Journal of Robotics, Networking and Artificial Life Vol. 10(4); March (2024), pp. 353–356
ISSN (Online): 2352-6386; ISSN (Print): 2405-9021
https://alife-robotics.org/jrnal.html

Research Article

Design of Intelligent Handling Robot Based on AT89C52

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ARTICLE INFO

Article History

Received 11 November 2023
Accepted 01 July 2024

Keywords

Logistics handling
Robot
MCU
Modularization
Obstacle avoidance

ABSTRACT

At present, manual logistics handling is inefficient and limited, Manual handling Most of the command and dispatch with experience, it is difficult to carry tasks in real time, confirm the location of the handling, cargo inventory and other work tasks time-consuming and laborious, manual operation is prone to error, workers labor intensity, resulting in greatly reduced work efficiency. This paper presents a logistics handling robot based on AT89C52 single chip microcomputer. The integration of the power module, sensor, and drive motor module enables automatic obstacle avoidance and information collection. Integrating an ultrasonic obstacle avoidance module alongside an infrared tracking module significantly boosts obstacle evasion and pathfinding capabilities, adeptly adapting to various work environments. Handling robot arm structure reference Yaskawa MPL manipulator, the Yaskawa MPL manipulator is highly suitable for high-speed and high-precision palletizing, picking, packaging, and other industries.

1. Introduction

In the 21st century, the logistics transportation and handling sector has undergone significant transformations due to technological advancements. While manual handling has a long-standing history in logistics production lines, it suffers from several drawbacks including high physical exertion, limited automation, inefficiency, and environmental impact. Presently, numerous domestic logistics enterprises continue to heavily rely on physical handling and manual operations in their daily logistics processes. This situation in the current logistics industry can no longer adapt to the development needs of the market.

While manual logistics handling remains crucial, it contends with inherent challenges such as reliance on human resources, susceptibility to human errors, reduced efficiency, and escalating labor expenses. In contrast, deployment of handling robots offers potential enhancements in logistics efficiency, cost reduction, safety enhancement, and heightened adaptability and flexibility. With the continuous development of technology, handling robots will play an increasingly important role in the logistics industry.

However, the current handling robot still has some shortcomings and still faces certain difficulties in the complex and dynamic environment. For instance, factors such as diverse object shapes and sizes, varied terrain types, and the presence of individuals and other robotic entities can influence the robot's functionality and navigation outcomes. The accuracy and flexibility of handling robots still need to be improved. This paper presents a logistics handling robot design centered around the AT89C52 single-chip microcomputer. It enhances current robotic systems by enabling autonomous tracking, obstacle avoidance, and automated object picking using a robotic arm. These advancements aim to significantly improve the efficiency and safety of logistics operations.

The rest of this article is organized as follows. The second part of the design of the robot, first introduces the system design of the robot, and then introduces the design of the drive module and the robot arm according to the

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system design. The third part is hardware design, which introduces the main hardware used by the robot. The fourth part of the module test, mainly ultrasonic obstacle avoidance module and infrared tracking module for testing, data analysis. The fifth part summarizes the main content of this paper.

2. Design of Handling Robot

2.1. Robot system design

The design of this paper is based on the modular design of AT89C52 microcontroller. The functions of the whole design system are divided into power module, motor drive module, ultrasonic obstacle avoidance module, infrared tracking module and robot arm module. The control of the robot arm is achieved through a vision sensor, through which information about the desired object is obtained [1]. The System composition diagram is shown in the Fig. 1.

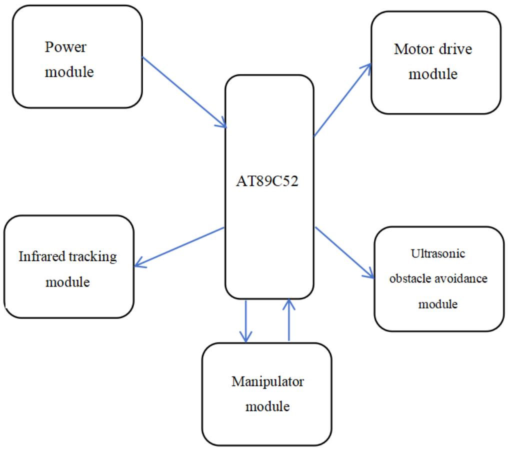

Fig.1 The system composition diagram

2.2. Drive module design

The whole work flow of the handling robot starts from the designated starting work area and gets the route information through the road condition feedback, so as to reach the designated area in accordance with the set route to complete the corresponding work. Therefore, the design of the driving module of the robot in this paper needs an automatic tracking system to realize. The automatic tracking system flow is shown in Fig. 2.

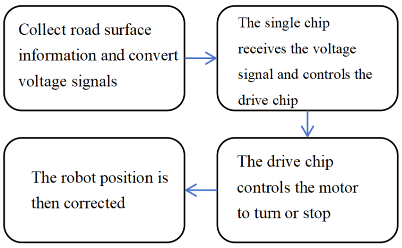

Fig.2 The automatic tracking system flow

The infrared tracking module uses the TCRT5000 infrared sensor as the path detection sensor to realize the detection of the road track route [2].

2.3. Robot arm design

Mechanical arm structure reference Yaskawa MPL series mechanical arm, Yaskawa MPL series mechanical arm structure is simple, fewer parts, parts of low failure rate, reliable performance, simple maintenance and maintenance, less inventory parts required. The MPL architecture offers exceptional control performance and precision, addressing intricate motion control requirements effectively. Its flexible configuration and expandability cater to diverse application scenarios and specific operational demands.

The Yaskawa MPL manipulator features a modular design, allowing for independent installation and replacement of individual joints and components. This design simplifies and accelerates repair and maintenance processes, minimizing downtime and repair expenses. The Yaskawa MPL0100 robot arm model and fixture model is shown in the Fig. 3.

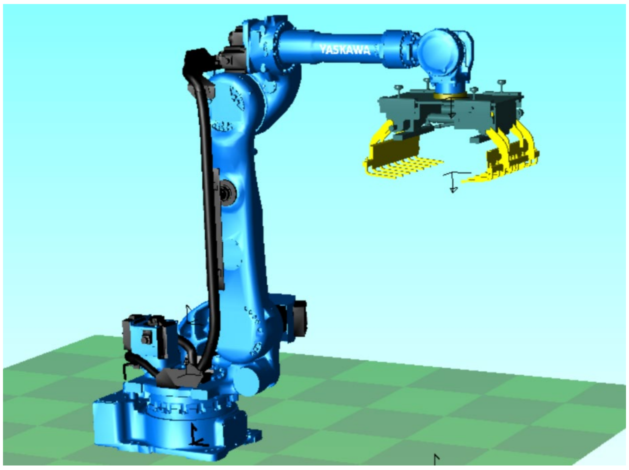

Fig.3 Yaskawa MPL0100 robot arm model and fixture model

3. Hardware Design

3.1. Main control chip

The main controller of the control system uses AT89C52 microcontroller, AT89C52 microcontroller has powerful functions and flexibility, suitable for a variety of embedded systems and control applications, belongs to CMOS8-bit microcontroller. Its advantages are mainly reflected in low power consumption, high performance, and flash memory [3], [4]. Receive the input signal collected by the sensor, and output the control signal to the driver chip, so as to control the robot to walk along the specified route and stop to the specified destination.

3.2. Power supply

In the overall system design, the AT89C52 MCU functions as the central controller, powered by two 3.7V power modules. Sensor data acquisition requires a 5V operating voltage, managed through an AMS1117 voltage regulator. This regulator is known for its cost-effectiveness, affordability, stable performance, ease of use, low power consumption, overload protection, multiple output voltages, and high efficiency. The operating voltage of the motor drive module in the device is 5 V, if the voltage is greater than 5 V, it is directly supplied by the power module.

3.3. Drive motor

The robot is usually driven by DC reducer motor, which can output large torque through the deceleration of the gear box [5]. After thorough evaluation and comparison, the JGB37-550 DC gear motor model was chosen. Known for its high torque, excellent stability, wide speed range, superior energy efficiency, reliability, and ease of installation, this motor finds extensive applications across various industrial and commercial sectors.

3.4. Controls the robotic arm chip

In order to identify the grasping material workpiece, the color and shape of the material workpiece are used to identify the target. The recognition sensor utilizes the OpenMV3 vision module interfaced with an MCU. Equipped with a camera, the OpenMV3 module captures images of objects, subsequently processed by the AT89C52 microcontroller.

4. Module Testing

4.1. Ultrasonic obstacle avoidance module test

According to the actual working environment of the handling robot, the indoor environment is selected for ultrasonic obstacle avoidance test, obstacles are set, and ECH0 of the HC-SR04 ultrasonic module is connected to the needle J9-P2.0, TRIG is connected to J9-2.1, VCC is connected to J9-VCC, and GND is connected to J9-GND. The LCD1602 liquid crystal was installed in the LCD1602 socket of the single chip microcomputer, and the contrast of the liquid crystal was adjusted. Ultrasonic obstacle avoidance module test data is shown in Table 1.

Table 1 Ultrasonic obstacle avoidance module test data

Ultrasonic ranging(mm)	Ruler ranging(mm)	Error(%)
266.8	266.0	0.15
350.6	350.2	0.18
439.5	439.1	0.17
658.4	658.0	0.13
772.1	771.3	0.14

The error between the ultrasonic obstacle avoidance module's ranging value and the actual ruler's ranging value is less than 2%, which can realize automatic obstacle avoidance.

4.2. Infrared tracking module test

Natural ambient lighting affects the reception capability of the infrared receiver, necessitating indoor environment testing that closely mimics real-world conditions for accurate evaluation. Before the test, connect P3.2~3.5 of the pin J11 and P3.2~3.5 of the AT89C52. Place the robot on the white test bench, turn on the power, and fine-tune the potentiometer RW3 and RW4 in a clockwise manner until LED2 and LED light up.Infrared tracking module test data is shown in Table 2.

Table 2 Infrared tracking module test data

Transfer robot	Left infrared tube	Right infrared tube
Go forward	1	1
Back up	0	0
Turn left	1	0
Turn right	0	1

5. Conclusion

This study focuses on a handling robot, employing the AT89C52 microcontroller as the core processor. It integrates an infrared tracking module, ultrasonic obstacle avoidance module, power management module, motor control module, and robotic arm module. This design aims to enhance operational efficiency and mitigate risks associated with manual logistics handling in diverse environments.

Intelligent handling robots exhibit promising growth opportunities. As technology advances and their applications diversify, these robots are poised to significantly enhance operational efficiency, cut down expenses, and drive industrial evolution towards greater intelligence.

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