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Kinematics Analysis Of 8-UPS Parallel Robot Walking Mode

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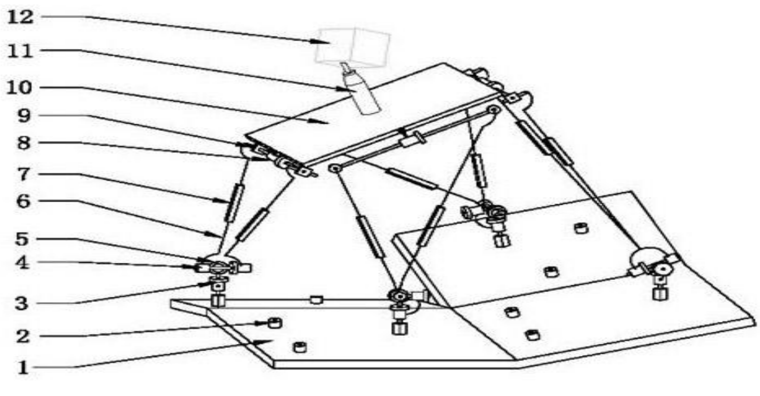
ABSTRACT: Achieving stable machining is a difficult problem in large workspace robot field, this paper proposes a new 8-UPS parallel robot with 6 DOF as well as walking and machining ability. In machining mode, it equals to a traditional parallel robot, in walking mode it is a 4 legs walking robot. It mainly from kinematics and inverse solution, workspace, mobile platform trajectory planning, singularity analysis, performance analysis to do kinematics analysis in machining mode; when the robot works in walking mode, the reseach mainly from configuration design, gait planning and kinematics analysis aspects. The inverse kinematic model of 8-UPS Parallel robot under machining mode was established, and the rod length function was obtained. Based on the machining mode workspace, a robot design method was proposed, and the full performance indicator was used to help design the main parameters of the robot. Based on MATLAB, Simulink model was established to complete inverse kinematics simulation and get the rod length as well as drive speed variation of the 8-UPS parallel robot. Based on SolidWorks, 8-UPS model was established, with using Motion part according to the specified trajectory, kinematics simulation curve was obtained to help analyse the performance of the robot. At the end, interference checking process was proposed to help to check the interface between hinge and rods.
Keywords: Large work space; Parallel Mechanism; Walk; Kinematics; Simulation

I. INTRODUCTION

The quadruped robot, the kinematics movement between the robot and the main body of each leg, and provide a theoretical basis for the design of motion simulation and control system of the robot. The movement is the credit of quadruped robot kinematics and inverse kinematics, including position analysis, velocity analysis and acceleration analysis. Firstly, the parallel robot walking pattern under the configuration design and gait planning, walking on the kinematic characteristics of robot robot mode, including the reconstruction stage loading platform key pose solution and the robot walking mode and kinematics, the kinematic parameters in the simulation mode of walking robot.

In this paper 8-UPS walking parallel robot walking mode processing configuration shown in figure 1, the load line platform, a support base and connected load platform and the base drive components, including: four of the linear drive branch between the support base and the loading platform is symmetrically distributed, a UPS parallel mechanism based on Ontology of the walking robot; loading platform the mounted on the end effector; the base is fixedly connected with a locking pin two or more, the robot foot end of the locking ring with the locking pin, so that the robot can walk along the path of the locking pin. This paper proposes for the industrial application of the robot walking robot concept processing. With high stiffness characteristics of legged robot with high maneuverability and parallel mechanism, with six axis machining, stable operation and walking ability, and,through the system configuration and the end effector of the weight In this paper, the robot is expected to complete the task of cutting, loading and unloading, handling, and so on. The research work of this paper is expected to provide a feasible mobile processing solution for the high efficiency of the work space and the wide area distributed multi production line



1.Support pedestal 2.Locking pin 3.Locking ring 4.Vertical axis 5.Down vertical shaft 6.Down lateral axis 7.Ball screw 8.Up lateral axis 9.Ball screw mother sets 10.Loading platform 11.End effector 12.Processing parts

Fig.1 Configuration of 8-UPS parallel robot walking mode

8-UPS walking parallel robot by processing, loading platform, linear support base and connected load platform and the base drive components, characterized in that: four of the linear drive of symmetric branching between the support base and the load on each platform, including two branch line drive with the same structure of UPS driving branch, formed with 8 legs 8 motor, installed 8 legs on the upper branch of each UPS telescopic driving through a transverse shaft, connecting cardan joint and load platform and vertical shaft, intermediate by a mechanical telescopic driving mechanism consisting of the lower end of the mobile side, a vertical axis, vertical axis. Under the horizontal axis and connected by side equivalent sphere locking ring and the support base are connected, a UPS parallel mechanism of walking robot based on ontology.

1.Gait planning

Quadruped robot gait planning, refers to the component of motion trajectory planning of robot walking process, such as when the foot leaves the ground, the entire foot swing phase in the air trajectory and when landing. The joint space trajectory planning, planning function generated value is the amount of joint and Cartesian space trajectory planning, function generation is the value of the robot end effector pose, they need by solving the inverse kinematics equation can be transformed into the joint.

This walking processing robot parallel mechanism based on ontology has two basic modes, the processing mode is actually a parallel or hybrid machine tool / manipulator, and walking pattern when a multi legged robot. After the robot completes the processing task, it is necessary to move to a new position. Prior to this, some passive joints must be locked in advance, and the position and attitude of the loading platform should be adjusted accurately to ensure the stable transformation of the processing stage and the walking phase.

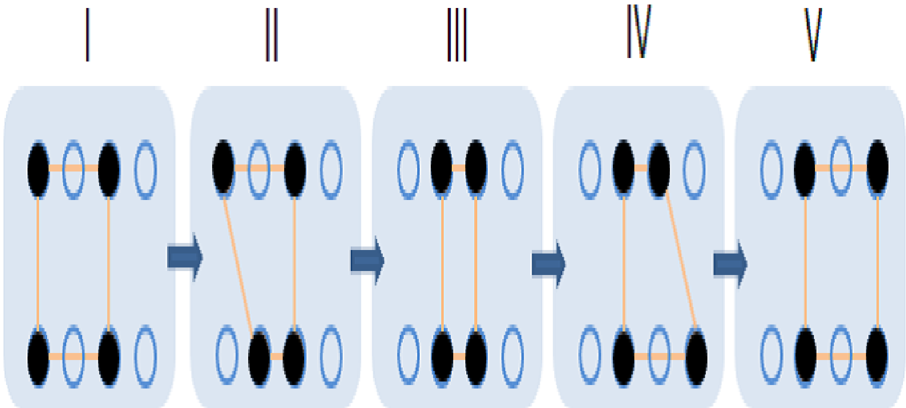


Fig.2 Whole gait cycle of 8-UPS parallel robot under walking mode

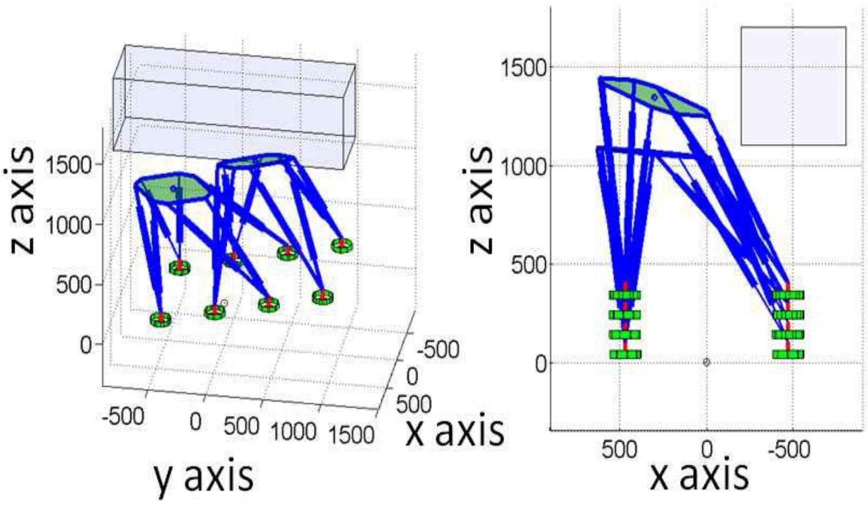


Fig.3 Different postures of a gait cycle of 8-UPS parallel robot

2.Kinematics analysis of 8-UPS parallel robot walking mode

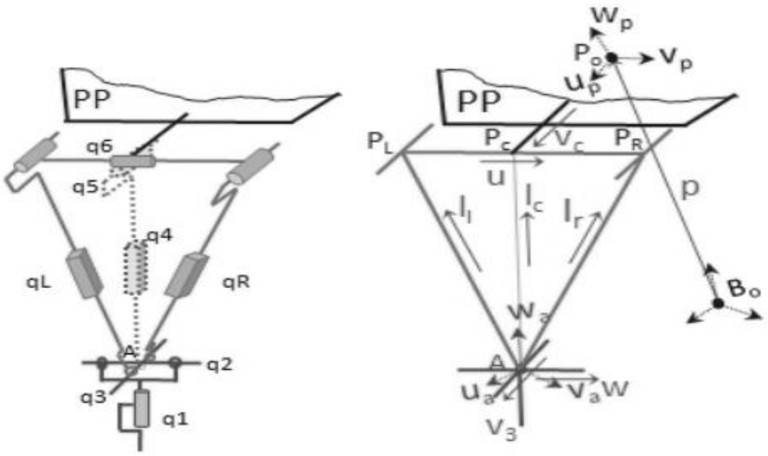


Fig.4 Side chain symbols and relevant parameters

In order to give the reconstruction stage leg swing up to prepare, in this process, all robots still locked in the leg support pin, before locking the corresponding joint loading platform should be adjusted to the specific position to make the joint angle should be locked to lock the expected.

3.Walking mode simulation

The 3D model is built in SolidWorks, using the Motion module, the establishment and driving constraint of each joint constraint, will foot trajectory curve and the interpolation points into the Motion database, the movement diagram and establish corresponding interpolation points and endpoints of foot.

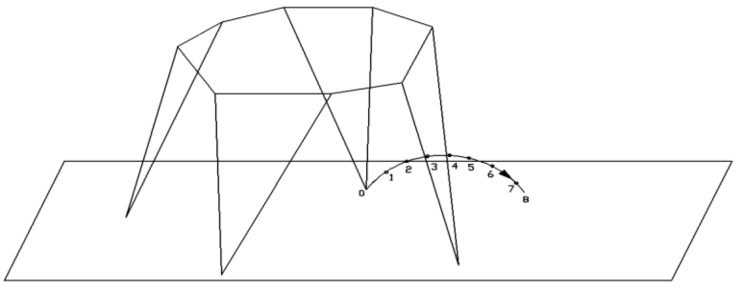


Fig.5 Motion interpolation state diagram

When the foot end from a pin point movement to the next pin point trajectory as shown in Figure 5, in Motion state in each interpolation directly read the swing leg two bar changes compared to the initial state of the angle, and then change the angle of interpolation curve fitting, can be obtained by rod angle curve. The change curve as shown in figure 6.

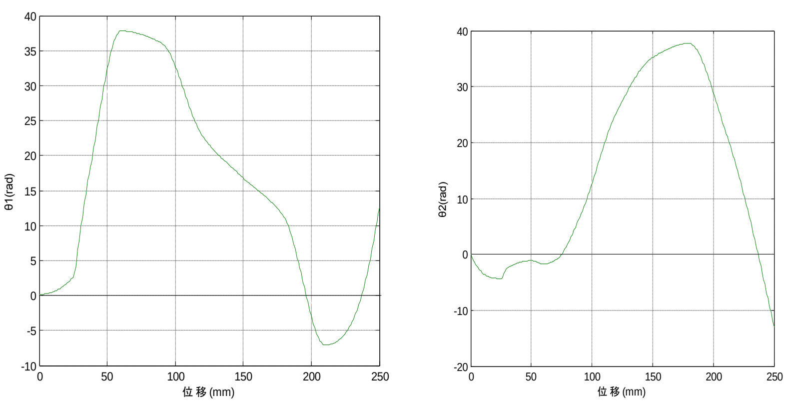


Fig.6 The angle curves of swinging leg

The robot walking stage in the leg, the foot end is in a locking state, from the foot end point interpolation inverse solution to parallel driving period, the inverse operation set on hinge for the uniform motion, which hinges on the driving function theory should be a linear function of absolute value. As for the simulation curve obtained by 6, it can get the approximate sine / cosine function. It is easy to see from the figure that the interpolation points of the driving function are located on both sides of the line of an absolute value function. At the same time, the simulation results show that the fitting curve of the foot end trajectory is consistent with the definition of the drive motor.

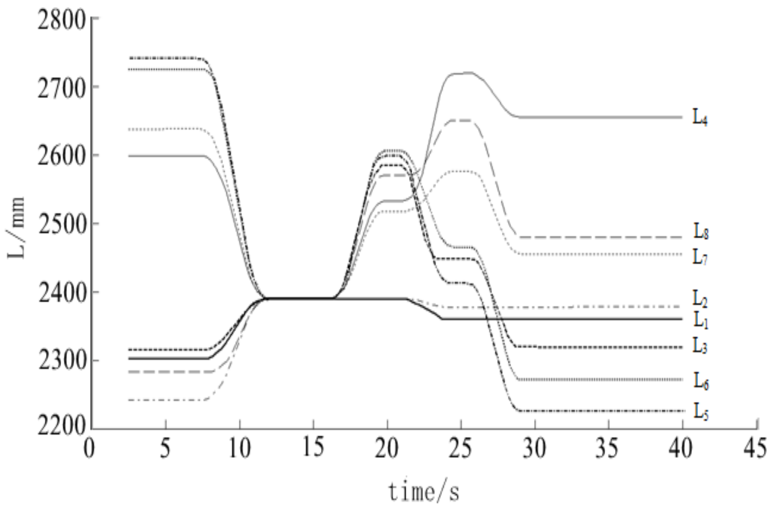


Fig.7 The rods variation in one gait cycle

Fig.8 Moving platform reference point in WP direction under 8-UPS parallel robot walking mode

II. SUMMARY

This chapter of the walking mode of 8-UPS robot configuration design and gait planning, efficient processing for multi station production line put forward the feasible scheme of mobile robot, and ensure the stability of walking in the stage; mode of walking robot kinematics is analyzed, including the key to the robot pose reconstruction stage of loading platform to solve the constraint condition of load on the platform pose, walking mode robot joint angle and load platform for the kinematics parameters; simulation of the robot walking mode, get two different support patterns and exercise space about walking leg member relative to the initial state of curve, and the whole gait the dynamic stability of the platform were studied. The obtained motion characteristic curve of different axis.

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