

ORTHOPEDIC Z-SHAPED CUTTING GUIDE DEVICE AND ORTHOPEDIC SURGICAL ROBOT COMPRISING GUIDE DEVICE

[0001] Cross Reference of Related Applications

[0002] The present disclosure claims priority of Chinese patent application No. CN201911139075.7, entitled "Orthopedic Z-shaped cutting guide device and orthopedic surgical robot comprising guide device", filed via the Chinese patent office on 11/20/2019, the entire contents of which are incorporated by reference in the present disclosure.

Technical Field

[0003] The present disclosure belongs to technical field of medical equipment, specifically involves a guiding device for guiding bone cutting in an oriented manner during an orthopedic operation, and an orthopedic operation robot provided with the guiding device.

Background

[0004] With the rapid advance of the robot technology, the application requirements of various fields are continuously widened, and the development prospect of the medical field is also much attention. In the field of orthopedic surgery, the benefits of assisting robots are becoming more and more apparent. For the bone cutting operation, the determination of the cutting surface is always a larger layer occupied by the hand feeling and visual observation of the operator, which has a great influence on the accuracy of the whole operation process, and further influences the rehabilitation progress of the patient.

[0005] Disclosure of disclosure

[0006] In response to this situation, the present disclosure discloses a Z-shaped cutting guide device that functions to assist the operator in determining the position and angle of the cutting surface during the operation. In the use process, the active mode and the passive mode of the mechanical arm are used, and the cutting surface is accurately positioned by utilizing the mutual switching of the active mode and the passive mode.

[0007] For solving above-mentioned technical problem, the present disclosure provides orthopedics Z-shaped cutting guide device and applied this guider's orthopedic surgery robot. Optionally, one technical scheme adopted is a Z-shaped orthopedic cutting guide device, includes rapid mounting flange, mounting base, Z-shaped extension handle, limiter, its characterized in that: rapid mounting flange one end is installed in the end of mechanical arm to fix a position through location structure fast, the rapid mounting flange other end carries on the mounting base, fixedly connected with Z-shaped extension handle on the mounting base, the end of Z-shaped extension handle is fixedly connected with limiter, and the central of limiter has guide groove slightly wider than the oscillating saw blade that allow the blade to pass through the guide groove.

[0008] Optionally, the Z-shaped expansion handle is screwed with a shifting handle.

[0009] Optionally, the rapid mounting flange is in a groove shape, the location structure comprises three pin holes settled on the front surface of the rapid mounting flange, the three pin holes are distributed in an isosceles triangle shape and respectively correspond to the rapid positioning pin, the cylindrical pin and the diamond pin, wherein the pin holes on the top point are used for the interference fit of the rapid mounting flange and the rapid positioning pin of the mechanical arm end interface, and the two pin holes on the bottom side are respectively fitted with the cylindrical pin and the diamond pin.

[0010] Optionally, the front surface of the rapid mounting flange has another isosceles triangle that formed by three countersunk through holes which is opposite to the isosceles triangle formed by the three pin holes, the rapid mounting flange and the end of mechanical arm are locked while three countersunk bolts pass through the three countersunk through holes respectively.

[0011] Optionally, the front surface of the rapid mounting flange has two threaded holes for locking the mounting base to the rapid mounting flange.

[0012] Optionally, the three pin holes, three countersunk through holes and two threaded holes on the front surface of the rapid mounting flange are positioned on the same circumference at an angle of 45 degree to each other.

[0013] Optionally, the mounting base has a similar shape of the rapid mounting flange, two pin holes are formed in the groove surface of the mounting base and are in interference fit with the

cylindrical pins and the diamond-shaped pins respectively, the included angle of the connecting line between two pin holes and the circle center of the mounting base is 90 degree.

[0014] Optionally, the groove surface of the mounting base has two bolts connected with the inner hexagon countersunk head to fixedly connect the Z-shaped expansion handle to the inner hexagonal countersunk head through hole I of the mounting base.

[0015] Optionally, the front of mounting base has two inner hexagonal countersunk head through holes II, the mounting base is fixed to the end interface of mechanical arm through the inner hexagon countersunk head blots of inner hexagonal countersunk head through holes II.

[0016] Optionally, the screw holes of the inner hexagon countersunk head through hole I and the inner hexagon countersunk head through hole II are opposite in direction, the connecting line between the two inner hexagon countersunk head through holes I and two inner hexagon countersunk head through holes II form an angle of 90 degree to each other.

[0017] Optionally, the front surface of mounting base has a rectangular groove, the bottom of the rectangular groove allows the inner hexagon countersunk head through hole I to penetrate.

[0018] Optionally, four vertexes of the rectangular groove (16) has 3/4 cylindrical groove.

[0019] Optionally, the Z-shaped extension handle is in a Z shape structure, the matching surface of Z-shaped extension handle and mounting base has two threaded holes correspondingly, the threaded hole correspond to the inner hexagon countersunk head through hole I of the groove surface of the mounting base, and lock the mounting base with the Z-shaped extension handle though a bolt.

[0020] Optionally, the two corners of Z-shaped extension handle (3) are obtuse angles.

[0021] Optionally, a rapid positing clamping groove matching the middle vertical section of the limiter is in front of the Z-shaped end of Z-shaped extension handle.

[0022] Optionally, above the Z-shaped end of Z-shaped extension handle is threaded hole I, the limiter has threaded hole II corresponding to the threaded hole I, the limiter and Z-shaped expansion handle are locked by threaded hole I and threaded hole II through bolts.

[0023] Optionally, the limiter is in a Z shape, the bending angle of limiter is right angle.

[0024] Optionally, the outer surface of Z-shaped expansion handle has two staggered miniature semicircular grooves I, the outer surface of limiter also has two staggered miniature semicircular grooves II, miniature semicircular groove I and miniature semicircular groove II are not

positioned on the same horizontal plane, miniature semicircular groove I and miniature semicircular groove II are used for positioning the Z-shaped cutting guide device.

[0025] Optionally, the present disclosure also disclose an orthopedic surgery robot, comprising mechanical arm and the above-mentioned Z-shaped orthopedic cutting guide device, mechanical arm has an active mode and a passive mode, the Z-shaped cutting guide device of the orthopedic surgery robot is driven by utilizing the mutual switching of the two modes, to accurately position the cutting surface.

[0026] Compared with the prior art, the beneficial effect of this disclosure is: the front surface of the rapid mounting flange has the isosceles triangle with three countersunk through holes, which is opposite to the isosceles triangle of the pin hole, and the countersunk bolts penetrate through the countersunk through holes to lock the rapid mounting flange and the end interface of the mechanical arm, thus keep the stress even, and fully save the upper surface space of the rapid mounting flange. In present disclosure, the two corners of the Z-shaped expansion handle are obtuse angles, so that the whole Z-shaped cutting guide device can be fully expanded, leave more operation space for operator. Moreover, a rapid positioning clamping groove is formed right in front of the Z-shaped end of the Z-shaped expansion handle, so that the relative position of the limiter and the Z-shaped expansion handle can be quickly positioned. Finally, to overcome the position deviation problem that exists existing in bone cutting in orthopedic surgery, the technique in present disclosure can achieve the a quick location and guide through switching the active and passive mode of mechanical arm, also provide a better operational mode with simple process and good reliability.

Drawings

[0027] FIG. 1 is a schematic structural view of the orthopedic Z-shaped cutting guide device;

[0028] FIG. 2 is a perspective view of the orthopedic Z-shaped cutting guide device ;

[0029] FIG. 3 is a schematic view of the end interface of the mechanical arm in the orthopedic surgical robot;

[0030] FIG. 4 is a schematic structural diagram of the orthopedic surgery robot after the mechanical arm and the rapid mounting flange are connected in a positioning manner;

[0031] FIG. 5 is a schematic view of the installation base showing the recessed surface;

[0032] FIG. 6 is a schematic view of the front side of the mounting base;

[0033] FIG. 7 is a schematic view of the structure of the Z-shaped expansion handle;

[0034] FIG. 8 is a schematic view of the structure of the position-limiting handle ;

[0035] In figure: 1-rapid mounting flange; 2-mounting base; 3-Z-shaped extension handle; 4-limiter; 5-shifting handle; 6-diamond pin; 7-cylindrical pin; 8-guide groove; 9-inner hexagonal countersunk head through hole I; 10-orthopedic Z-shaped cutting guide device; 11-countersunk through hole; 12-pin hole; 13-threaded hole A; 14-inner hexagonal countersunk head through hole II; 15-mechanical arm; 16-rectangular groove; 17-rapid positioning clamping groove ; 18-threaded hole I; 19-threaded hole II; 20-miniature semicircular groove I; 21-miniature semicircular groove II; 22-threaded hole B.

Embodiment

[0036] The present disclosure is described in detail with reference to the drawings and specific embodiments, wherein the exemplary embodiments and descriptions are only intended to illustrate the present disclosure, but not to unduly limit the disclosure.

[0037] As shown in figure 1 and 2, an orthopedics Z-shaped cutting guide device 10, including rapid mounting flange 1, mounting base 2, Z-shaped extension handle 3, limiter 4, rapid mounting flange 1 one end is installed in end of mechanical arm 15 to fix a position fast through location structure, other end of rapid mounting flange 1 carries on mounting base 2, the installation base 2 is fixedly connected with Z-shaped extension handle 3, the end of Z-shaped extension handle 3 is fixedly connected with limiter 4 , and the central of limiter 4 has guide groove slightly wider than the oscillating saw blade that allow the blade to pass through the guide groove.

[0038] To facilitate the process of Z-shaped cut and rapid move of device 10, the Z-shaped expansion handle 3 is screwed with a shifting handle 5.

[0039] As shown in figure 3 and 4, the rapid mounting flange 1 is in in a groove shape, the location structure comprises three pin holes 12 settled on the front surface of the rapid mounting flange 1, the three pin holes 12 are distributed in an isosceles triangle shape and respectively correspond to the rapid positioning pin, the diamond pin 6 and the cylindrical pin 7, wherein the pin holes on the top point are used for the interference fit of the rapid mounting flange 1 and the rapid positioning pin of the mechanical arm 15 end interface, and the two pin holes on the

bottom side can fit with diamond pin 6 and the cylindrical pin 7 respectively, the mounting base 2 can be quickly installed by utilizing the principle of one-surface two-pin positioning.

[0040] The front surface of the rapid mounting flange 1 has an isosceles triangle that formed by three countersunk through holes 11, three countersunk bolts pass through the three countersunk through holes 11 respectively, the rapid mounting flange 1 and the end of mechanical arm 15 are locked, keep the stress even, and fully save the upper surface space of the rapid mounting flange 1.

[0041] The front surface of the rapid mounting flange 1 has two threaded holes A 13 for locking the mounting base 2 to the rapid mounting flange 1.

[0042] The three pin holes 12, three countersunk through holes 11 and two threaded holes A 13 on the front surface of the rapid mounting flange 1 are positioned on the same circumference; for pin holes 12, countersunk through holes 11 and threaded holes A 13, the angle between any two adjacent is 45 degree; such design can reduce the processing procedures and simultaneously ensure the processing precision.

[0043] As shown in figure 5 and 6, the mounting base 2 has a similar shape of the rapid mounting flange 1, two pin holes are formed in the groove surface of the mounting base 2 and are in interference fit with the cylindrical pins and the diamond pins respectively, the included angle of the connecting line between two pin holes and the circle center of the mounting base 2 is 90 degree, thus the rapid mounting flange 1 can be matched with pin holes at the top points of the bottom edges of isosceles triangles formed by connecting lines of three countersunk through holes 11 on the front surface of the rapid mounting flange 1.

[0044] The groove surface of the mounting base 2 has two bolts connected with the inner hexagon countersunk head to fixedly connect the Z-shaped expansion handle 3 to the inner hexagonal countersunk head through hole I 9 of the mounting base 2; the front of mounting base 2 has two inner hexagonal countersunk head through holes II 14, the mounting base 2 is fixedly connect to the end interface of mechanical arm 15 through the inner hexagon countersunk head blots of inner hexagonal countersunk head through hole II 14; the screw holes of the inner hexagon countersunk head through hole I 9 and the inner hexagon countersunk head through hole II 14 are opposite in direction, the connecting line between the two inner hexagon countersunk head through holes I 9 and II 14 form an angle of 90 degree to each other; the front

surface of mounting base 2 has a rectangular groove 16, the bottom of the rectangular groove 16 allows the inner hexagon countersunk head through hole I 9 to penetrate; four vertexes of the rectangular groove 16 has 3/4 cylindrical groove. As the right angle in the milling process can only be approximate, the inconvenience of right angle processing can be avoided by using 3/4 cylindrical grooves, it is also beneficial to the quick positioning of the Z-shaped expansion handle 3 and the mounting base 2.

[0045] As shown in figure 7 and 8, the Z-shaped extension handle 3 is in a Z shape structure, its matching surface with mounting base (2) has two threaded holes B 22 correspondingly, threaded hole B 22 correspond to the inner hexagon countersunk head through holes I 9 of the groove surface of the mounting base 2, and locked by bolts; two corners of Z-shaped extension handle 3 are obtuse angles, so the whole Z-shaped cutting guide device can be fully expanded, leave more operation space for operator; a rapid positing clamping groove 17 matching the middle vertical section of the limiter 4 is in front of the Z-shaped end of Z-shaped extension handle 3, thus achieve the quick positioning of limiter 4 and Z-shaped extension handle 3.

[0046] Above Z-shaped end of Z-shaped extension handle 3 is threaded hole I 18; limiter 4 has threaded hole II 19 corresponding to the threaded hole I 18; threaded hole I (18) and threaded hole II (19) are locked through bolts.

[0047] The limiter 4 is in a Z shape, the bending angle of limiter 4 is right angle.

[0048] The outer surface of Z-shaped expansion handle 3 has two staggered miniature semicircular grooves I 20, the outer surface of limiter 4 also has two staggered miniature semicircular grooves II 21; miniature semicircular groove I 20 and miniature semicircular groove II 21 are not positioned on the same horizontal plane; miniature semicircular groove I 20 and miniature semicircular groove II 21 are both used for positioning the Z-shaped cutting guide device. During the positioning process, a probe point is firstly utilized to reach the positions of the miniature semicircular groove I 20 and the miniature semicircular groove II 21, then the position of the probe is read by a binocular vision instrument, and the position and posture change is carried out, so that the position of the Z-shaped cutting guide device in the whole space is determined.

[0049] Optionally, the present disclosure also provide an orthopedic surgery robot, comprising mechanical arm 15 and above-mentioned Z-shaped orthopedic cutting guide device; mechanical

arm 15 can be switched between an active mode and a passive mode, the Z-shaped cutting guide device of the orthopedic surgery robot is driven by utilizing the mutual switching of the two modes, to accurately position the cutting surface, and provide a better operation mode for operators, with simple process and strong reliability.

[0050] The present disclosure provides an orthopedic surgery robot, install the orthopedic Z-shaped cutting guide device 10 using the above-mentioned process, then utilize the notch of limiter 4 to confirm the position of targeted cutting, the operator will use the saw blade and insert along notches of limiter 4 and carry out the cutting operation, the operator can adjust cutting speed and cutting depth according to the experience, withdraw the saw after the operation finishes and adjust mechanical arm 15 to safe position.

[0051] The above description is only a preferred embodiment of the present disclosure, and does not limit the technical scope of the present disclosure, so that any minor modifications, equivalent changes and modifications made to the above embodiments according to the technical essence of the present disclosure still fall within the technical scope of the present disclosure.

Industrial Capability

[0052] The design features and beneficial effects of the present disclosure include: the front surface of the rapid mounting flange is provided with three pin holes and three countersunk holes, an isosceles triangle formed by connecting lines among the three pin holes is opposite to an isosceles triangle formed by connecting lines among the three countersunk holes, the pin holes are respectively configured to be matched with a quick positioning pin, a cylindrical pin and a diamond pin to quickly position the mounting base, a countersunk bolt penetrates through the countersunk through hole to lock the rapid mounting flange and an end interface of a mechanical arm, the stress is kept even, and the upper surface space of the rapid mounting flange is fully saved; the two corners of the Z-shaped expansion handle are obtuse angles, so that the whole Z-shaped cutting guide device can be fully expanded, and more operating space is left for an operator; meanwhile, a quick positioning clamping groove is formed right in front of the Z-shaped end of the Z-shaped expansion handle, so that the relative position of the limiting stopper and the Z-shaped expansion handle can be quickly positioned; the position deviation problem that exists to bone surgery intercepting bone realizes the quick location and the

direction of the device through switching the initiative and the passive mode of arm to provide better operational mode, simple structure, the good reliability for the operator.

Claims

1. A Z-shaped orthopedic cutting guide device, comprises rapid mounting flange (1), installation base (2), Z-shaped extension handle (3), limiter (4), characterized in that: one end of the rapid mounting flange (1) is installed in the end of mechanical arm to fix a position fast through location structure, the other end of rapid mounting flange (1) carries on installation base (2), the mounting base (2) is fixedly connected with Z-shaped extension handle (3), the end of Z-shaped extension handle (3) is fixedly connected with limiter (4) , and the central of limiter (4) has guide groove slightly wider than the oscillating saw blade that allow the blade to pass through the guide groove.

2. Z-shaped orthopedic cutting guide device according to claim 1, characterized in that: the Z-shaped expansion handle (3) is screwed with a shifting handle (5).

3. Z-shaped orthopedic cutting guide device according to claim 1 or 2, characterized in that: the rapid mounting flange (1) is in in a groove shape, the location structure comprises three pin holes (12) settled on the front surface of the rapid mounting flange (1), the pin hole correspond to the rapid positioning pin, the cylindrical pin (7) and the diamond pin (6), the connecting lines along the three pin holes (12) form an isosceles triangle with the vertex facing downwards, wherein the pin hole on the vertex of the isosceles triangle formed by connecting lines among the three pin holes are configured to be in interference fit with the rapid mounting flange (1) and the rapid positioning pin of the mechanical arm end interface, two pin holes on the bottom edge of the isosceles triangle formed by connecting lines among the three pin holes are respectively matched with the cylindrical pin (7) and the diamond-shaped pin (6).

4. Z-shaped orthopedic cutting guide device according to any claim of 1~3, characterized in that: the front surface of the rapid mounting flange (1) also has three countersunk through holes (11), the isosceles triangle formed by connecting lines among the three countersunk through holes (11) is opposite to the isosceles triangle formed by connecting lines of the three pin holes (12), the rapid mounting flange (1) and the end of mechanical arm (15) are locked as three countersunk bolts pass through the three countersunk through holes (11) respectively.

5. Z-shaped orthopedic cutting guide device according to any claim of 1~4, characterized in that: the front surface of the rapid mounting flange (1) has two threaded holes A (13) for locking the

mounting base (2) to the rapid mounting flange (1).

6. Z-shaped orthopedic cutting guide device according to any claim of 1~5, characterized in that: the three pin holes (12), three countersunk through holes (11) and two threaded holes A (13) on the front surface of the rapid mounting flange (1) are positioned on the same circumference at an angle of 45 degree to each other.

7. Z-shaped orthopedic cutting guide device according to any claim of 1~4, characterized in that: the mounting base (2) has a similar shape of the rapid mounting flange (1), two pin holes are formed in the groove surface of the mounting base (2) and are in interference fit with the cylindrical pins (7) and the diamond pins (6) respectively, the included angle of the connecting line between two pin holes and the circle centre of the mounting base (2) is 90 degree.

8. Z-shaped orthopedic cutting guide device according to any claim of 1~7, characterized in that: the groove surface of the mounting base (2) has two bolts connected with the inner hexagon countersunk head to fixedly connect the Z-shaped expansion handle (3) to the inner hexagonal countersunk head through hole I (9) of the mounting base (2).

9. Z-shaped orthopedic cutting guide device according to any claim of 1~8, characterized in that: the front of mounting base (2) has two inner hexagonal countersunk head through holes II (14), the mounting base (2) is fixedly connect to the end interface of mechanical arm (15) through the inner hexagon countersunk head blots of inner hexagonal countersunk head through holes II (14).

10. Z-shaped orthopedic cutting guide device according to any claim of 1~9, characterized in that:

the screw holes of the inner hexagon countersunk head through hole I (9) and the inner hexagon countersunk head through hole II (14) are opposite in direction, the connecting line between the two inner hexagon countersunk head through holes I (9) and connecting line between two inner hexagon countersunk head through holes II (14) form an angle of 90 degree to each other.

11. Z-shaped orthopedic cutting guide device according to any claim of 1~10, characterized in that:

the front surface of mounting base (2) has a rectangular groove (16), the bottom of the rectangular groove (16) allows the inner hexagon countersunk head through hole I (9) to penetrate.

12. Z-shaped orthopedic cutting guide device according to any claim of 1~11, characterized in that:

four vertexes of the rectangular groove (16) has 3/4 cylindrical groove.

13. Z-shaped orthopedic cutting guide device according to claim 8, characterized in that:

the Z-shaped extension handle (3) is in a Z shape structure, the matching surface of Z-shaped extension handle (3) and mounting base (2) has two threaded holes B (22) correspondingly, threaded hole B (22) correspond to the inner hexagon countersunk head through hole I (9) of the groove surface of the mounting base (2), and lock the mounting base (2) with the Z-shaped extension handle (3) through a bolt.

14. Z-shaped orthopedic cutting guide device according to any claim of 1~13, characterized in that:

two corners of Z-shaped extension handle (3) are obtuse angles.

15. Z-shaped orthopedic cutting guide device according to any claim of 1~14, characterized in that:

a rapid positioning clamping groove matching the middle vertical section of the limiter (4) is in front of the Z-shaped end of Z-shaped extension handle (3).

16. Z-shaped orthopedic cutting guide device according to any claim of 1~15, characterized in that:

above Z-shaped end of Z-shaped extension handle (3) is threaded hole I (18), limiter (4) has threaded hole II (19) corresponding to the threaded hole I (18), the limiter (4) and Z-shaped expansion handle (3) are locked by threaded hole I (18) and threaded hole II (19) through bolts.

17. Z-shaped orthopedic cutting guide device according to any claim of 1~15, characterized in that:

the limiter (4) is in a Z shape, the bending angle of limiter (4) is right angle.

18. Z-shaped orthopedic cutting guide device according to any claim of 1~15, characterized in that:

the outer surface of Z-shaped expansion handle (3) has two staggered miniature semicircular grooves I (20), the outer surface of limiter (4) also has two staggered miniature semicircular grooves II (21), miniature semicircular groove I (20) and miniature semicircular groove II (21) are not positioned on the same horizontal plane, miniature semicircular groove I (20) and

miniature semicircular groove II (21) are used for positioning the Z-shaped cutting guide device.

19. Orthopedic surgery robot, comprising mechanical arm (15) and Z-shaped orthopedic cutting guide device according to any claim of 1~18, mechanical arm has an active mode and a passive mode, the Z-shaped cutting guide device of the orthopedic surgery robot is driven by utilizing the mutual switching of the two modes, to accurately position the cutting surface.