The invention relates to a small logistics handling trolley based on omni-directional wheel movement

Xinyu Yang1,a*
1School of Transportation and Logistics Engineering, Wuhan University of Technology, Wuhan, China
a*301371@whut.edu.cn

Abstract. Through the research and analysis of the existing gantry crane and cantilever crane to unload and transport goods, at the same time the application of the characteristics of triangular stability, a combination of the advantages of the three: A triangular omnidirectional cantilever crane is designed and developed by using electric push rod instead of rope lifting and the most basic triangular body.

1. Introduction
The traditional gantry crane has the problems of too large body size, easily unstable force and inflexible operation, while the triangle base has more stable performance, easy to control the direction, stable and flexible route. This project adopts triangle base and simple and practical claws, so that the practicability of the machine can be realized.

2. Machine structure
The whole machine is divided into five modules, respectively is marching module, fixture module, cantilever rotating module, lift module and jig moving module, each module cooperate with each other to complete the handling and loading and unloading tasks. In the moving module, the main application of three omnidirectional wheels, for the three omnidirectional wheels are equipped with an independent reduction motor control, so that the crane can be omnidirectional movement, and ensure the stability of movement. In order to make the movement of the clamping mechanism more accurate, the mechanism adopts the electric push rod to accurately control the upper and lower movement of the cantilever, and uses the stepping motor and the electric push rod to control the transverse movement of the fixture and its clamping mechanism.

Figure 1. Schematic diagram of machine mechanism
2.1 Marching module: Three-wheel omnidirectional wheel structure
The mechanism adopts omni-directional wheel, triangular layout, forming omni-directional wheel mobile platform. Omni-directional wheel mobile platform has the ability to move freely in all angles, and has a high degree of flexibility. The classic omni-directional wheel mobile platform is that the axis of the three wheels is 120 angles, the center of the omnidirectional wheel is distributed on the same circle, and the wheel axis points to the center of the platform. The simplified kinematic mathematical model is shown in the figure:

![Figure 2. Model of omni-directional wheel](image)

2.2 Fixture module
The fixture mobile connection platform adopts 3D printing technology, light curing molding, under the premise of ensuring the strength, as much as possible to reduce the weight. The fixture moving platform is connected with moving trolley by bolt to ensure the connection is reliable. 3D-printed ribs can effectively prevent the fixture from being turned out. The rubber pad at the bottom of the fixture can effectively prevent the deformation of the cargo while increasing the friction.

![Figure 3. Model fixture mechanism](image)

One end of the fixture is fixed and the other end is moving. The moving end is connected with the clamping piece and the slide block. The slide block is coordinated with the slide rail fixed on the fixture platform, so that it can be moved. The electric push rod is connected with the clip through the L-shaped
connector, considering the load distribution of the clip, the push rod is placed in the middle of the clip, so that the load is more reasonable, the fixture is not turning out. To sum up, the moving end of the fixture can be easily clamped and opened under the action of the electric push rod. And the electric push rod has the characteristics of large force, fast speed, easy to control and so on. The fixture can better realize the function of fast clamping goods and placing.

![Figure 4. Model fixture mechanism 2](image)

2.3 Cantilever rotating module
This module is mainly composed of 57 stepper motors and ball bearings. The 57 stepper motor provides the power to drive the outer ring of the ball bearing, which can rotate at a certain Angle. The use of the ball bearing reduces friction, reduces the rotation error, and makes the loading and unloading more accurate.

![Figure 5. Model of cantilever rotating mechanism](image)

2.4 Lift module
This module is mainly composed of electric push rod, auxiliary rod and tray. The electric push rod provides power to push the tray to move along the auxiliary rod. The three electric push rods distributed in a triangle can provide stable and uniform thrust to the tray, so that it can move up and down smoothly and avoid tilting due to uneven force. The auxiliary rod makes the tray have a fixed movement track, so that it can avoid the tray shaking.
2.5 Jig moving module

The synchronous belt drive is adopted, and the synchronous belt is pressed by pressing plate and then connected with bolts on the trolley. Synchronous belt transmission without sliding, accurate transmission ratio, so can improve the transmission accuracy to reduce error. The driving shaft and the stepper motor are combined, the bearing block is fixed on the aluminum profile, the rolling bearing is fixed on the bearing block, the synchronous belt pulley is fixed on the optical shaft, and then the optical shaft is connected with the bearing block. 42 stepper motor drives the synchronous belt wheel on the shaft to drive the XL type synchronous belt, and then drive the car forward and backward. The stepper motor can accurately control the rotation Angle of the transmission shaft, accurately control the movement of the module, simple and accurate control, positioning without error.

The mobile trolley wheel is located in the aluminum profile track, sliding smoothly, not easy to derailment. The car is printed with 3D printing technology, and the wheel shaft of the car is replaced with an optical shaft, which can reduce the weight as much as possible under the premise of meeting the strength, and reduce the disadvantages of the cantilever.
3. **feasibility analysis**

The key to the normal operation of the mechanism is to ensure that its structure is basically unchanged when the mechanism is stressed. By calculating the end point deformation of the cantilever beam, whether the designed cantilever beam can support the weight of the goods without large deformation is judged, which leads to clamping instability, clamping shaking and working instability.

### 3.1 Force deformation analysis of mechanism

![Figure 9. Schematic diagram of the organization](image)

Due to the small deformation, the fixture can work normally, and the clamping is stable. There will be no phenomenon that the fixture cannot work normally due to the excessive bending amplitude of the cantilever beam.
3.2 mechanical simulation

Figure 10. Mechanism force cloud diagram

Through the mechanical simulation analysis, it is found that the force deformation is basically consistent with the above calculation results, and the deformation is small, which can basically ensure the stable driving of the mechanism.

4. Conclusion
Triangular omnidirectional cantilever crane has the characteristics of small volume and high flexibility; the lower chassis, so that it keeps a low center of gravity and stable trajectory when carrying goods. The machine can be applied to suitable logistics system and may give new inspiration to logistics warehouse and port logistics transportation.

References
[1]. Haoyu Zhao, Wenchao Li, Shuanghong Li. Design and experimental study of pneumatic clamping and ejection mechanism based on engineering truck manipulator[J]. Machine Design, 2020, 37(S2):27-30.
[2]. Yong Liu, Yanhui Lv, Yunshang Bai. Chassis Control and Analysis of three-wheel omnidirectional wheel Robot[J]. China New Communications, 2019, 21(16):143.
[3]. Xian Zhang. Problems existing in Working Principle and Optimized Structure Design of Double Jig for Roasting Multi-function Crane [J]. Science and Technology Information, 2012(14):115-116.