To Determine the Three Speed Truss Manipulator Solutions Starts

Jiushuai Ren [a], Jirong Wang [b], Shan Niu [c], Mingshun Su [d]

School of Qingdao University, Qingdao 266071, China

[a]1005226164@qq.com, [b]wangjirong43@163.com, [c]807685689@qq.com, [d]2464309093@qq.com

Abstract

In order to solve the problem of handling tire production enterprises of all steel radial tire, this paper describes the design of a three speed truss robot system. The three speed truss manipulator system design in this paper will be divided into four modules,namely a horizontal motion module, a vertical movement module, a manipulator module and a robot support.The mechanism can realize automatic grabbing, stacking and unloading of tyres. In this paper, three grasping schemes of manipulator are compared and analyzed, and the four link mechanism is chosen to design.The research has certain practical significance for improving the efficiency of tire handling and improving the modernization of tire production.

Keywords

Cartesian Robot with Triple-speed Truss,Manipulator, Connecting rod, tyre.

1. Introduction

In developed countries, industrial robots, automated production lines and their complete sets of equipment have long since become automated equipment mainstream.Oliver Sawodny applies robot technology to automatic crane[1].They designed a Longmen style robot with automatic storage and retrieval capabilities for wide range of operations[2].P.H. Chappell designed an adaptive three finger robot[3].Each finger of the robot has an independent drive source[4].They also use the Jacobian matrix to control the motion of the robot[5].A new type of three DOF parallel robot has been developed by Dan Zhang of Ontario Polytechnic University in Canada, and its design and static analysis are carried out[6].In our preliminary analysis,the three speed truss manipulator system design in this paper will be divided into four modules,namely a horizontal motion module, a vertical movement module, a manipulator module and a robot support[7]. This design uses the module design, finally carries on the modular combination, in order to facilitate in the design process the revision and the debugging[8]. According to the actual demand, the main design parameters of three speed truss manipulator system for project are as follow:

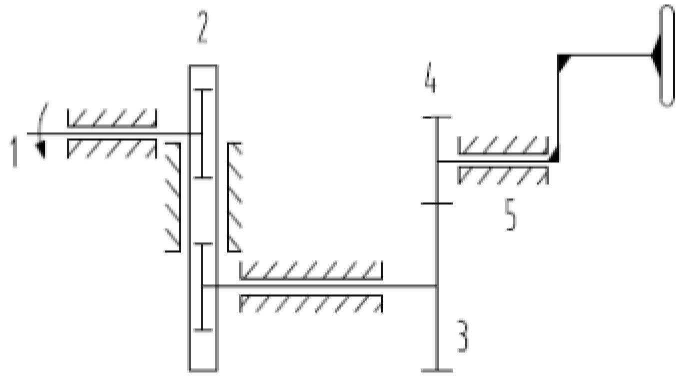
(1) The inner diameter range of all steel radial tire is 406.4mm ~ 609.6mm, and the outer diameter range is 745mm ~ 1120mm, the tire cross section height is 240mm ~ 430mm, the maximum tire weight is not more than 100 Kg.

(2) The running speed of three speed manipulators in the horizontal direction is 2.5m / s, the running speed of the vertical direction is 2m / s, the vertical direction range is 2.5m ~ 3m.

2. Design and selection of manipulator grab part scheme

As the main part of grasping tires, it is important to determine the manipulator grasping scheme[9]. Mechanical hand should be able to meet the design requirements of different diameter tires, and to facilitate the operation and installation, and reduce processing costs as the principle[10]. This design discussed three kinds of manipulator grasping plan, and carries on the crosswise comparison to it, finally determined this design plan which adopts[11]. As is known to all, the three jaw chuck in a machine tool has better automatic centering[12]. Therefore, the manipulator is designed according to the three jaw chuck, and three identical claws are distributed in the circumferential direction[13]. In order to simplify the analysis of the scheme, the same mechanical gripper is analyzed when the three schemes are discussed.

2.1 Manipulator grab program one

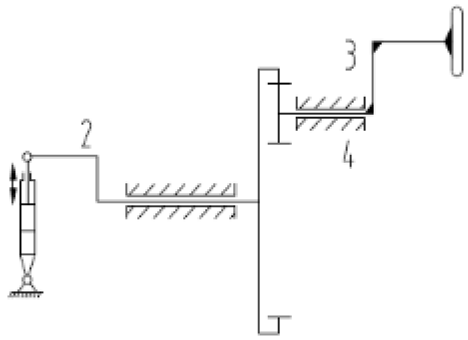


1- Drive, 2- rack, 3- external gear, 4- mechanical gripper, 5- base

Fig. 1 Schematic diagram of mechanism motion

The scheme adopts the combination of external meshing gear drive and gear rack drive(as shown in Figure 1).The power source is an electric motor, and the motor drives the component 1 when the work is performed. Through two pairs of gear rack mechanism, the movement is transmitted to component 3, and finally the component is transmitted to the circumferential direction by the cylindrical gear mechanism to distribute the movement to the component 4. A tray is mounted at the end of the component 4 so as to lift the tire from the interior of the tire. When the motor rotates at a certain angle, the component 4 also rotates a certain angle correspondingly, so that the manipulator can grasp different parts through the adjustment of the rotation angle of the motorb diameter tire.

2.2 Manipulator grab scheme two

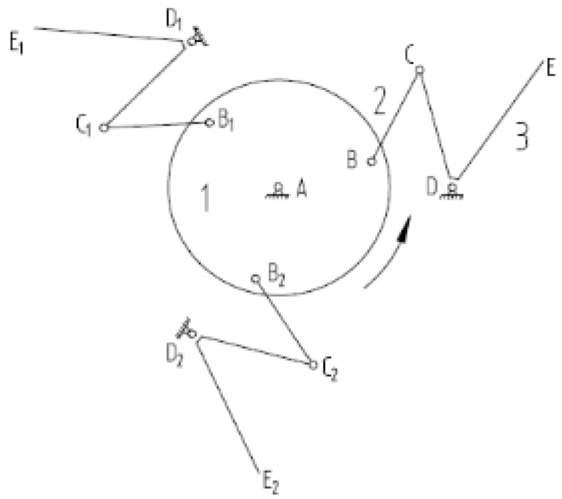


1- Drive, 2- internal gear, 3- mechanical gripper, 4- base

Fig.2 Program two institutional movement Brief

In the scheme, the pneumatic or hydraulic power is used as the power source 1, and the cylinder push rod or the hydraulic cylinder push rod is hinged with the component 2(The right gear of the component 2 can also be an external meshing gear) through the connecting rod. By adjusting the stroke of the push rod, the component 2 rotates different angles, and finally, the component 3 rotates correspondingly to a certain angle so as to realize the grasping of the tyres with different inner diameter sizes. Although this scheme does not have complex mounting problems such as gears and racks, In actual work, the equipment has a longer horizontal running range, and pneumatic or hydraulic drive is required to design a longer trachea or tubing. In addition, when hydraulic drive is adopted, there will be leakage of hydraulic oil, and for rubber tires and other flammable products, the leakage of hydraulic oil will cause significant security risks.

2.3 Manipulator grab scheme two



1- Rotates the disc 2 and 3- connecting rod

Fig.3 Program three institutional movement Brief

The scheme adopts four connecting rod mechanism, and the power source is motor.In actual use, the three gripper rod AB system is simplified as a disc, the motor through the gear reducer is connected with the disc coupling, and then drives the connecting rod 2 and a connecting rod 3 by adjusting the motor rotation, the rotation angle of the connecting rod to rotate the corresponding angle to grasp the tire.

2.4 Comparison of three schemes

In the processing and installation of the connecting rod, it is ensured that only two adjacent connecting rods have relative movement, and the device can not run stably because of the redundancy of the degree of freedom[14].At the same time, by installing deep groove ball bearings and thrust bearings in the hinge hole of the connecting rod, the friction between adjacent connecting rods can be reduced, and the device can not generate clearance when running for a long time[15].To sum up, the first three schemes adopt the gear drive mode, and the gear drive has accurate transmission,smooth and high transmission efficiency.But because of the error of processing and installation, the backlash exists in the actual gear drive, and there will be impact when it is running in reverse direction, which will affect the accuracy of the equipment.Compared with the gear drive and gear rack drive, the four link mechanism is easy to process and install, and the quality is lighter.Therefore, finally, the manipulator grasping part is designed by connecting rod.The design of the connecting rod takes into account the need to distribute three sets of connecting rods in the circumferential direction, so as to avoid the middle of the running process. The utility model is provided with a pair of rocker mechanisms, each of which is connected with each other and is convenient for motor control. According to the design parameters, the radial diameter of all steel radial tire is 406.4mm to 609.6mm.The maximum diameter of the tyre to be grasped by the manipulator is 609.6mm, and the connecting rod DE is required to be added at the hinge point D so that the E joint can reach the maximum tire inner diameter.Finally, the connecting rod CD and the connecting rod DE are made into a whole to meet the service requirement.

When the tire is grabbed, the E point is connected to the vertical rod and the tray, and the inner ring of the tyre is lifted by the tray.Because the connecting rod DE, D1E1 and D2E2 are all designed as the form of cantilever beam, the length of DE rod should not be too long so as not to cause greater deformation. At the same time, the design of the three groups of double rocker structure installed in the box structure, in order to reduce the weight of the box, the length of the connecting rod AD needs to be reduced as much as possible.The length of the primary link AD is 180mm.According to the design of the largest double rocker mechanism with typical frame size and motion line D, the sizes of the four connecting rods are a=0.7, B=0.9, C=1.0, D=1.4.Among them, a is the active component.According to the relationship between the dimensions of the connecting rod, AB, BC and CD three connecting rod sizes can be obtained: AB, =90mm, BC, =115.7mm, CD, =128mm.According to the above dimensions, a three-dimensional model of three groups of double rocker mechanisms is established. Interference detection shows that the interference exists and does not meet the actual needs. Then, according to the actual structure, the size of the connecting rod is adjusted to avoid interference. Finally, the length of the AB rod is 100mm, the length of the BC rod is 110mm, and the length of the CD rod is 130mm.Finally, the maximum tire diameter and minimum tire diameter are calculated according to the design requirements, and the length of the DE rod is determined to be 165mm.

3. Conclusion

This paper dissertates the design of three speed truss manipulator manipulator scheme.By discussing each scheme in detail and comparing the advantages and disadvantages between them, the manipulator grasping scheme is designed. The connecting rod form is designed, and the dimensions of connecting rod are designed and calculated.

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