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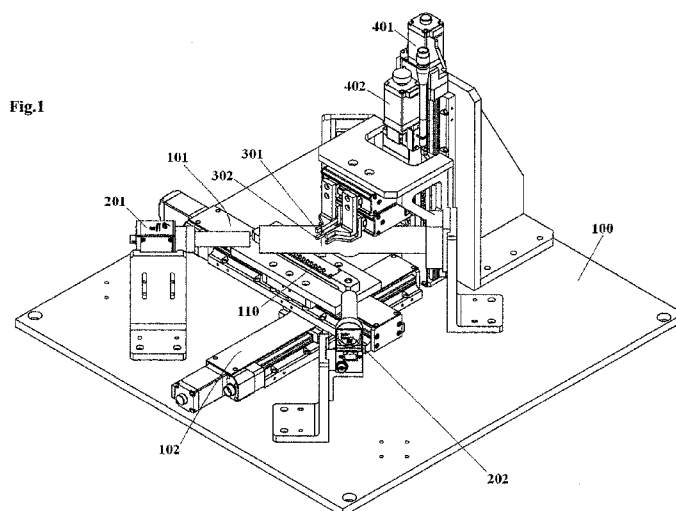
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(54) Title: AUTOMATIC ASSEMBLING SYSTEM AND METHOD



(57) Abstract: An automatic assembling system for inserting an elongated first member (600) into a hole of a second member (500), comprising: a movement unit (101, 102) configured to move the second member (500) in a horizontal plane; a vision alignment unit (201, 202), under the visual guidance of the vision alignment unit (20, 202), the movement unit (101, 102) moving the second member (500) to a position where the first member (600) is aligned with the hole of the second member (500); and a step insertion unit (301, 302, 401, 402) configured to grip and move the first member (600) so as to insert the first member (600) into the hole of the second member (500) step by step. The first member (600) may be an optical fiber which be accurately aligned with the hole of an optical ferrule, improving the alignment accuracy and efficiency, effectively preventing the optical fiber from being bent or broken.



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AUTOMATIC ASSEMBLING SYSTEM AND METHOD

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the benefit of Chinese Patent Application No. 201310308321.3 filed on July 22, 2013 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

The present invention relates to an automatic assembling system and an automatic assembling method for inserting an elongated first member into a hole of a second member, more particularly, relates to an automatic assembling system and an automatic assembling method for inserting an optical fiber into a hole of an optical ferrule.

Description of the Related Art

In the prior art, it is difficult to insert an elongated member, for example, a wire-like member, into a hole of another member. Particularly, if the elongated member is very fragile and may be easily bent, the insertion operation becomes more difficult. In an example, the elongated member may comprise an optical fiber to be inserted into a hole of an optical ferrule (please refer to Fig.3), for example, a fiber optic connector. In this case, the optical fiber may have a diameter of about 0.1250mm with a diameter tolerance of $\pm 0.0007\text{mm}$, and the hole of the optical ferrule may have a diameter of about 0.1253mm with a diameter tolerance of 0~0.0007mm.

The optical fiber is a high precision optical element, and is not allowed to be bent. If the optical fiber is bent, the optical property of it will be destroyed. Thereby, it is very difficult to insert the optical fiber with such small diameter into the small hole of the optical ferrule.

In the prior art, the optical fiber is usually inserted into the hole of the optical ferrule by manual. Since the optical fiber and the hole of the optical ferrule both are very small, it is difficult to align the optical fiber with the hole of the optical ferrule by manual, it needs to take great deal of time. Furthermore, during inserting the optical fiber into the hole of the optical ferrule, the operator cannot stably hold his/her hands, any tiny quiver of hands will cause the optical fiber to be bent or even broken, deteriorating the optical property of the optical fiber inserted into the optical ferrule.

Accordingly, the method of manually inserting the optical fiber into the hole of the optical ferrule has the disadvantages of low efficiency, wasting time and energy, poor accuracy and high scrap rate.

SUMMARY OF THE INVENTION

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

According to an object of the present invention, there is provided an automatic assembling system and an automatic assembling method for inserting an elongated first member into a hole of a second member in high efficiency.

According to another object of the present invention, there is provided an automatic assembling system and an automatic assembling method for inserting an elongated first member into a hole of a second member in high accuracy.

According to an aspect of the present invention, there is provided an automatic assembling system for inserting an elongated first member into a hole of a second member, comprising:

- a movement unit configured to move the second member in a horizontal plane;

- a vision alignment unit, under the visual guidance of the vision alignment unit, the movement unit moves the second member to a position where the first member is aligned with the hole of the second member; and

- a step insertion unit configured to grip and move the first member so as to insert the first member into the hole of the second member step by step.

According to an exemplary embodiment of the present invention, the elongated first member comprises an optical fiber, and the second member comprises an optical ferrule with a hole.

According to another exemplary embodiment of the present invention, wherein the movement unit comprising: a first moving arm configured to be capable of moving in a first direction in the horizontal plane; and a second moving arm configured to be capable of moving in a second direction perpendicular to the first direction in the horizontal plane, wherein the first moving arm is mounted on the second moving arm to be capable of moving with the movement of the second moving arm in the second direction; and wherein the optical ferrule is fixed on the first moving arm.

According to another exemplary embodiment of the present invention, a fixture feature for fixing the optical ferrule is formed in the first moving arm.

According to another exemplary embodiment of the present invention, the vision alignment unit comprising: a first camera configured to take a first picture of the optical ferrule and the optical fiber along a first shooting direction in the horizontal plane; and a second camera configured to take a second picture of the optical ferrule and the optical fiber along a second shooting direction different from the first shooting direction in the horizontal

plane.

According to another exemplary embodiment of the present invention, the first shooting direction is perpendicular to the second shooting direction.

According to another exemplary embodiment of the present invention, the step insertion unit comprising: a first gripper configured to grip the optical fiber; a second gripper configured to grip the optical fiber and disposed below the first gripper in a vertical direction perpendicular to the horizontal plane; a first moving mechanism configured to move both the first gripper and the second gripper downward by a step distance in the vertical direction when the first gripper and the second gripper grip the optical fiber at the same time; and a second moving mechanism configured to move only the second gripper upward by a step distance in the vertical direction when the second gripper loses the optical fiber.

According to an aspect of the present invention, there is provided an automatic assembling method for inserting an elongated first member into a hole of a second member, comprising steps of:

S100: providing an automatic assembling system according to any of the above exemplary embodiments;

S200: fixing the second member on the movement unit, and gripping the elongated first member with the step insertion unit;

S300: moving the second member to a position where the first member is aligned with the hole of the second member by the movement unit under the guidance of the vision alignment unit; and

S400: inserting the elongated first member into the hole of the second member step by step by use of the step insertion unit.

According to an exemplary embodiment of the present invention, the elongated first member comprises an optical fiber, and the second member comprises an optical ferrule with a hole.

According to another exemplary embodiment of the present invention, the movement unit comprising: a first moving arm configured to be capable of moving in a first direction in the horizontal plane; and a second moving arm configured to be capable of moving in a second direction perpendicular to the first direction in the horizontal plane, wherein the first moving arm is mounted on the second moving arm to be capable of moving with the movement of the second moving arm in the second direction; and wherein the optical ferrule is fixed on the first moving arm.

According to another exemplary embodiment of the present invention, a fixture feature for fixing the optical ferrule is formed in the first moving arm.

According to another exemplary embodiment of the present invention, the vision alignment unit comprising: a first camera configured to be capable of taking a first picture of the optical ferrule and the optical fiber along a first shooting direction in the horizontal plane;

and a second camera configured to be capable of taking a second picture of the optical ferrule and the optical fiber along a second shooting direction different from the first shooting direction in the horizontal plane.

According to another exemplary embodiment of the present invention, the first shooting direction is perpendicular to the second shooting direction.

According to another exemplary embodiment of the present invention, the step insertion unit comprising: a first gripper configured to grip the optical fiber; a second gripper configured to grip the optical fiber and disposed below the first gripper in a vertical direction perpendicular to the horizontal plane; a first moving mechanism configured to move both the first gripper and the second gripper downward by a step distance in the vertical direction when the first gripper and the second gripper together grip the optical fiber; and a second moving mechanism configured to move only the second gripper upward by a step distance in the vertical direction when the second gripper loses the optical fiber.

According to another exemplary embodiment of the present invention, the step S400 comprising steps of:

S401: operating the first gripper and the second gripper to together grip the optical fiber, and moving the optical fiber downward by one step distance in the vertical direction, so as to insert the optical fiber into the hole of the optical ferrule by one step distance;

S402: operating the second gripper to loose the optical fiber with the first gripper gripping the optical fiber, moving the second gripper upward by one step distance in the vertical direction, and operating the second gripper to grip the optical fiber again; and

S403: repeating the step S401 to the Step S402 until the optical fiber is inserted into the hole of the optical ferrule by a predetermined length.

The automatic assembling system according to above various exemplary embodiments of the present invention can insert the elongated first member into the second member in higher accuracy and efficiency than the convention manual insertion solution, and can prevent the elongated first member from being bent or broken during the insertion operation, improving the quality of inserting the elongated first member into the second member.

For example, in an exemplary embodiment of the present invention, the first and second cameras, disposed cross with each other, may guide the optical fiber to accurately align with the hole of the optical ferrule, improving the alignment accuracy and efficiency. Furthermore, in an exemplary embodiment of the present invention, the first and second grippers, arranged in the vertical direction, can reliably hold the optical fiber in the vertical direction, effectively preventing the optical fiber from being bent or broken. Moreover, since the second gripper below the first gripper grips the optical fiber at a location proximal to the upper end surface of the optical ferrule, shortening the distance from the location where the second gripper grips the optical fiber to the upper end surface of the optical ferrule, further prevent the optical fiber from being bent or broken.

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 an automatic assembling system according to an exemplary embodiment of the present invention;

Fig.2 is an illustrative perspective view of a step insertion unit of Fig.1, showing an optical fiber acted as an elongated first member and an optical ferrule acted as a second member with a hole;

Fig.3 is an illustrative view of inserting an elongated optical fiber into a hole of an optical ferrule;

Fig.4 is an illustrative view of a pair of crossing cameras of Fig.1;

Fig.5a and Fig.5b show a set of pictures taken by a pair of crossing cameras of Fig.1; and

Fig.6a and Fig.6b show another set of pictures taken by a pair of crossing cameras of 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 an automatic assembling system for inserting an elongated first member into a hole of a second member, comprising: a movement unit configured to move the second member in a horizontal plane; a vision alignment unit under the visual guidance of which the movement unit moves the second member to a position where the first member is aligned with the hole of the second member; and a step insertion unit configured to grip and move the first member so as to insert the first member into the hole of the second member step by step.

Fig.1 is an illustrative perspective view of an automatic assembling system according

to an exemplary embodiment of the present invention.

As shown in Fig.1, in the illuminated embodiment, the automatic assembling system is used to insert an elongated first member into a hole of a second member, for example, insert an elongated optical fiber 600 into a hole of an optical ferrule 500, for example, a fiber optic connector, as shown in Figs.2-3. But the present invention is not limited to this, the automatic assembling system of the present invention is adapted to insert any elongated wire-like member into a hole of another member.

In an exemplary embodiment, as shown in Fig.1, the automatic assembling system mainly comprises a movement unit 101, 102, a vision alignment unit 201, 202 and a step insertion unit 301, 302, 401, 402.

As shown in Fig.1, in an exemplary embodiment, movement unit 101, 102, a vision alignment unit 201, 202 and a step insertion unit 301, 302, 401, 402 are mounted on a horizontal station or base 100. The movement unit 101, 102 is configured to move the optical ferrule 500 in a horizontal plane (see Fig.2). The movement unit 101, 102 moves the optical ferrule 500 to a position where the optical fiber 600 is aligned with the hole of the optical ferrule 500 under the visual guidance of the vision alignment unit 201, 202. The step insertion unit 301, 302, 401, 402 is configured to grip and move the optical fiber 600 so as to insert the optical fiber 600 into the hole of the optical ferrule 500 step by step.

As shown in Fig.1, in an exemplary embodiment, the movement unit mainly comprises a first moving arm 101 and a second moving arm 102. The first moving arm 101 is configured to be capable of moving in a first direction in the horizontal plane, and the second moving arm 102 is configured to be capable of moving in a second direction perpendicular to the first direction in the horizontal plane.

In an exemplary embodiment, as shown in Fig.1, the first moving arm 101 is mounted on the second moving arm 102 to be capable of moving with the movement of the second moving arm 102 in the second direction. A fixture feature 110 for fixing the optical ferrule 500 is formed in the first moving arm 101. In an example, the fixture feature 110 may be configured to be a position hole formed in the first moving arm 101, and the optical ferrule 500 may be inserted into and fixed in the position hole. In this embodiment, the axis of the hole of the optical ferrule 500 is positioned in a vertical direction perpendicular to the horizontal plane. In this way, when the optical ferrule 500 is fixed in the fixture feature 110 of the first moving arm 101, the optical ferrule 500 can be moved in the horizontal plane with the movement of the first moving arm 101 and the second moving arm 102. As a result, the coordinate position of the optical ferrule 500 in the horizontal plane can be freely adjusted to align the axis of the hole of the optical ferrule 500 to the axis of the optical fiber 600.

In an exemplary embodiment of the present invention, the first moving arm 101 and the second moving arm 102 may be driven by individual driving systems, respectively, to move in the respective directions thereof.

Fig.4 is an illustrative view of a pair of crossing cameras 201, 202 of Fig.1.

As shown in Fig.1 and Fig.4, the vision alignment unit mainly comprises a first camera 201 and a second camera 202.

In an exemplary embodiment of the present invention, as shown in Fig.1 and Fig.4, the first camera 201 is configured to take a first picture of the optical ferrule 500 and the optical fiber 600 along a first shooting direction in the horizontal plane. And the second camera 202 is configured to take a second picture of the optical ferrule 500 and the optical fiber 600 along a second shooting direction different from the first shooting direction in the horizontal plane. In an example, as shown in Fig.4, the first shooting direction is perpendicular to the second shooting direction, so as to facilitate the coordinate conversion and position calculation. But the present invention is not limited to this, an angle between the first shooting direction and the second shooting direction may be set to be 45 degrees, 60 degrees, or other angle.

Hereafter, it will describe the vision alignment principle of the vision alignment unit with reference to Figs. 5a, 5b, 6a and 6b.

Fig.5a and Fig.5b show a set of pictures taken by a pair of crossing cameras of Fig.1. Fig.5a shows a first picture taken by the first camera 201, and Fig.5b shows a second picture taken by the second camera 202.

As shown in Fig.5a and Fig.5b, the axis of the optical fiber 600 is offset from the axis of the hole of the optical ferrule 500, and is not aligned to the axis of the hole of the optical ferrule 500. Accordingly, based on the taken pictures, a position of the axis of the hole of the optical ferrule 500 relative to the axis (an original point) of the optical fiber 600 in a first coordinate system defined by the first and second shooting directions may be calculated. Then, the position of the axis of the hole of the optical ferrule 500 relative to the axis (the original point) of the optical fiber 600 in the first coordinate system may be converted into a position of the axis of the hole of the optical ferrule 500 relative to the axis (the original point) of the optical fiber 600 in a second coordinate system defined by the first and second movement directions of the first and second moving arms. Thereafter, based on the position of the axis of the hole of the optical ferrule 500 relative to the axis (the original point) of the optical fiber 600 in the second coordinate system, the first and second moving arms 101, 102 may be controlled to move the optical ferrule 500 in the second coordinate system to a position where the axis of the hole of the optical ferrule 500 is aligned to the axis of the optical fiber 600.

Fig.6a and Fig.6b show another set of pictures taken by a pair of crossing cameras of Fig.1. Fig.6a shows a first picture taken by the first camera 201, and Fig.6b shows a second picture taken by the second camera 202.

As shown in Fig.6a and Fig.6b, the axis of the optical fiber 600 is aligned to the axis of the hole of the optical ferrule 500. Thereby, it may determine that the optical ferrule 500 has been moved to the position where the axis of the hole of the optical ferrule 500 is aligned to

the axis of the optical fiber 600. Then, the first and second moving arms 101, 102 are stopped and locked.

Fig.2 is an illustrative perspective view of a step insertion unit of Fig.1.

In an exemplary embodiment of the present invention, as shown in Figs.1-2, the step insertion unit mainly comprises a first gripper 301, a second gripper 302, a first moving mechanism 401 and a second moving mechanism 402.

As shown in Figs.1-2, the first gripper 301 and the second gripper 302 are configured to grip the optical fiber 600, and the second gripper 302 is disposed below the first gripper 301 in the vertical direction perpendicular to the horizontal plane. In this way, the first gripper 301 and the second gripper 302 may grip two different locations of the optical fiber 600 in the vertical direction at the same time, improving the stability of gripping the optical fiber 600.

Also, in an exemplary embodiment of the present invention, the second gripper 302 below the first gripper 301 is disposed at a position proximal to the upper end surface of the optical ferrule 500. As a result, a distance from the second gripper to the upper end surface of the optical ferrule 500 is very short, preventing the optical fiber 600 from being bent or broken.

In an exemplary embodiment of the present invention, the first gripper 301 and the second gripper 302 each comprises an individual driving mechanism for operating them to grip or loose the optical fiber 600. The first gripper 301 or the second gripper 302 may be any suitable gripper in the prior art.

As shown in Figs.1-2, the first moving mechanism 401 is configured to move both the first gripper 301 and the second gripper 302 downward by a step distance in the vertical direction when the first gripper 301 and the second gripper 302 grip the optical fiber 600 at the same time, and the second moving mechanism 402 is configured to move only the second gripper 302 upward by a step distance in the vertical direction when the second gripper 302 looses the optical fiber 600. In an exemplary embodiment, the first moving mechanism 401 comprises a first servo motor, and the second mechanism 402 comprises a second servo motor.

Hereafter, it will describe a process of inserting the elongated first member 600 into the hole of the second member 500 by use of the automatic assembling system. In an exemplary embodiment of the present invention, the process mainly comprises steps of:

S100: providing an automatic assembling system according to the above embodiments;

S200: fixing the second member 500 on the movement unit, and gripping the elongated first member 600 with the step insertion unit;

S300: moving the second member 500 to a position where the first member 600 is aligned with the hole of the second member 500 by the movement unit under the guidance of the vision alignment unit; and

S400: inserting the elongated first member 600 into the hole of the second member 500

step by step by use of the step insertion unit.

In an exemplary embodiment of the present invention, the elongated first member comprises an optical fiber 600, and the second member comprises an optical ferrule 500 with a hole. The automatic assembling system is used to insert the optical fiber 600 into the hole of the optical ferrule 500. In this case, the above step S400 may comprise steps of:

S401: operating the first gripper 301 and the second gripper 302 to grip the optical fiber 600 at the same time, and moving the optical fiber 600 downward by one step distance in the vertical direction, so as to insert the optical fiber 600 into the hole of the optical ferrule 500 by one step distance;

S402: operating the second gripper 302 to loose the optical fiber 600 with the first gripper 301 gripping the optical fiber 600, moving the second gripper 302 upward by one step distance in the vertical direction, and operating the second gripper 302 to grip the optical fiber 600 again; and

S403: repeating the step S401 to the Step S402 until the optical fiber 600 is inserted into the hole of the optical ferrule 500 by a predetermined length.

In the above exemplary embodiments, the step distance may be set based on the practical conditions, for example, the diameter of the elongated first member, the diameter of the hole of the second member, or the strength of the elongated first member. In an exemplary embodiment of the present invention, the step distance may be set to be equal to 0.1mm.

In the above exemplary embodiments, at the beginning, the first gripper 301 should grip a location of the optical fiber 600 at a distance from the upper end surface of the optical ferrule 500 as far as possible within a distance range allowed by the optical fiber flexural yield strength, for example, at a distance of 2mm from the upper end surface of the optical ferrule 500. Contrary, at the beginning, the second gripper 302 below the first gripper 301 should grip a location of the optical fiber 600 at a distance from the upper end surface of the optical ferrule 500 as near as possible, for example, at a distance of 0.2mm (two step distances) from the upper end surface of the optical ferrule 500. In this way, it can reliably prevent the optical fiber 600 from being bent or broken during inserting the optical fiber 600 into the hole of the optical ferrule 500.

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. An automatic assembling system for inserting an elongated first member (600) into a hole of a second member (500), comprising:

a movement unit (101, 102) configured to move the second member (500) in a horizontal plane;

a vision alignment unit (201, 202) , under the visual guidance of the vision alignment unit, the movement unit (101, 102) moving the second member (500) to a position where the first member (600) is aligned with the hole of the second member (500); and

a step insertion unit configured to grip and move the first member (600) so as to insert the first member (600) into the hole of the second member (500) step by step.

2. The automatic assembling system according to claim 1,

wherein the elongated first member (600) comprises an optical fiber, and the second member (500) comprises an optical ferrule with a hole.

3. The automatic assembling system according to claim 2, wherein the movement unit comprising:

a first moving arm (101) configured to be capable of moving in a first direction in the horizontal plane; and

a second moving arm (102) configured to be capable of moving in a second direction perpendicular to the first direction in the horizontal plane,

wherein the first moving arm (101) is mounted on the second moving arm (102) and capable of moving with the movement of the second moving arm (102) in the second direction; and

wherein the optical ferrule (500) is fixed on the first moving arm (101).

4. The automatic assembling system according to claim 3,

wherein a fixture feature (110) for fixing the optical ferrule (500) is formed in the first moving arm (101).

5. The automatic assembling system according to claim 2, wherein the vision alignment unit comprising:

a first camera (201) configured to take a first picture of the optical ferrule (500) and the optical fiber (600) along a first shooting direction in a horizontal plane; and

a second camera (202) configured to take a second picture of the optical ferrule (500) and the optical fiber (600) along a second shooting direction different from the first shooting direction in a horizontal plane.

6. The automatic assembling system according to claim 5,
wherein the first shooting direction is perpendicular to the second shooting direction.

7. The automatic assembling system according to claim 2, wherein the step insertion unit comprising:

- a first gripper (301) configured to grip the optical fiber (600);
- a second gripper (302) configured to grip the optical fiber (600) and disposed below the first gripper (301) in a vertical direction perpendicular to the horizontal plane;
- a first moving mechanism (401) configured to move both the first gripper (301) and the second gripper (302) downward by a step distance in the vertical direction when the first gripper (301) and the second gripper (302) grip the optical fiber (600) at the same time; and
- a second moving mechanism (402) configured to move only the second gripper (302) upward by a step distance in the vertical direction when the second gripper (302) loosens the optical fiber (600).

8. An automatic assembling method for inserting an elongated first member (600) into a hole of a second member (500), comprising steps of:

- S100: providing an automatic assembling system according to claim 1;
- S200: fixing the second member (500) on the movement unit, and gripping the elongated first member (600) with the step insertion unit;
- S300: moving the second member (500) to a position where the first member (600) is aligned with the hole of the second member (500) by the movement unit under the guidance of the vision alignment unit; and
- S400: inserting the elongated first member (600) into the hole of the second member (500) step by step by use of the step insertion unit.

9. The method according to claim 8,
wherein the elongated first member (600) comprises an optical fiber, and the second member (500) comprises an optical ferrule with a hole.

10. The method according to claim 9, wherein the movement unit comprising:
a first moving arm (101) configured to be capable of moving in a first direction in the horizontal plane; and

a second moving arm (102) configured to be capable of moving in a second direction perpendicular to the first direction in the horizontal plane,

wherein the first moving arm (101) is mounted on the second moving arm (102) and capable of moving with the movement of the second moving arm (102) in the second direction; and

wherein the optical ferrule (500) is fixed on the first moving arm (101).

11. The method according to claim 10,
wherein a fixture feature (110) for fixing the optical ferrule (500) is formed in the first moving arm (101).

12. The method according to claim 9, wherein the vision alignment unit comprising:
a first camera (201) configured to take a first picture of the optical ferrule (500) and the optical fiber (600) along a first shooting direction in the horizontal plane; and
a second camera (202) configured to take a second picture of the optical ferrule (500) and the optical fiber (600) along a second shooting direction different from the first shooting direction in the horizontal plane.

13. The method according to claim 12,
wherein the first shooting direction is perpendicular to the second shooting direction.

14. The method according to claim 9, wherein the step insertion unit comprising:
a first gripper (301) configured to grip the optical fiber (600);
a second gripper (302) configured to grip the optical fiber (600) and disposed below the first gripper (301) in a vertical direction perpendicular to the horizontal plane;
a first moving mechanism (401) configured to move both the first gripper (301) and the second gripper (302) downward by a step distance in the vertical direction when the first gripper (301) and the second gripper (302) grip the optical fiber (600) at the same time; and
a second moving mechanism (402) configured to move only the second gripper (302) upward by a step distance in the vertical direction when the second gripper (302) looses the optical fiber (600).

15. The method according to claim 14, wherein the step S400 comprising steps of:
S401: operating the first gripper (301) and the second gripper (302) to grip the optical fiber (600) at the same time, and moving the optical fiber (600) downward by one step distance in the vertical direction, so as to insert the optical fiber (600) into the hole of the optical ferrule (500) by one step distance;
S402: operating the second gripper (302) to loose the optical fiber (600) with the first gripper (301) gripping the optical fiber (600), moving the second gripper (302) upward by one step distance in the vertical direction, and operating the second gripper (302) to grip the optical fiber (600) again; and
S403: repeating the step S401 to the Step S402 until the optical fiber (600) is inserted into the hole of the optical ferrule (500) by a predetermined length.

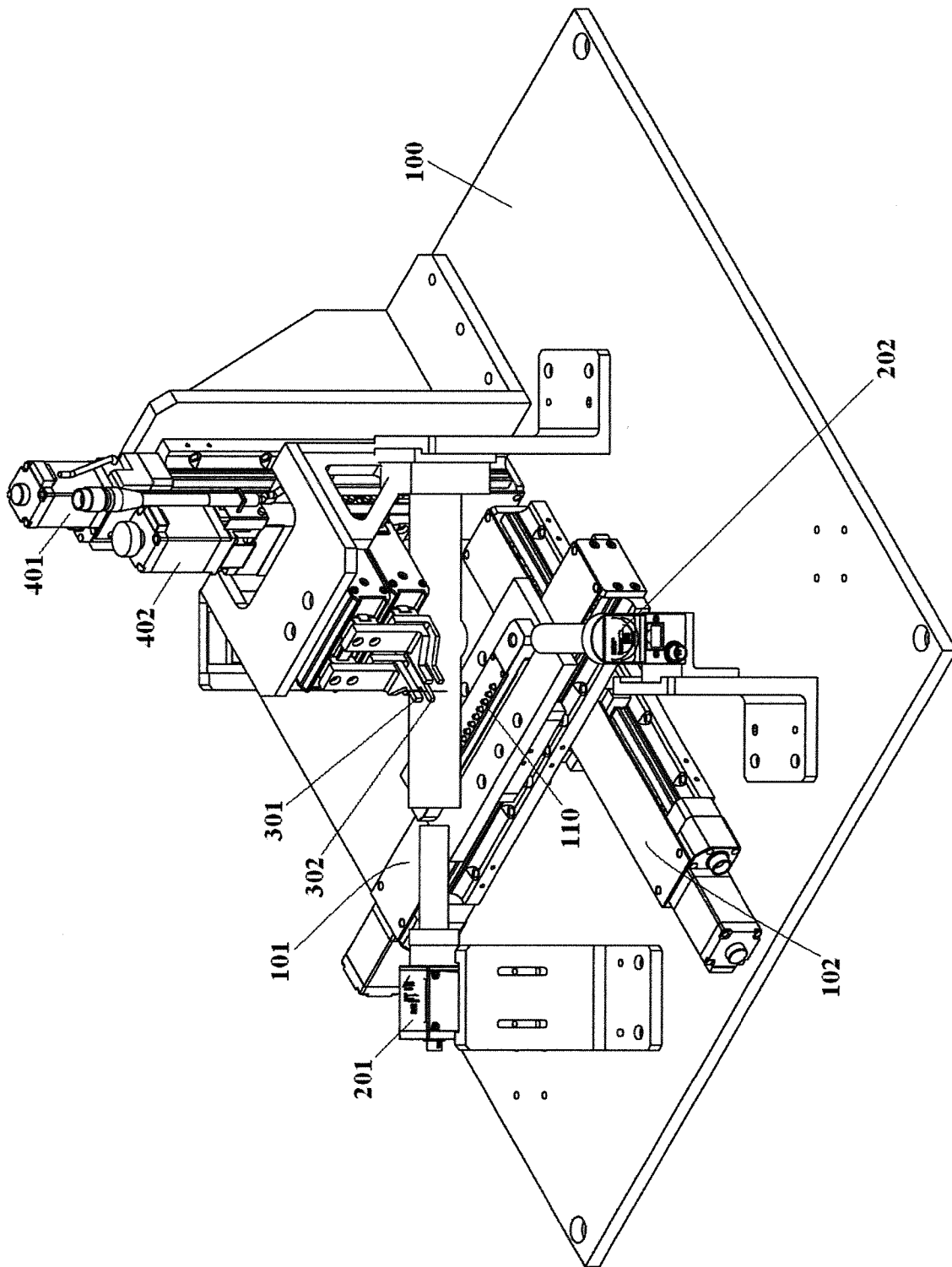


Fig.1

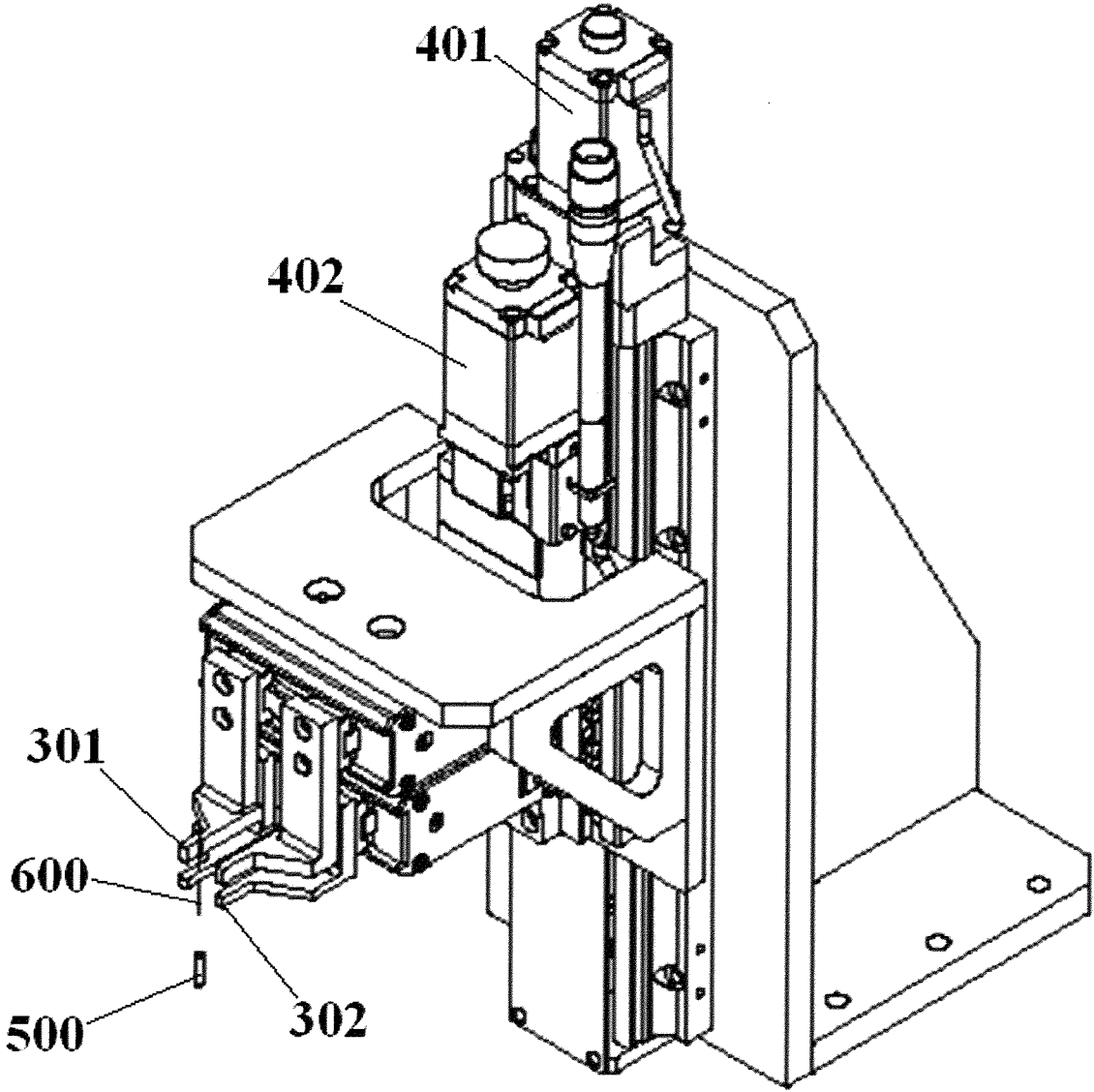


Fig.2

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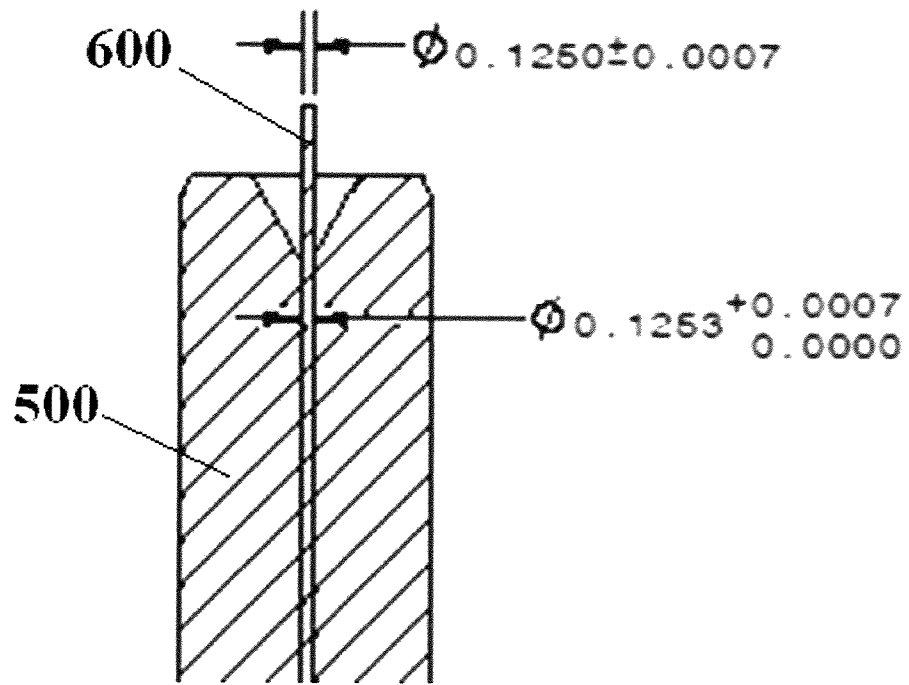


Fig.3

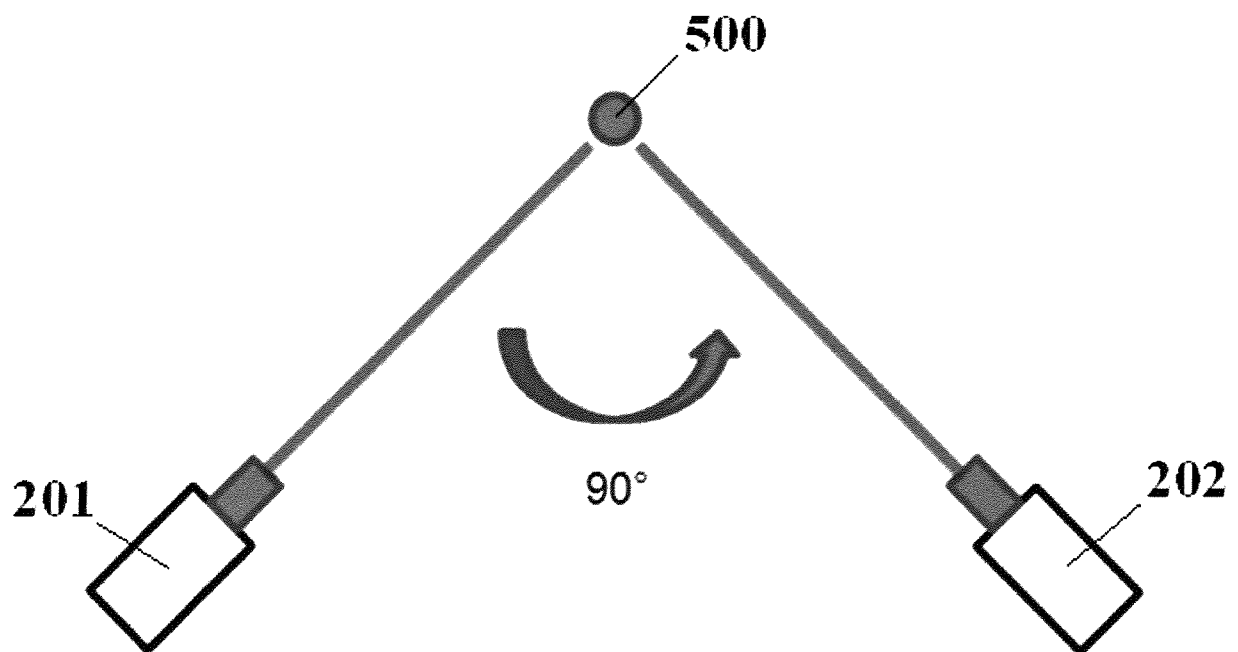


Fig.4

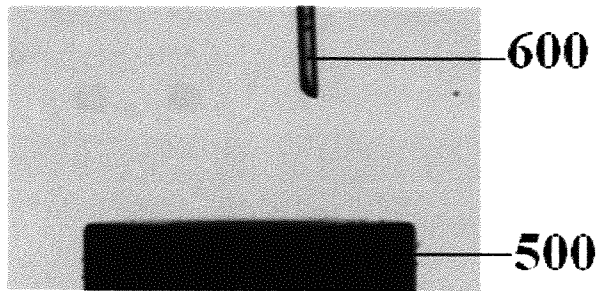


Fig.5a

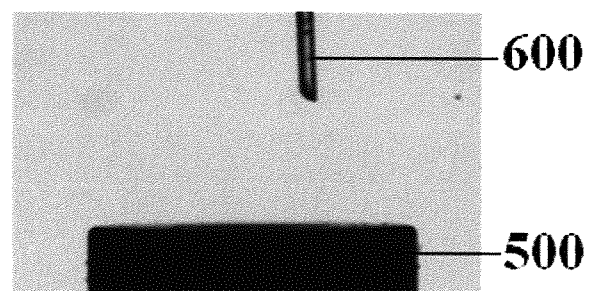


Fig.5b

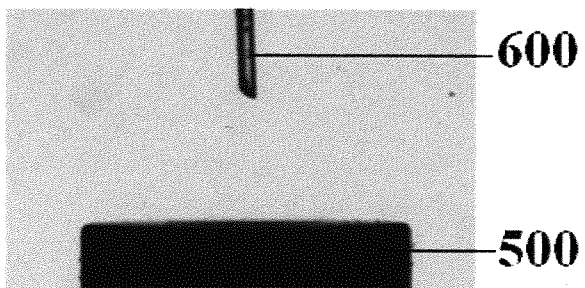


Fig.6a

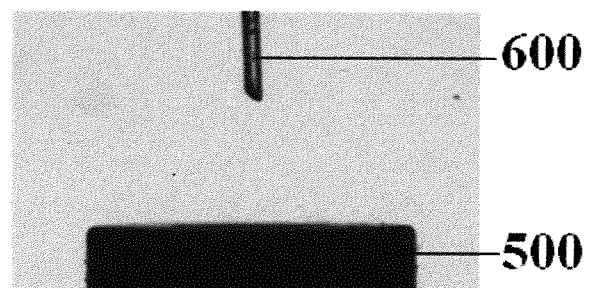


Fig.6b

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2014/063091

A. CLASSIFICATION OF SUBJECT MATTER

INV. G02B6/38
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)
G02B

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	WO 2004/086110 A2 (SCHLEUNIGER HOLDING AG [CH]; MUEHLEMATTER ULRICH [CH]; JOST MICHAEL [C] 7 October 2004 (2004-10-07) abstract; figures 6-11 page 10, lines 1-16 page 21, lines 18-24 page 20, lines 5-17 page 25, line 25 - page 26, line 20 -----	1-4,8, 10,11
X	WO 02/052326 A2 (SCHOTT GLAS [DE]; ZEISS STIFTUNG [DE]; FRAUNHOFER GES FORSCHUNG [DE];) 4 July 2002 (2002-07-04) page 5, lines 1-5; figures page 6, lines 20-25 page 7, lines 3-14 page 9, line 26 - page 11, line 3 page 10, lines 24-26 page 15, line 18 - page 16, line 18 ----- -/--	1-15

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

☒ See patent family annex.

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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

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Date of the actual completion of the international search

17 November 2014

Date of mailing of the international search report

25/11/2014

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Riblet, Philippe

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2014/063091

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 562 164 B1 (FAULKNER LYNN LEROY [US] ET AL) 13 May 2003 (2003-05-13) column 10, line 43 - column 12, line 6; figure 6 -----	1-15

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Information on patent family members

International application No

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