Research on Intelligent Shopping Robot Based on PLC

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Abstract. For the large variety of shopping malls, supermarkets, cafeterias and other places, customers need to spend a lot of time looking for goods. Due to this, a smart shopping guide is designed based on PLC. The robot mainly uses the CPU 224 controller to control the motor to drive at a speed of 1 m/s, and the DC brushless motor can load 75 kg of goods at a constant speed. If the distance between the pedestrian and the robot exceeds the allowable range, the CPU will execute the interrupt program and the robot will stop moving to avoid the pedestrian until the pedestrian completely walks out of the maximum allowable range. The sensor could not detect the pedestrian, and the CPU controlled robot continued to work. After testing, this robot can reduce the time spent by customers in finding goods, which greatly saves manpower and material resources.

1. Introduction
With the combination of robot technology and information technology, the intelligent service robot will become the mainstream in the future. Based on this social background, the intelligent shopping guide robot proposed in this paper meets the needs of the times. The robot is composed of a touch screen, a car and a shopping basket. With one click on the touch screen, the robot takes the customer to the desired item and loads the item to the checkout. If a pedestrian is found in front of you in the process of driving, you will stop to avoid it and turn on the light.

2. Model analysis of shopping guide robot

2.1. Motor drive structure
The load part of the shopping guide robot adopts the trolley structure and uses four-wheel drive to control with four drives respectively, which increases the load capacity of the robot. Four-wheel drive increases the flexibility and stability of the robot. During the travel process, the four-wheel structure ensures that the robot can maintain stability even during acceleration or deceleration. When turning, one side of the wheel reverses and the other side of the wheel rotates forward, allowing 360° rotation in place, ensuring the flexibility of the robot[1].

2.2. The software design
The shopping guide robot adopts Siemens S7-200 224CN as the core controller, and the price is relatively economical. It has 14 digital input interfaces and 10 digital output interfaces. A communication interface that ACTS as a PPI interface for programming functions, HMI functions (TD 200, OP).S7-200 internal CPU/CPU communication (9.6/19.2/187.5kbps), or as MPI slave station, for
data exchange with MPI master station (s7-300 / -400, OP, TD, button board). The user can program the interface, which has its own interrupt capability and is used for serial data exchange with non-siemens equipment. No extension module is required. Its I/O table is shown in Table 1.

Table 1. CPU224 controller I / O table.

| Input | Explain | Output | Explain       |
|-------|---------|--------|---------------|
| I0.0  | Start   | Q0.0   | Left wheel forward |
| I0.1  | Stop    | Q0.1   | Left wheel reverse |
| I0.2  | Scram   | Q0.2   | Right side wheel forward |
| I0.3  |         | Q0.3   | Right side wheel reversal |
| I0.4  |         | Q0.4   |               |
| I0.5  |         | Q0.5   |               |
| I0.6  |         | Q0.6   |               |
| I0.7  |         |        |               |
| I1.0  |         |        |               |

2.3. Host computer screen
The upper computer adopts Siemens 175B PN/DP touch screen, which uses the upper computer to imitate the customer service end. The user can self-service through the touch screen, which truly realizes the selection and guiding function, which is convenient for customers to make choices[2]. Some pictures are shown in Figure 1 and Figure 2.

![Figure 1. Host computer program diagram.](image-url)
3. How the shopping guide robot works

3.1. The function and core value of shopping guide robot
This product is applied to unmanned supermarkets and large and medium-sized traditional supermarkets. It adopts Siemens PLC S7-200 series CPU, CPU drive motor drives intelligent shopping guide robot, and the infrared photoelectric sensor of vehicle body collects distance information. When the pedestrian is too close, the emergency interruption system will be implemented immediately to stop the vehicle and ensure the safety of pedestrians. We will program the system according to the actual layout of the supermarket, so that the robot can make the best planning and guiding route, and enable consumers to have the fastest and most efficient shopping experience. The appearance of the shopping guide robot is a mobile shopping basket that can work 24 hours a day. Not only can it enhance the shopping experience of consumers, but also reduce the cost of employing people in supermarkets, which is in the interest of all parties[3].

3.2. Technical characteristics of shopping guide robot
The core of the shopping guide robot is the load car, and the load car adopts the four-wheel drive to ensure the load capacity of the robot. The robot has high flexibility, each motor can be controlled separately, and the distance calculation is performed according to the step angle and the subdivision degree to realize 360-degree flexible turning, and the estimated arrival position and actual error are small. On the support bracket is a touch screen and a load basket, through the selection input of the touch screen, after the processing of the Siemens PLC, the PLC controls the motor movement to realize the operation of the robot. The PLC control used by the shopping guide robot has a good self-diagnosis function. Once the power or hardware is abnormal, the CPU immediately adopts effective measures. It has simple programming and easy programming, and can be developed twice[4]. The control ability is strong, and it is extremely difficult to cause procedural disorder. The robot is simple to assemble, cost-effective and saves manpower and material resources. The overall structure is shown in Figure 3.
3.3. Shopping guide robot operating principle
The intelligent shopping guide robot will be placed at the entrance of the supermarket or shopping mall. When customers enter the supermarket or shopping mall, they can choose our robot for service. The intelligent robot has a touch screen on the top end, which is convenient for customers to operate. Take drinks as an example. When a customer wants to buy a bottle of mineral water in the drinks area for the first time, he needs to click on the touch screen to start shopping. After clicking, we will see some large preset areas, such as drink area, snack area, fruit area and so on. At this time, the customer needs to click the area he wants to go to again. We continue to take mineral water as an example. When the customer clicks the drink area and then click ok, the list of the next level of refinement will appear. At this time, the customer only needs to select the mineral water in the list. If the customer does not have a good idea of what to buy at this time, the customer can click "ok" to start the shopping guide. At this time, the robot will take the customer to a specific position at the entrance of the drink area and let the customer free shopping. The simplified process is shown in Figure 4.

When the customer finishes shopping, repeat the above steps to continue to let the robot guide shopping. When all shopping is finished, click "end shopping" and the shopping guide robot will guide the customer to the cashier desk for the customer to settle accounts.
3.4. How the shopping guide robot works
When the customer inputs the desired destination from the touch screen of the shopping guide robot, the touch screen is the input end, and the customer's operation will be transmitted to the CPU of PLC200 series as the input signal, and the output will be controlled by executing the internal program. At this point, the motor drive of the shopping guide robot serves as the output, and the CPU controls the motor rotation to realize the movement of the shopping guide robot, and controls the walking route of the shopping guide robot through internal programming[5]. If other customers appear near the shopping guide robot, the photoelectric sensor will be used as the input end to detect the distance. If the distance between the pedestrian and the robot exceeds the detection range, the CPU will execute the interrupt program to make the shopping guide robot stop moving and avoid the pedestrian until the pedestrian completely walks out of the maximum detection range. When the photoelectric switch could not detect the pedestrian, the CPU controlled robot continued to work. The product outline is shown in Figure 5.

![Physical picture of shopping robot.](image)

3.5. Shopping guide robot function test
During the product demonstration, we will randomly select the area we want to go through the touch screen at the starting point. The shopping guide robot will take us to the pointing area. After that, we will randomly select the next desired area, and the shopping guide will guide again. Let's go to another area. When someone else appears next to the shopping guide robot, the robot detects the signal and will immediately stop running. When the other person leaves the shopping guide robot, the robot continues to run. Finally, when we choose to end the shopping, the robot will take us back to the starting point, which is the end of the shopping.

4. Conclusion
Because the shopping guide robot has the characteristics of convenience, quick operation, low cost, safety and reliability, it is popular among merchants and customers. Similar products have appeared at home and abroad, but they cannot be universally applied due to cost and after-sales reasons. This car is to make up for this shortcoming. Once it is put into the market, it will produce good economic and social benefits, and it will cater to the future era of artificial intelligence.
Appendices
1. [2018017] Major science and technology projects in Jilin Institute of Chemical Technology
2. [2016033] Major science and technology projects in Jilin Institute of Chemical Technology
3. [2018064] Science and technology research project of Jilin Institute of Chemical Technology

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