, a base of the robot 100 is mounted on a stationary seat 10. In an

embodiment, the robot 100 has six freedoms, that is, the robot 100 is movable in the first direction, the second direction and the third direction and rotatable about an axis in the first direction, an axis in the second direction and an axis in the third direction. In this way, during printing, the robot may adjust the position and the posture of the product in real time based on control instructions, so that the ink jet printing head prints out the first conductive pattern on the 3D surface region 310 of the product.

In an embodiment, the first conductive pattern may comprise a point, a curve or a 3D surface formed or printed on the 3D surface region 310 of the product 300. As shown in Fig.2, during printing the first conductive pattern on the 3D surface region 310 of the product 300, the robot 100 adjusts the posture of the product 300, so that the central axis Z of a nozzle 210 of the ink jet printing head 200 is always substantially perpendicular to a currently printed 3D surface region of the product 300, for example, so that an angle between the axis Z of the nozzle 210 of the ink jet printing head 200 and the normal line of the 3D surface region 310 is in a range of 0~30 degrees.

As shown in Figs.1 and 2, the conductive ink is transmitted to the ink jet print head 200 through a pipe 220 from an ink supply device located far away from the ink jet print head 200. If possible in space, the ink supply device may be provided on the ink jet print head 200.

As shown in Figs.1 and 2, a gripper 110, adapted to grip the product 300, is mounted on an end effector or end arm of the robot 100. The gripper 110 may be a finger type gripper adapted to directly grip the product 300.

Although it is not shown, in another embodiment, the 3D ink jet printing system may comprise a fixing device adapted to fix the product 300. The fixing device may be connected to the end effector of the robot 100 by a connection device. In this way, the product 300 may be fixed on the end effector of the robot 100 by means of the fixing device. After the printing, the product 300 may be detached from the robot 100 by disengaging the connection device from fixing device.

In another embodiment, the surface of the product 300 may further comprise a 2D surface region, and the 3D ink jet printing system may be further configured to print out a second conductive pattern on the 2D surface region of the product 300. The second conductive pattern may comprise a point, a straight line, a curve or a 2D plane printed on the 2D surface region of the product 300.

In another embodiment, an ink jetting frequency and/or an ink jetting flow rate of the ink jet print head 200 matches with a movement speed of the robot 100, so that the printed first conductive pattern and/or the printed second conductive pattern has an even thickness.

In another embodiment, the ink jet print head 200 may comprise ink jet print heads with different resolutions configured to print out conductive patterns with different sizes. For example, a conductive trace with a larger width may be printed out by an ink jet print

head of low resolution with a larger nozzle; a conductive trace with a smaller width may be printed out by an ink jet print head of high resolution with a smaller nozzle. In this way, during printing, an ink jet print head with proper resolution may be selected to perform printing operations based on parameters of an object to be printed, thereby improving printing efficiency.

In another embodiment, the ink jet print head 200 may comprise ink jet print heads adapted to eject different kinds of conductive inks, for example, to eject conductive inks of different materials. In this way, it may print out conductive patterns with different conductive properties on the surface of the product.

Hereafter, a 3D ink jet printing method according to an exemplary embodiment of the present invention will be described in detail with reference to Figs.1 and 2. The 3D ink jet printing method mainly comprises steps of:

S100: constructing an ideal 3D digital model of a product 300 to be printed;

S200: obtaining parameters of a conductive pattern to be printed on a surface of the product 300 based on the constructed ideal 3D digital model;

S300: planning a printing path for the conductive pattern based on the obtained parameters of the conductive pattern;

S400: calculating working parameters of a robot 100 and an ink jet print head 200 based on the panned printing path;

S500: manipulating the robot 100 and the ink jet print head 200 to print the conductive pattern based on the calculated working parameters; and

S600: monitoring a print quality of the conductive pattern printed on the surface of the product 300 and adjusting the working parameters in real time, so that the print quality meets preset requirements.

During printing, the robot 100 adjusts a position and a posture of the product 300, so that the product 300 moves along the panned printing path relative to the ink jet print head 200in a state where the ink jet print head 200 is always substantially perpendicular to a currently printed target surface region of the product 300. In this way, it may print out a first conductive pattern on a 3D surface region 310 of the product 300.

In the above method, the parameters of the conductive pattern may comprise a shape, a size, a position and an orientation of the conductive pattern.

In the above method, the working parameters of the robot 100 may comprise, but not limited to, kinematic parameters and dynamic parameters of the robot 100. The working parameters of the ink jet print head 100 may comprise, but not limited to, an ink jetting frequency, an ink jetting flow rate, an ink temperature and an ink jetting pressure.

In the above method, the step S600 may comprise steps of:

S610: scanning the printed product 300 with a 3D scanner and constructing an actual 3D digital model of the printed product 300;

S620: comparing the actual 3D digital model of the printed product 300 and the ideal 3D digital model of the product 300; and

S630: determining, based on the comparing in S620, whether or not a difference between the actual 3D digital model and the ideal 3D digital model is less than or equal to a preset threshold, and if not, adjusting the working parameters in real time until the difference becomes less than or equal to the preset threshold, thereby meeting preset requirements for the print quality.

In the above method, the working parameters of the robot and the ink jet print head may be adjusted by a closed loop feedback control algorithm, for example, a typical PID control algorithm or a neural network control algorithm, until the print quality meets the preset requirements.

In an embodiment, the working parameters of the ink jet print head 200 may be controlled to match with the working parameters of the robot 100, so that the conductive pattern printed on the product 300 has an even thickness.

In the above method, as shown in Fig.2, during printing the first conductive pattern on the 3D surface region 310 of the product 300, the robot 100 adjust the posture of the product 300, so that the central axis Z of the nozzle 210 of the ink jet print head 200 is always substantially perpendicular to the 3D surface region of the product 300, for example, so that an angle between the central axis Z of the nozzle 210 of the ink jet printing head 200 and the normal line of the 3D surface region 310 is in a range of 0~30 degrees. The first conductive pattern may comprise a point, a curve or a 3D surface printed on the 3D surface region 310 of the product 300.

In another embodiment, the surface of the product 300 may further comprise a 2D surface region, and the 3D ink jet printing system may be further configured to print out a second conductive pattern on the 2D surface region of the product 300. The second conductive pattern may comprise a point, a straight line, a curve or a 2D plane printed on the 2D surface region of the product 300.

In an embodiment, the actual 3D digital model of the printed product 300 and the ideal 3D digital model of the product 300 may be constructed by computer aided design and manufacturing software, for example, CAD software.

It should be appreciated for those skilled in this art that the above embodiments are intended to be illustrated, and not restrictive. For example, many modifications may be made to the above embodiments by those skilled in this art, and various features described in different embodiments may be freely combined with each other without conflicting in configuration or principle.

Although several exemplary embodiments have been shown and described, it would be appreciated by those skilled in the art that various changes or modifications may be made in these embodiments without departing from the principles and spirit of the disclosure, the

scope of which is defined in the claims and their equivalents.

As used herein, an element recited in the singular and proceeded with the word "a" or "an" should be understood as not excluding plural of said elements or steps, unless such exclusion is explicitly stated. Furthermore, references to "one embodiment" of the present invention are not intended to be interpreted as excluding the existence of additional embodiments that also incorporate the recited features. Moreover, unless explicitly stated to the contrary, embodiments "comprising" or "having" an element or a plurality of elements having a particular property may include additional such elements not having that property.

What is claimed is,

1. A 3D ink jet printing system, comprising:

a multi-freedom robot configured to grip and move a product to be printed; and

an ink jet print head configured to eject a conductive ink onto a surface of the product to be printed,

wherein the surface of the product comprises a 3D surface region, and the 3D ink jet printing system is configured to print out a first conductive pattern on the 3D surface region of the product, and

wherein the robot is configured to adjust a position and a posture of the product during printing, so that the product moves along a predetermined space path relative to the ink jet print head in a state where the ink jet print head is always substantially perpendicular to a currently printed target surface region of the product.

2. The 3D ink jet printing system according to claim 1, wherein the ink jet print head is stationary during printing.

3. The 3D ink jet printing system according to claim 1, wherein the ink jet print head is movable in at least one of a first direction, a second direction and a third direction, which are perpendicular to each other.

4. The 3D ink jet printing system according to claim 1, wherein

during printing, an angle between an axis of the ink jet printing head and a normal line of the currently printed target surface region of the product is in a range of 0~30 degrees.

5. The 3D ink jet printing system according to claim 1,

wherein the robot is movable in a first direction, a second direction and a third direction, which are perpendicular to each other; and

wherein the robot is rotatable about an axis in the first direction, an axis in the second direction and an axis in the third direction.

6. The 3D ink jet printing system according to claim 1,

wherein the conductive ink is transmitted to the ink jet print head through a pipe from an ink supply device located far away from the ink jet print head.

7. The 3D ink jet printing system according to claim 1,

wherein a gripper, adapted to directly grip the product, is mounted on an end effector of the robot.

8. The 3D ink jet printing system according to claim 1, further comprising:

a fixing device, adapted to fix the product and connected to an end effector of the robot by a connection device.

9. The 3D ink jet printing system according to claim 1,

wherein the first conductive pattern comprises a point, a curve or a 3D surface printed on the 3D surface region of the product.

10. The 3D ink jet printing system according to claim 1, wherein

the robot is configured, during printing the first conductive pattern on the 3D surface region of the product, to adjust the posture of the product, so that an angle between a central axis of a nozzle of the ink jet printing head and a normal line of the 3D surface region is in a range of 0~30 degrees.

11. The 3D ink jet printing system according to claim 1,

wherein the surface of the product further comprises a 2D surface region, and the 3D ink jet printing system is further configured to print out a second conductive pattern on the 2D surface region of the product.

12. The 3D ink jet printing system according to claim 11,

wherein the second conductive pattern comprises a point, a straight line, a curve or a 2D plane printed on the 2D surface region of the product.

13. The 3D ink jet printing system according to claim 11,

wherein an ink jetting frequency and/or an ink jetting flow rate of the ink jet print head is configured to match with a movement speed of the robot, so that the printed first conductive pattern and/or the printed second conductive pattern has an even thickness.

14. The 3D ink jet printing system according to claim 1,

wherein the ink jet print head comprises ink jet print heads of different resolutions configured to print out conductive patterns with different sizes; and/or

wherein the ink jet print head comprises ink jet print heads adapted to eject conductive inks of different materials.

15. A 3D ink jet printing method, comprising steps of:

S100: constructing an ideal 3D digital model of a product to be printed;

S200: obtaining parameters of a conductive pattern to be printed on a surface of the

product based on the constructed ideal 3D digital model;

S300: planning a printing path for the conductive pattern based on the obtained parameters of the conductive pattern;

S400: calculating working parameters of a robot and an ink jet print head based on the panned printing path;

S500: manipulating the robot and the ink jet print head to print the conductive pattern based on the calculated working parameters; and

S600: monitoring a print quality of the conductive pattern printed on the surface of the product and adjusting the working parameters in real time, so that the print quality meets preset requirements,

wherein the surface of the product comprises a 3D surface region, and the conductive pattern comprises a first conductive pattern printed on the 3D surface region of the product, and

wherein the robot adjusts a position and a posture of the product during printing, so that the product moves along the panned printing path relative to the ink jet print head in a state where the ink jet print head is always substantially perpendicular to a currently printed target surface region of the product.

16. The 3D ink jet printing method according to claim 15, wherein the ink jet print head is stationary during printing.

17. The 3D ink jet printing method according to claim 15, wherein the ink jet print head is movable in at least one of a first direction, a second direction and a third direction, which are perpendicular to each other.

18. The 3D ink jet printing method according to claim 15, wherein

during printing, an angle between an axis of the ink jet printing head and a normal line of the currently printed target surface region of the product is in a range of 0~30 degrees.

19. The 3D ink jet printing method according to claim 15,

wherein the parameters of the conductive pattern comprise a shape, a size, a position and an orientation of the conductive pattern.

20. The 3D ink jet printing method according to claim 15,

wherein the working parameters of the robot comprise kinematic parameters and dynamic parameters of the robot; and

wherein the working parameters of the ink jet print head comprise an ink jetting frequency, an ink jetting flow rate, an ink temperature and an ink jet pressure.

21. The 3D ink jet printing method according to claim 15, wherein the step S600 comprises steps of:

S610: scanning the printed product with a 3D scanner and constructing an actual 3D digital model of the printed product;

S620: comparing the actual 3D digital model of the printed product and the ideal 3D digital model of the product; and

S630: determining whether or not a difference between the actual 3D digital model and the ideal 3D digital model is less than or equal to a preset threshold, and if not, adjusting the working parameters in real time until the difference becomes less than or equal to the preset threshold.

22. The 3D ink jet printing method according to claim 21,

wherein the working parameters are adjusted by a closed loop feedback control algorithm until the print quality meets the preset requirements.

23. The 3D ink jet printing method according to claim 22,

wherein the working parameters of the ink jet print head are controlled to match with the working parameters of the robot, so that the conductive pattern printed on the product has an even thickness.

24. The 3D ink jet printing method according to claim 15,

wherein the robot is movable in a first direction, a second direction and a third direction, which are perpendicular to each other; and

wherein the robot is rotatable about an axis in the first direction, an axis in the second direction and an axis in the third direction.

25. The 3D ink jet printing method according to claim 15,

wherein the first conductive pattern comprises a point, a curve or a 3D surface printed on the 3D surface region of the product.

26. The 3D ink jet printing method according to claim 15, wherein

during printing the first conductive pattern on the 3D surface region of the product, the robot adjusts the posture of the product, so that an angle between a central axis of a nozzle (210) of the ink jet printing head and a normal line of the 3D surface region is in a range of 0~30 degrees.

27. The 3D ink jet printing method according to claim 15,

wherein the surface of the product further comprises a 2D surface region, and the conductive pattern further comprises a second conductive pattern printed on the 2D surface region of the product.

28. The 3D ink jet printing method according to claim 27,

wherein the second conductive pattern comprises a point, a straight line, a curve or a 2D plane printed on the 2D surface region of the product.

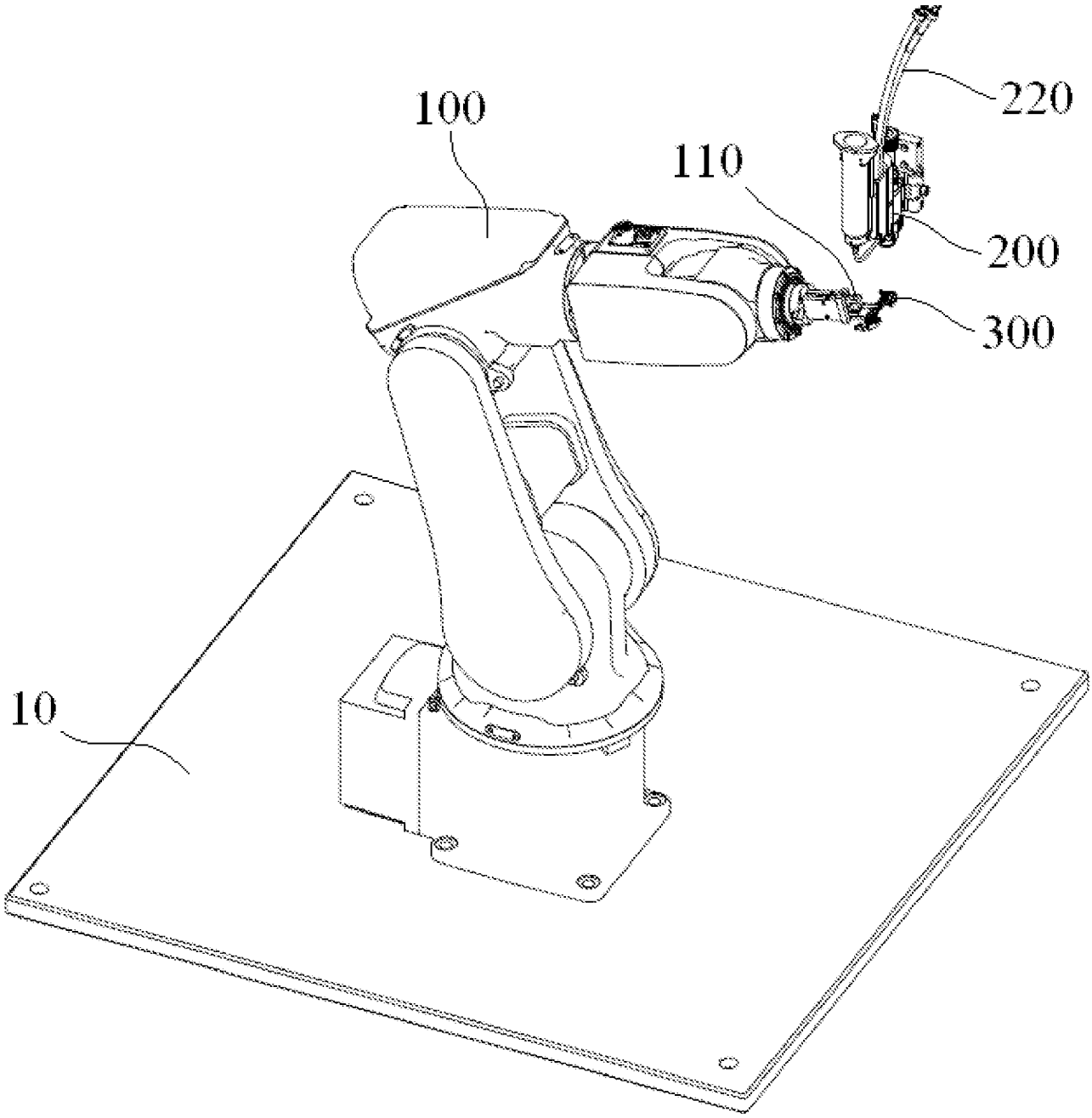


Fig.1

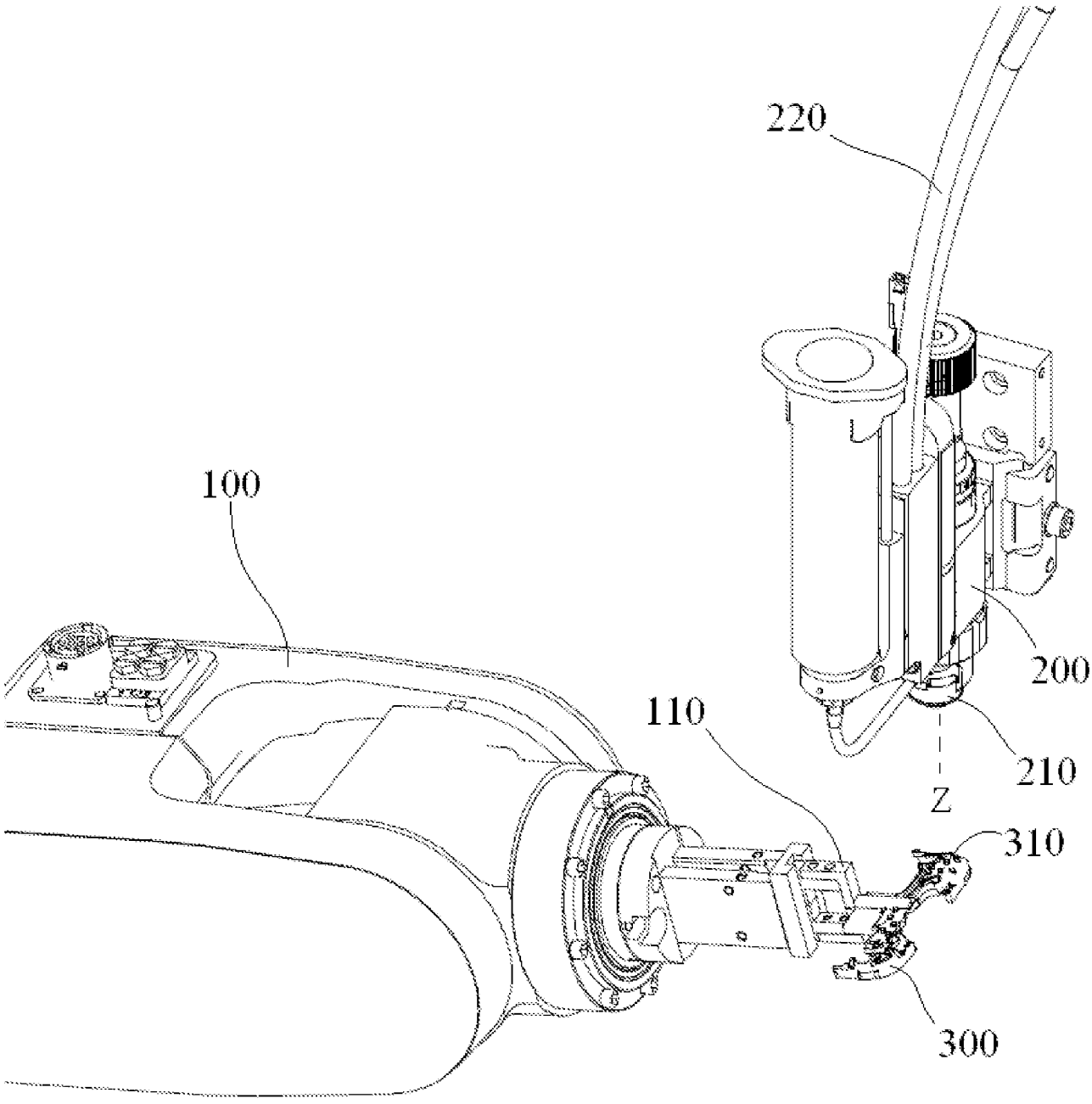


Fig.2

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2015/059442

A. CLASSIFICATION OF SUBJECT MATTER
INV. H05K3/12 B41J3/407
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)
B41J H05K

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, CHEM ABS Data, INSPEC, IBM-TDB, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 10 2010 004496 A1 (MUELLER HERMANN [DE]) 14 July 2011 (2011-07-14) paragraphs [0001], [0004] - [0006] paragraphs [0047] - [0052], [0067] claims 1-6; figure 1	1-28
A	JP H05 293955 A (SUZUKI SOGYO K.K.) 9 November 1993 (1993-11-09) abstract	1-28
A	DE 39 13 028 A1 (FRAUNHOFER GES FORSCHUNG [DE]) 25 October 1990 (1990-10-25) column 2, line 64 - column 3, line 28 claims 1-6; figure 1	1-28

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"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
14 March 2016	24/03/2016

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	Bacon, Alan

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2015/059442

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 102010004496 A1	14-07-2011	NONE	
JP H05293955 A	09-11-1993	NONE	
DE 3913028 A1	25-10-1990	NONE	