International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 3 Issue 1 ǁ Jan. 2015 ǁ PP.71-73

A Two-DOF Parallel Mechanism Analysis Based on Position and Orientation Characteristics Theory

XU Hai, HANG Lubin, SHEN Chenwei, CAI Jin, BIAN Huaiqiang, WANG Yuzhao, LI Chang
(College of Mechanical Engineering, Shanghai University of Engineering Science, Shanghai 201620)
Corresponding author: Hang Lubin
hanglb@126.com

Abstract: This paper proposed a comprehensive analysis of a two-DOF parallel mechanism based on Position and Orientation Characteristics Theory(POC). According to the POC theory analysis, the topological structure of the parallel mechanism was given, the POC equation for the parallel mechanism was instituted. Compile the math model of parallel mechanism in Maple, obtained three dimensional surface of the positive position solutions and space trajectories of three dimensional surface.

Key words: Position and Orientation Characteristics (POC) Theory, topology structure, Maple software, parallel mechanism

I. Instruction

Omni-Wrist parallel mechanism is Ross Hime Design company and New York University common development of two freedom parallel movement platform,has fast positioning,high speed, high precision and compact structure advantages[1]. It has widely of application prospects in aviation space, electronic communications, camera remote sensing fields which needs target objects in track[2-4].

The characteristics of topological of structural design theory based on POC Theory [5] ：

a) Freedom of access to non-transient and non-instant.
b) The resulting geometry with existing institutions in general.
c) By contrast, operation is relatively simple, and has a clear physical meaning.
d) Used with over constrained and non-over constrained topology design.

II. Mechanism topology structure analysis

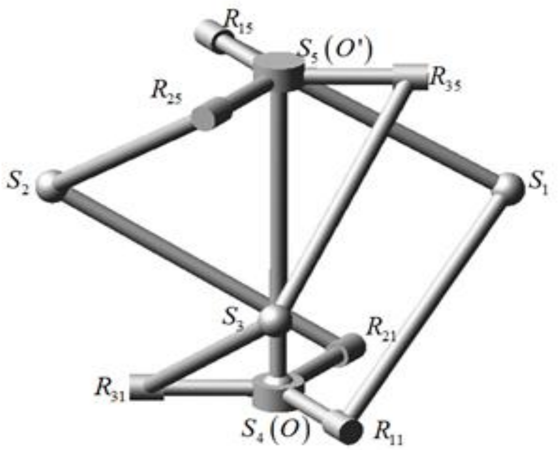

Fig 1Omni-Wrist mechanism schematic

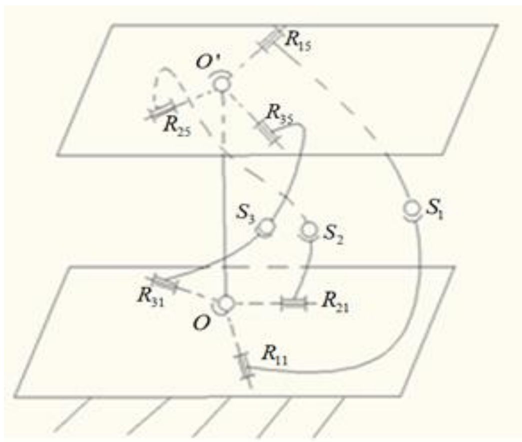

Fig 2 Omni-Wrist mechanism diagram

As shown in Figure 1 and Figure 2,Omni-Wrist mechanism schematic and mechanism diagram organization a of two-DOF spherical parallel mechanism respectively, consists of moving platforms, static platforms, three spaced a static 120 degree of the same RSR movement branched-chain and a SS consisting of connecting rod, connecting each branch consists of two rotating platforms and static platform vice deputy and a ball. Every stage rotating pair r_{i1}(i=1,2,3) axis center point to center point of static platforms, namely ball deputy under S_4 center. Similarly, rotating pair on a moving platform r_{i5}(i=1,2,3) axis center point to move the center point, namely ball under S_5 of the Center. Ball under S_i(i=1,2,3), can be converted into three mutually perpendicular and intersecting in the ball under the center point of the rotations r_{ij}(i=1,2,3,j=2,3,4).Ball under S_4, and S_5 can be converted to their respective ball perpendicular and intersecting pair of rotations of the center point r_{4i}(i= 1,2,3) and r_{5k}(k=4,5,6). Available based on POC,topology of symbols of the institution as follows:

$$3-SOC\left\{-R_{i1}\parallel-\overbrace{R_{i2}R_{i3}R_{i4}}-R_{i5}\right\}\oplus 1-SOC\left\{-\overbrace{R_{41}R_{42}R_{43}}-\overbrace{R_{44}R_{44}R_{45}}-\right\}PM \quad (1)$$

Based on POC theory, institution the Omni-Wrist parallel mechanism POC set of steps is as follows:

a) The topological structure of the branch. Three identical RSR branched-chain, whose topology is:

$$SOC\left\{-R_{i1}\parallel-\overbrace{R_{i2}R_{i3}R_{i4}}-R_{i5}\right\} \qquad (i=1,2, \quad (2)$$

The SS middle branch, whose topology is:

$$SOC\left\{-\overbrace{R_{41}R_{42}R_{43}}-\overbrace{R_{44}R_{44}R_{45}}-\right\} \quad (3)$$

b) To determine branch location at the end of the feature set. According to the common type of end POC Theory scale constraints [27], launched three branch location at the end of the same feature set as follows:

$$M_{Si}=\begin{bmatrix} t^1(\perp(R_{i1},\rho)) \\ r^1(\parallel R_{i1}) \end{bmatrix}\bigcup\begin{bmatrix} t^2(\perp\rho_i) \\ r^3 \end{bmatrix}\bigcup\begin{bmatrix} t^1(\perp(R_{i5},\rho)) \\ r^1(\parallel R_{i5}) \end{bmatrix} \quad (i=1,2,3) \quad (4)$$

Similarly, the POC set of middle-chain is:

$$M_{S4}=\begin{bmatrix} t^2(\perp\rho_4) \\ r^3 \end{bmatrix}\bigcup\begin{bmatrix} t^2(\perp\rho_5) \\ r^3 \end{bmatrix} \quad (5)$$

c) To establish parallel orientation of the characteristic equation. Algorithm based on POC theory, that:

$$M_{Pa}=M_{s1}\bigcap M_{s2}\bigcap M_{s3}\bigcap M_{s4} \quad (6)$$

where M_{Pa} is the POC set of Omni-Wrist parallel mechanism.

III. Mechanism's position analysis with Maple software

According to the literature[6] proposed mathematical model method to establish the position equation based on Maple software powerful symbolic computation capabilities and convenience of three dimensional plotting function, using its built-in plot 3D functions, institutional location visualization.

Assuming the body position of the moving platform to:

$$\overline{OO'}=\begin{pmatrix} d_x \\ d_y \\ d_z \end{pmatrix} \quad (7)$$

Use plot3d Function to draw the body forward position when you pose displacement relative to the input of the component (two branched-chain type angle) of the three dimensional surface. Enter the following:

$$plot3d(d_x,\theta_1=0..\frac{2\theta_0}{180}\cdot\pi,\theta_2=0..\frac{2\theta_0}{180}\cdot\pi) \quad (8)$$

$$plot3d(d_y,\theta_1=0..\frac{2\theta_0}{180}\cdot\pi,\theta_2=0..\frac{2\theta_0}{180}\cdot\pi) \quad (9)$$

$$plot3d(d_z,\theta_1=0..\frac{2\theta_0}{180}\cdot\pi,\theta_2=0..\frac{2\theta_0}{180}\cdot\pi) \quad (10)$$

$$plot3d(d_x,d_y,d_z,\theta_1=0..\frac{2\theta_0}{180}\cdot\pi,\theta_2=0..\frac{2\theta_0}{180}\cdot\pi) \quad (11)$$

Type represented in drawing on input angular displacement Interval of the output location and enter the angle of the surface, and the equitation11 represents a space trajectory drawing bodies surface. The surface chart is shown below.

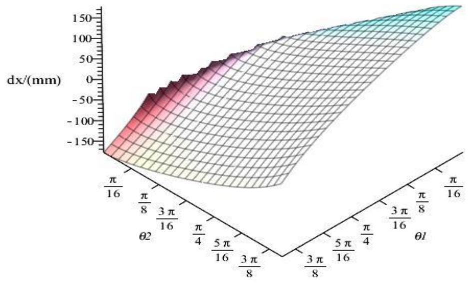

Fig 3 The surface plot of

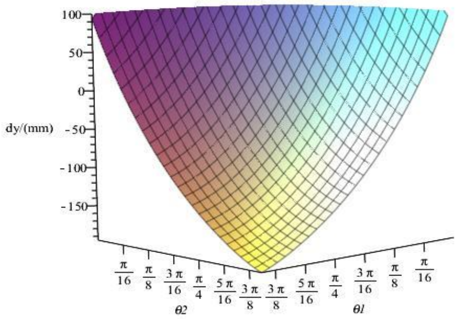

Fig 4 The surface plot of y

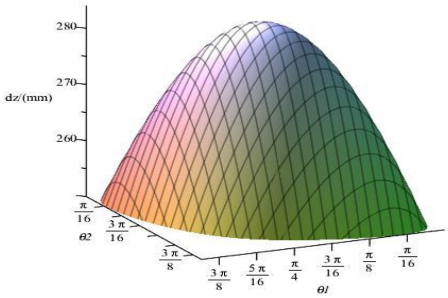

Fig 5 The surface plot of

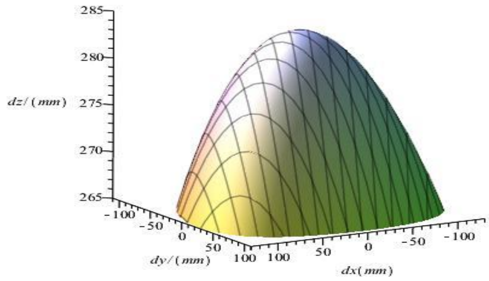

Fig 6 Trajectory diagram of forward positional

IV. Conclusions

This paper proposed a comprehensive analysis of a two-DOF parallel mechanism based on Position and Orientation Characteristics Theory(POC). The topological structure of the parallel mechanism was given, the POC equation for the parallel mechanism was instituted. With Maple software, obtained three dimensional surface of the positive position solutions and space trajectories of three dimensional surface of the Omni-Wrist parallel mechanism.

V. Acknowlgement

This work is supported by the Shanghai Committee of Science and Technology Key Support Project (1251 0501100); NFS(51475050); Enterprise Project(SX-005-1JX); SUES.st(A-0500-09-240); School Research and Innovation Projects:E1-0903-14-01013 and E1-0903-14-01016

References

[1] GOSSELIN C, CARON F. Two-degree-of-freedom spherical orienting device. U.S. Patent 5966991[P/OL]. 1999-10-19 [2012-12-21]. http: //robot.gmc. ulval.ca/docs/ brevets/us596691.pdf.

[2] BERNELLI-ZAZZERAF, GALLINI D. Analysis and design of a hexapod mechanism for autonomous payload pointting[C]//46th IAF Congress, October 2-6, 1995, Oslo.1995:135-139.

[3] BISHOP Jr R M. Development of precision pointing controllers with and without vibration suppression for the NPS precision pointing hexapod[R/OL].Monterey, CA: Naval Postgraduate School, DEPT of Aeronautics and Astronautics, 2002.http://hdl.handle.net/10945/4292.

[4] HOSPODAR JR E J. A laser metrology system for precision pointing[R/OL].Monterey, CA: Naval Postgraduate School,2003.http://hdl.handle.net/10945/6190.

[5] Yang Tingli，LIU Anxin，LUO Yufeng. Theory and Application of Robot Mechanism Topology [M]，Beijing：Science Press，2012(5). 364.

[6] DONG Xin，YU Jingjun，CHEN Bin, et al. Geometric Approach for Kinematic Analysis of a Class of 2-DOF Rotational Parallel Manipulators.[J].Chinese Journal of Mechanical Engineering. 2012. 25(2). 241-247.