Two-arm Handing Robot Based on the Path Recognition

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Abstract. This paper describes a two-arm handing robot, whose two sets of big arms and small arms rotate in the horizontal plane, and same with the two hooks. It uses motor to drive gear transmission and power screw, which make the hooks up and down move. The robot is also equipped with path recognition camera and materials address recognition camera, and it can walk and make turns and avoid obstacles automatically alongside the magnetic track, and identify the location information of material, and load and unload material. And it implements the automation on handling materials in kitchen and supermarket.

Introduction

At present, large enterprises, institution, schools and hospitals all have canteens to solve the staff dining problems. Large hotels, cafeterias and guest houses all have their own canteens to receive guests for dinner every day. Some literates put forward a kitchen robot based on the task which can complete many actions such as making pancakes and Hand-Pulled Noodle and also cooking\cite{1-2}. Some patent techniques introduce a restaurant-service robot, which can provide basic services, ordering, independent take and delivery, etc., for customers \cite{3-4}. These kitchen robots and restaurant-service robots are all not related to handling material in the kitchen. However, canteen and restaurant kitchen have to process a lot of vegetables, flour and other materials every day. These vegetables and pasta need multi-channel processing, such as vegetables need cleaning, slicing and shredding, stuffing and molding process, flour needs mixing, pressing, forming and cutting process. Kitchen staff needs to repeatedly transport vegetables, flour, tableware, etc. Apart from this, it is a large quantity in logistics scale and also a large amount of goods that needs to be transported in all kinds of supermarkets. At present, the kitchen and the supermarket still need manual handling of goods. Workers put the material on the trolley, pull or drive the trolley to the destination and then manually unload the material. So the workers are in heavy labor intensity but low efficiency.

This paper introduces a two-arm handling robot based on path recognition. It is able to complete the handling, loading and unloading of material in the kitchen and supermarket. The robot has two mechanical arms and a walking device, capable of automatic loading and unloading material. According to the information on the magnetic track and bar code, it would automatically walk, make turns, obstacle avoidance, stop, and so on. It also can deliver material to a predetermined position, which saves manpower and material resources, and improves production efficiency and accelerates the velocity of the material.
The Working Principle of Robot

Fig. 1 is the two-arm handling robot’s structure diagram, figure 1 (a) is the robot's main view, figure 1 (b) is the robot's A-A section view. Because of the mobile robot, two groups of left and right symmetrical handling manipulator can keep the balance of the robot, lifting material causes no robot flip, two mechanical arm lifting stationary, easy to grab and unloading under. The four corners of the universal wheel can support the frame.

![Structure Diagram of Two Arm Handling Robot](image)

1-Universal wheel; 2-The path identification camera; 3-The material address recognition camera; 4-Frame; 5-Column; 6-Big arm; 7-The big arm motor; 8-Small arms; 9-The motor controlling the up and down movement; 10-Threaded rod; 11-Hook rotating motor; 12-Hook transmission case; 13-Hook; 14-Material cases; 15-Steering motor; 16-Forward motor; 17-Charging connector; 18-Forward wheel; 19-Carriage of wheel drive system; 20-Steering wheel; 21-The small arm motor; 22-Steering motor fix-disk; 23-Steering speed reducer; 24-Gear output tray; 25-Steering shaft; 26-Steering bearing

Figure 1. Structure diagram of two arm handling robot.

When receiving the material handling instructions, forward motor 16 drives robot’s two forward wheels’ 18 rotation through a chain drive. The robot walking straight along the track, when you need to turn, the forward motor 16 stops turning, turning motor 15 drives the gear output 24 disc rotation through the steering gear reducer's 23 deceleration, steering shaft 25 rotates at the same time to achieve the steering. Path recognition camera 2 can identify the road there is obstacle or not, when confronted with obstacles, control system automatic design path to obstacle avoidance.

After reaching the destination, the forward motor 16 and steering motor 15 stop rotating and braking. Two forward wheels 18 and two steering wheels 20 stop moving. Large arm motor of two groups of left and right arm7, and arm motor 21 separately drive big arms6 and small arms8 rotating in the horizontal plane. Hook rotating motor 11 drives hook 13 rotating in the horizontal plane through hook transmission case 12. Up and down motor 9 drives screw 10 mobile up and down by a transmission gear, threaded rod 10.the hook 13 in any position of height. Two hook 13 put the handling material into the robot’s material box 14. At the same time the robot grasp the material, the material address recognition camera 3 identifies the bar code on the material. So the robot "know" the stacking position of the material, and then start the motor forward 16, steering motor 15 along the track in order to optimize the path taken to bar code on the set position and two sets of mechanical arm remove the material.
The Steering Movement of Robot

In Fig.1, steering of the motor fixing plate 22 is fixed on the rear part of the wheel drive system frame 19, steering motor 15 is mounted on the steering motor fixing plate 22, the output shaft of the steering motor 15 and the input end of the steering gear reducer 23 is connected, the shell of the steering reducer 23 is fixed on the steering motor fixing plate 22, the output end of the steering reducer 23 is connected with the top of the reducer output plate 24, its’ bottom part is processed with the horizontal hole which is through it, the steering shaft 25 pass through the hole, its' two ends is connected to the steering shaft 'connecting disc of through the bearings of the steering shaft, the steering shaft 25 are arranged of the steering wheel 20 at both ends. So the axial shaft and the steering wheel can rotate with the output disk of the speed reducer. After the deceleration the of the motor, the output disk of the speed reducer, the steering shaft and the steering wheel are driven to rotate together, and the steering movement of the robot is realized.

The Up and Down Movement and Rotation Hook

In Fig.2, small arm is provided with a motor, the output of the shaft is provided with a drive gear 4, it is meshed with the driven gear 9, the center of the driven gear is machined with threaded holes, which is formed screw driving in the hole with the external screw of the threaded rod 7. The upper and the lower ends of the driven gear 9 are respectively provided with an upper bearing 8 and a lower bearing 11, which makes the driven gear 9 axially fixed and the circumferential direction is rotated. The left and the right sides of the screw rod 7 are processed with a longitudinal moving groove. A guided rail is processed on the left and right sides of the upper cover 6 of the small arm, which is formed a sliding pair with the two guide grooves on the screw rod 7. The linear movement of the screw rod 7 is driven by the rotation of the driven gear 9, so as to realize the up and down of the reciprocation on hock 15.

Figure 2. Structure diagram of hook’s moving and rotating.

Hook transmission box 13 is fixed below screw 7. Hook rotating motor 19 is connected on the left of hook transmission box 13. Hook rotation motor 19 of the output shaft with driving bevel gear 18. Driving bevel gear 18 with a driven bevel gear 17 is meshed with the driving. Driven bevel gear 17 is fixed in the hook output shaft 14, which is connected with output
shaft connecting sleeve 16 by left thread and the output shaft connecting sleeve 16 is connected with the left thread of the hook 15. The three threaded connections turn more tightly when use the left thread to make hook 15 turn. The purpose of adding output shaft connecting sleeve is to make it convenient to change hook. The motor of rotating hook rotates to material position capturing through the bevel gears driving the hook.

The Movement Control of Two Sets of Mechanical Arms

The two sets of mechanical arms are respectively arranged in the central column on both ends of the front and back of the machine frame. The two group of the big arm, small arm and a hook in the horizontal plane of rotation and the size and structure of the two groups of mechanical arms is the same, and symmetrically arranged, the material handling is located in the middle of the robot. We can know that the big arms and small arms on the left turn counter clockwise, while the big arms and small arms on the right side turn clockwise from Fig.3’s two sets of big arms and small arms movement direction. The large and small arms of the left side of the rotation angle and the right side of the big arm and small arms were equal, but the direction of rotation is opposite; The left and right hook are in the same rotation angle but opposite direction(Facing the material, hook lifting). The control system of the two groups of mechanical arms is relatively simple, when determining the location of the material, you can calculate a set of big arm, small arm and the hook rotation angle and steering, another group of big arm, small arm and the hook rotation angle and steering is determined. If you use plastic boxes and other containers for materials in the kitchen, the hooks rotate to the under of plastic boxes to lifting. For the height of the material, the control system makes the two sets of screw move up and down synchronously, keeps the two hooks at the same height all the time.

Figure 3. The movement diagrammatic drawing of two sets of mechanical arms.

Figure 4. The end point of mechanical arm.
As seen in Fig. 4, symmetrical arrangement of two sets of mechanical arms. The length of the arm of the two sets \((L_1)\) is equal, and the length of the small arms of the two sets \((L_2)\) is equal. The included angles between the two big arms and the X axis are equal, that is \(\alpha = \alpha_1\), the included angles between the two big arms and the X axis are also equal, that is \(\beta = \beta_1\). The length of the two hook \((N)\) is also equal. You can use the following formulas to calculate the coordinates of the point A at the end of mechanical arm:

\[
x = L_1 \cos \alpha + L_2 \cos \beta = \frac{(L - 2N - M)}{2}.
\]

\[
y = L_1 \sin \alpha + L_2 \sin \beta.
\]

The stop position of the robot is determined by the position of the track and bar code, that means the end point of the mechanical arm A\((x, y)\) can be determined. When values of the X and Y are known, we can find the corners of the big arm \((\alpha)\) and small arm \((\beta)\) by formula (1) and (2). Then the control program can be easily written.

**Path Identification System and Bar Code Identification System**

In Fig. 1, the front end of the robot equipped with camera 2 to identify the path. The camera is used to shoot the case of the front end of the road when it forward or turn. The robot can walk along the magnetic track of ground laid when there isn’t obstacle on the road the robot walking. The path identification camera shows the obstacles when obstacles appear on the road of robot walking. Then the robot’s control system emits instructs to control of the steering motor to leave the magnetic track for avoiding obstacles and back to the magnetic path to move forward with the minimum path.

The frame 4 is provided with a material address recognition camera 3. Because each piece of material labeled material barcarole information, material address recognition camera can shoot to the material information of the bar code when the robot’s two sets of arms handling materials. The robot control system can automatically identify bar code of material’s information including the material name, store address, walking paths and docked position information [5]. Two mechanical arms carry material to material box of the robot. Then the robot’s walking system and steering system work to transport materials to the docking location. Finally, the robot carries materials to a storage position.

In addition, all the motors on the robot are powered by a battery, and the battery is connected to the charging connector 17 on the frame 4. When the storage battery needed to charge, you can connect the power supply and the charging connector to charge the battery.

**Summary**

The two-arm handing robot can automatically walk and turn, automatically identify the location of materials information and avoid obstacles, and automatically load and unload materials. It needn’t people to carry materials and manipulate equipment. It has higher degree of automation and production efficiency. It can save labor and production costs and to make operation control become simple and reliable.
References


