International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 13 Issue 4 ǁ April 2025 ǁ PP. 255-256

Express delivery handling robot based on four-wheel drive

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***Abstract*：**
The research direction of this paper is an express delivery handling robot based on four-wheel drive. With online shopping becoming a shopping method for an increasing number of people, the quantity of express deliveries has been growing steadily. In order to deliver express items to customers as soon as possible and improve the quality and efficiency of logistics, an express delivery handling robot has been designed. Its main functions include grasping express parcels, stacking express parcels, storing express parcels, and pushing or pulling express delivery carts. To grasp more express parcels and enhance transportation efficiency, the robot needs to grasp as many express boxes as possible, stack them successfully, and quickly transport the entire batch of stacked express parcels.
Keywords: *Handling robot; Four-wheel drive; Multi-sensor fusion; Express parcel stacking*
This paper designs an intelligent four-wheeled robot with human-machine interaction function. The robot has an aesthetically pleasing and lightweight appearance, and excellent performance (as shown in Figure 1), realizing the functions of express delivery handling and stacking.

Date of Submission: 14-04-2025 Date of acceptance: 27-04-2025

I.Mechanical mechanism design and analysis

The method of using suction cups for adsorption is adopted to grasp the express boxes, which improves the compatibility of express box grasping. The mechanism is compact and lightweight, which can enhance the sensitivity of the grasping mechanism and thus improve the overall efficiency of the robot. The express box grasping mechanism can move horizontally to the left and right as a whole, enabling the robot to quickly stack the next express box without moving its chassis. It can also perform rapid and continuous grasping when grabbing express boxes, achieving fast grasping. The grasping mechanism has a 360° degree of freedom on the PITCH axis, which makes the way the robot picks up the express boxes more diverse.（as shown in Figure 2)

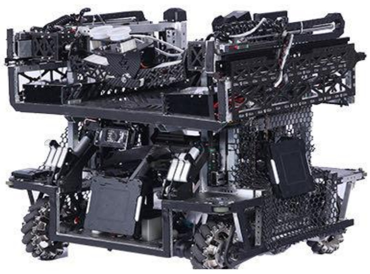

Figure 1

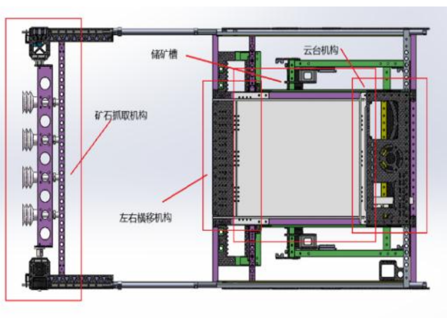

Figure 2

The chassis of the robot is required to be able to smoothly complete basic movements such as moving horizontally forward, backward, left and right, as well as rotating, while stably supporting the robot's own weight. Meanwhile, within the dimension requirements of the engineering robot, the wheelbase of the chassis should be increased as much as possible. A four-wheel drive independent suspension system is adopted, and by reducing the height of the chassis, the overall center of gravity of the engineering robot is lowered, so as to enhance its mobility and the stability of the chassis (Figure 3).

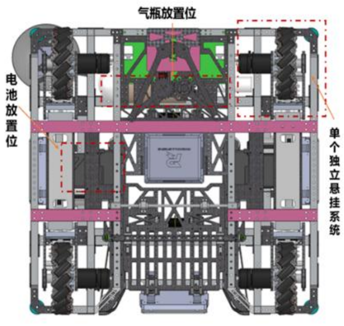

Figure 3

II.Design of the Control System

The robot uses the RoboMaster Type C development board as the main control board, and develops the Type C board using the STM32F4 standard firmware library. The bottommost layer of the entire set of code is the driver layer, which mainly consists of two parts: The first part is the initialization of the peripherals of the Type C board. A series of parameters such as the clock of the peripherals of the Type C board (for example, the SPI required by the BMI088 gyroscope and the GPIO corresponding to the buzzer) are all configured properly. Then, in the subsequent development process, the relevant peripherals can be directly used without any further modification to the underlying layer. The second part is the initialization of important parameters in the application layer. Since certain parameters of the tasks in the application layer (such as KP, KI, and KD of the PID) need to be assigned values in advance, and the flag bits and communication variables need to be set to zero, we place these variables in the driver layer for initialization. At the same time, the acquisition of the pointers of the structure is also implemented in the driver layer.

The robot chassis adopts single-loop speed loop PID control, while the pan-tilt and other mechanisms all use dual-loop PID control, which are respectively the outer-loop angle loop PID control and the inner-loop angular velocity loop PID control, and the single loop mainly adopts PD control. The proportional control function in the digital PD regulator can reduce the error, the integral function can eliminate the deviation and make the steady-state error zero, and the differential control function can reduce the overshoot of the output response. Moreover, since the actual differential PD formula contains a first-order inertial link and has the ability of digital filtering, the anti-interference ability is also relatively strong. The feedback values of the PID are all obtained through the electronic speed controller or its own encoder, and the expected values are assigned through the remote controller or the keyboard and mouse. By inputting the expected value, the feedback value and the PID structure body corresponding to each motor into the PID_Calc() function, the output value will be returned. Sending the output to the motor through the CAN message can complete the control.