FOUR-DEGREE-OF-FREEDOM FULLY DECOUPLED COMPOUND DRIVE PARALLEL MECHANISM

FIELD OF TECHNOLOGY

[0001] The present disclosure belongs to the technical field of parallel mechanisms, and particularly relates to a four-degree-of-freedom fully decoupled compound drive parallel mechanism.

BACKGROUND

[0002] A parallel mechanism is structurally characterized in that a plurality of serial branched chains are connected with a movable platform and a static platform, and has the advantages of high rigidity, speed and precision; and in the processing field, the parallel mechanism has the advantages of easy modularization and high universality, and is one of breakthroughs of a high-end progress of the manufacturing industry in China.

[0003] The parallel mechanism is a hot spot of domestic and foreign research, but because the structural characteristics of the parallel mechanism have strong coupling, the structure is complex relative to a machine tool with multiple main shafts. The problems of difficult development and precision of a control system are main bottlenecks restricting the development of the parallel mechanism in the processing field, and the above problems may be solved by realizing full decoupling. However, existing fully decoupled parallel mechanisms at this stage are complex in structure, have a large number of kinematic pairs in branched chains, and have few degrees of freedom, so that they rarely have engineering value and mostly only exist in the theoretical stage. In addition, the number of branched chains may be reduced by compound drive, and the complexity of the mechanism is greatly reduced, so that a fully decoupled compound drive parallel mechanism suitable for processing and manufacturing will be a revolutionary progress of the manufacturing industry.

SUMMARY

[0004] To solve the above problems, an objective of the present disclosure is to provide a four-degree-of-freedom fully decoupled compound drive parallel mechanism.

[0005] To achieve the above objective, the four-degree-of-freedom fully decoupled compound drive parallel mechanism provided by the present disclosure includes a base, a movable platform, a first branched chain, a second branched chain and a third branched chain,

[0006] wherein the base includes a first rail, a second rail, a third rail, a rack and a bottom plate; the first rail and the second rail are fixed on a surface of the bottom plate in a T shape; a lower end of the rack is fixed on a surface of the bottom plate, and is respectively positioned on two sides of the second rail together with the first rail; the third rail is fixed on a side surface of the rack facing the first rail and is vertical to the bottom plate;

[0007] the movable platform includes a first hinged support, a second hinged support, a third hinged support and a bedplate; the first hinged support is fixed in the middle of the bottom surface of the bedplate; the second hinged support and the third hinged support are respectively arranged in the middles of two side surfaces of the bedplate; a rotation axis of the first hinged support is parallel to the bottom surface of the bedplate and is parallel to a rotation axis of the second hinged support; a rotation axis of the third hinged support is vertical to a rotation axis of the first hinged support and is parallel to a side surface of the bedplate;

[0008] the first branched chain includes a first sliding block, a first connecting rod and a second connecting rod; the first sliding block is connected to the first rail through a first sliding pair; the first connecting rod has the same structure as the second connecting rod, and rotation axes at two ends thereof are parallel, wherein one end of the first connecting rod is connected to the top surface of the first sliding block through a first rotating pair, the other end of the first connecting rod is connected with one end of the second connecting rod through a second rotating pair, and the other end of the second connecting rod is connected to the second hinged support of the movable platform through a third rotating pair; rotation axes of the first rotating pair, the second rotating pair and the third rotating pair are all parallel to the first rail;

[0009] the second branched chain includes a second sliding block, two third connecting rods, two fourth connecting rods, a fifth connecting rod and a sixth connecting rod; the second sliding block is connected to the second rail of the base through a second sliding

pair; one ends of the two third connecting rods are respectively connected to the top surface of the second sliding block through a fourth rotating pair at intervals, and the other end of each of the third connecting rods is simultaneously connected with one end of the fifth connecting rod and one end of one of the fourth connecting rods through a fifth rotating pair; the other ends of the two fourth connecting rods are respectively connected with two ends of the sixth connecting rod through a sixth rotating pair; rotation axes of the fourth rotating pair, the fifth rotating pair and the sixth rotating pair are parallel to the second rail, and a distance between every two rotating pairs is equal, so that the second branched chain is of a double-parallelogram structure as a whole;

[0010] the third branched chain includes a third sliding block, a connecting piece, a seventh connecting rod and an eighth connecting rod; the third sliding block is connected to the third rail through a third sliding pair; one end of the connecting piece is connected to the top surface of the third sliding block through a seventh rotating pair, the other end of the connecting piece is connected with one end of the seventh connecting rod through an eighth rotating pair, and a rotation axis of the seventh rotating pair is parallel to the first rail; rotation axes of the seventh rotating pair and the eighth rotating pair are mutually vertical; and one end of the eighth connecting rod is connected with the other end of the seventh connecting rod through a ninth rotating pair, the other end of the eighth connecting rod is connected to the third hinged support of the movable platform through a tenth rotating pair, and rotation axes of the eighth rotating pair, the ninth rotating pair and the tenth rotating pair are parallel to one another.

[0011] The base is of a circular plate-shaped structure.

[0012] The movable platform is of a square plate-shaped structure.

[0013] The first connecting rod and the second connecting rod are of a rod-shaped structure with two ends in a bending state, and bending directions of the two ends are opposite.

[0014] The four-degree-of-freedom fully decoupled compound drive parallel mechanism provided by the present disclosure has the following advantages:

[0015] 1. Each of four degrees of freedom of the mechanism is completely controlled by a single kinematic pair, so that full decoupling is realized, and the theoretical analysis and

control system development of the mechanism is greatly simplified.

[0016] 2. The branched chains of the mechanism on the rack adopt two driving pairs, and compound drive is adopted, so that the number of the branched chains is reduced, the interference among the branched chains is avoided, the number of parts is reduced, and the manufacturing cost is further reduced.

[0017] 3. The mechanism adopts a double-parallelogram branched chain to replace a common decoupled branched chain with multiple rotating pairs, thereby increasing the motion stability and improving the rigidity of the mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] FIG. 1 is a schematic diagram of an overall structure of a four-degree-of-freedom fully decoupled compound drive parallel mechanism provided by the present disclosure.

[0019] FIG. 2 is a schematic diagram of a base in the four-degree-of-freedom fully decoupled compound drive parallel mechanism provided by the present disclosure.

[0020] FIG. 3 is a schematic diagram of a movable platform in the four-degree-of-freedom fully decoupled compound drive parallel mechanism provided by the present disclosure.

[0021] FIG. 4 is a schematic diagram of a first branched chain in the four-degree-of-freedom fully decoupled compound drive parallel mechanism provided by the present disclosure.

[0022] FIG. 5 is a schematic diagram of a second branched chain in the four-degree-of-freedom fully decoupled compound drive parallel mechanism provided by the present disclosure.

[0023] FIG. 6 is a schematic diagram of a third branched chain in the four-degree-of-freedom fully decoupled compound drive parallel mechanism provided by the present disclosure.

DESCRIPTION OF THE EMBODIMENTS

[0024] The four-degree-of-freedom fully decoupled compound drive parallel

mechanism provided by the present disclosure is described in detail below with reference to the accompanying drawings.

[0025] As shown in FIGS. 1-6, the four-degree-of-freedom fully decoupled compound drive parallel mechanism provided by the present disclosure includes a base 1, a movable platform 2, a first branched chain I, a second branched chain II and a third branched chain III,

[0026] wherein the base 1 includes a first rail 101, a second rail 102, a third rail 103, a rack 104 and a bottom plate 105; the first rail 101 and the second rail 102 are fixed on a surface of the bottom plate 105 in a T shape; a lower end of the rack 104 is fixed on a surface of the bottom plate 105, and is respectively positioned on two sides of the second rail 102 together with the first rail 101; the third rail 103 is fixed on a side surface of the rack 104 facing the first rail 101 and is vertical to the bottom plate 105;

[0027] the movable platform 2 includes a first hinged support 201, a second hinged support 202, a third hinged support 203 and a bedplate 204; the first hinged support 201 is fixed in the middle of the bottom surface of the bedplate 204; the second hinged support 202 and the third hinged support 203 are respectively arranged in the middles of two side surfaces of the bedplate 204; a rotation axis of the first hinged support 201 is parallel to the bottom surface of the bedplate 204 and is parallel to a rotation axis of the second hinged support 202; a rotation axis of the third hinged support 203 is vertical to a rotation axis of the first hinged support 201 and is parallel to a side surface of the bedplate 204;

[0028] the first branched chain I comprises a first sliding block 3, a first connecting rod 4 and a second connecting rod 5; the first sliding block 3 is connected to the first rail 101 through a first sliding pair 11; the first connecting rod 4 has the same structure as the second connecting rod 5, and rotation axes at two ends thereof are parallel, wherein one end of the first connecting rod 4 is connected to the top surface of the first sliding block 3 through a first rotating pair 301, the other end of the first connecting rod is connected with one end of the second connecting rod 5 through a second rotating pair 302, and the other end of the second connecting rod 5 is connected to the second hinged support 202 of the movable platform 2 through a third rotating pair 15; rotation axes of the first rotating pair 301, the second rotating pair 302 and the third rotating pair 15 are all parallel to the first rail 101;

[0029] the second branched chain II includes a second sliding block 404, two third connecting rods 405, two fourth connecting rods 406, a fifth connecting rod 407 and a sixth connecting rod 408; the second sliding block 404 is connected to the second rail 102 of the base 1 through a second sliding pair 12; one ends of the two third connecting rods 405 are respectively connected to the top surface of the second sliding block 404 through a fourth rotating pair 401 at intervals, and the other end of each of the third connecting rods 405 is simultaneously connected with one end of the fifth connecting rod 407 and one end of one of the fourth connecting rods 406 through a fifth rotating pair 402; the other ends of the two fourth connecting rods 406 are respectively connected with two ends of the sixth connecting rod 408 through a sixth rotating pair 403; rotation axes of the fourth rotating pair 401, the fifth rotating pair 402 and the sixth rotating pair 403 are parallel to the second rail 102, and a distance between every two rotating pairs is equal, so that the second branched chain II is of a double-parallelogram structure as a whole;

[0030] the third branched chain III includes a third sliding block 7, a connecting piece 8, a seventh connecting rod 9 and an eighth connecting rod 10; the third sliding block 7 is connected to the third rail 103 through a third sliding pair 13; one end of the connecting piece 8 is connected to the top surface of the third sliding block 7 through a seventh rotating pair 501, the other end of the connecting piece is connected with one end of the seventh connecting rod 9 through an eighth rotating pair 502, and a rotation axis of the seventh rotating pair 501 is parallel to the first rail 101; rotation axes of the seventh rotating pair 501 and the eighth rotating pair 502 are mutually vertical; and one end of the eighth connecting rod 10 is connected with the other end of the seventh connecting rod 9 through a ninth rotating pair 503, the other end of the eighth connecting rod 10 is connected to the third hinged support 203 of the movable platform 2 through a tenth rotating pair 16, and rotation axes of the eighth rotating pair 502, the ninth rotating pair 503 and the tenth rotating pair 16 are parallel to one another.

[0031] The base 1 is of a circular plate-shaped structure.

[0032] The movable platform 2 is of a square plate-shaped structure.

[0033] The first connecting rod 4 and the second connecting rod 5 are of a rod-shaped structure with two ends in a bending state, and bending directions of the two ends are

opposite.

[0034] Now, with the direction of the first rail 101 as an x-axis direction, the direction of the second rail 102 as a y-axis direction, and the direction of the third rail 103 as a z-axis direction, a working principle of the four-degree-of-freedom fully decoupled compound drive parallel mechanism provided by the present disclosure is described as follows:

[0035] the four-degree-of-freedom fully-decoupled compound drive parallel mechanism provided by the present disclosure selects the first sliding pair 11, the second sliding pair 12, the third sliding pair 13 and the seventh rotating pair 501 as driving pairs. When the first sliding block 3 on the first branched chain I moves on the first rail 101, the movable platform 2 may be provided with the degree of freedom of moving in the x-axis direction; when the second sliding block 404 on the second branched chain II moves on the second rail 102, the movable platform 2 may be provided with the degree of freedom of moving in the y-axis direction; when the third sliding block 7 on the third branched chain III moves on the third rail 103, the movable platform 2 may be provided with the degree of freedom of moving in the z-axis direction; when the connecting piece 8 on the third branched chain III rotates along with the seventh rotating pair 501, the movable platform 2 may be provided with the degree of freedom of rotating around an x-axis; and finally, the movable platform 2 may realize four degrees of freedom in total, namely the degree of freedom of moving in three directions and the degree of freedom of rotating around the x-axis.

WHAT IS CLAIMED IS:

1. A four-degree-of-freedom fully decoupled compound drive parallel mechanism, the parallel mechanism comprising a base (1), a movable platform (2), a first branched chain (I), a second branched chain (II) and a third branched chain (III),

wherein the base (1) comprises a first rail (101), a second rail (102), a third rail (103), a rack (104) and a bottom plate (105); the first rail (101) and the second rail (102) are fixed on a surface of the bottom plate (105) in a T shape; a lower end of the rack (104) is fixed on a surface of the bottom plate (105), and is respectively positioned on two sides of the second rail (102) together with the first rail (101); the third rail (103) is fixed on a side surface of the rack (104) facing the first rail (101) and is vertical to the bottom plate (105);

the movable platform (2) comprises a first hinged support (201), a second hinged support (202), a third hinged support (203) and a bedplate (204); the first hinged support (201) is fixed in the middle of the bottom surface of the bedplate (204); the second hinged support (202) and the third hinged support (203) are respectively arranged in the middles of two side surfaces of the bedplate (204); a rotation axis of the first hinged support (201) is parallel to the bottom surface of the bedplate (204) and is parallel to a rotation axis of the second hinged support (202); a rotation axis of the third hinged support (203) is vertical to a rotation axis of the first hinged support (201) and is parallel to a side surface of the bedplate (204);

the first branched chain (I) comprises a first sliding block (3), a first connecting rod (4) and a second connecting rod (5); the first sliding block (3) is connected to the first rail (101) through a first sliding pair (11); the first connecting rod (4) has the same structure as the second connecting rod (5), and rotation axes at two ends thereof are parallel, wherein one end of the first connecting rod (4) is connected to the top surface of the first sliding block (3) through a first rotating pair (301), the other end of the first connecting rod is connected with one end of the second connecting rod (5) through a second rotating pair (302), and the other end of the second connecting rod (5) is connected to the second hinged support (202) of the movable platform (2) through a third rotating pair (15); rotation axes of the first rotating pair (301), the second rotating pair (302) and the third rotating pair (15) are all parallel to the first rail (101);

the second branched chain (II) comprises a second sliding block (404), two third

connecting rods (405), two fourth connecting rods (406), a fifth connecting rod (407) and a sixth connecting rod (408); the second sliding block (404) is connected to the second rail (102) of the base (1) through a second sliding pair (12); one ends of the two third connecting rods (405) are respectively connected to the top surface of the second sliding block (404) through a fourth rotating pair (401) at intervals, and the other end of each of the third connecting rods (405) is simultaneously connected with one end of the fifth connecting rod (407) and one end of one of the fourth connecting rods (406) through a fifth rotating pair (402); the other ends of the two fourth connecting rods (406) are respectively connected with two ends of the sixth connecting rod (408) through a sixth rotating pair (403); rotation axes of the fourth rotating pair (401), the fifth rotating pair (402) and the sixth rotating pair (403) are parallel to the second rail (102), and a distance between every two rotating pairs is equal, so that the second branched chain II is of a double-parallelogram structure as a whole;

the third branched chain (III) comprises a third sliding block (7), a connecting piece (8), a seventh connecting rod (9) and an eighth connecting rod (10); the third sliding block (7) is connected to the third rail (103) through a third sliding pair (13); one end of the connecting piece (8) is connected to the top surface of the third sliding block (7) through a seventh rotating pair (501), the other end of the connecting piece is connected with one end of the seventh connecting rod (9) through an eighth rotating pair (502), and a rotation axis of the seventh rotating pair (501) is parallel to the first rail (101); rotation axes of the seventh rotating pair (501) and the eighth rotating pair (502) are mutually vertical; and one end of the eighth connecting rod (10) is connected with the other end of the seventh connecting rod (9) through a ninth rotating pair (503), the other end of the eighth connecting rod (10) is connected to the third hinged support (203) of the movable platform (2) through a tenth rotating pair (16), and rotation axes of the eighth rotating pair (502), the ninth rotating pair (503) and the tenth rotating pair (16) are parallel to one another.

2. The four-degree-of-freedom fully decoupled compound drive parallel mechanism according to claim 1, wherein the base (1) is of a circular plate-shaped structure.

3. The four-degree-of-freedom fully decoupled compound drive parallel mechanism according to claim 1, wherein the movable platform (2) is of a square plate-shaped structure.

4. The four-degree-of-freedom fully decoupled compound drive parallel mechanism

according to claim 1, wherein the first connecting rod (4) and the second connecting rod (5) are of a rod-shaped structure with two ends in a bending state, and bending directions of the two ends are opposite.