IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684, p-ISSN: 2320-334X, Volume 22, Issue 1 Ser. 1 (Jan. – Feb. 2025), PP 26-29
www.iosrjournals.org

Biped Wheeled Logistics Robot

Leqin Lei, Chenhui Lu*, Tao Liu, Chengxinyi Peng, Yang Li, Jiahao Yao

School Of Mechanical And Automotive Engineering, Shanghai University Of Engineer Science, Shanghai, China

Abstract:
The 21st century information technology and control technology to promote the rapid development of robotics, mobile robots are widely used in logistics, space, industry and other fields. Wheeled robots, as a branch of mobile robots, are widely used due to their structure and cost-effective advantages. However, most of the existing wheeled robots are limited to Specific fields and lack of universality, prompting us to design a wheeled logistics robot that can be applied to manufacturing and daily life. The robot is capable of moving, gripping and carrying objects freely on the ground. The main body of the robot adopts a four-link structure, which is relatively low in manufacturing and maintenance costs, and is capable of switching between multiple forms of motion. The hardware part of the electronic control system contains four modules: main control chip, sensor data acquisition, power supply and communication. We choose STM32F103RCT6 as the main control chip, with JY62 module, encoder and other sensors to achieve balance control, using Bluetooth serial port for wireless debugging and control. According to the structural characteristics of the logistics robot, we designed the robot motion control strategy and completed the software design of the robot control system.

Keywords: *Logistics robot; Bipedal wheeled robot; Electromechanical system design; Balancing robot*

Date of Submission: 16-01-2025 Date of Acceptance: 26-01-2025

I. Introduction

Since the 21st century, with the rapid development of information technology and control technology, the development of robotics technology at home and abroad has become more and more rapid. Mobile robots, as an important branch, have been widely cited in recent years in the fields of logistics and transportation, space survey, industrial inspection, etc., assisting humans to perform a variety of tasks, and bringing a lot of convenience to production and life. Wheeled robots are characterized by simple structure, high cost performance, etc., and have become one of the widely used robot types.

Most of the wheeled robots that have been put into application in the market have strong limitations, which are only applicable to a certain specialized field, and it is difficult to be applied to other scenarios, which are not universal. This puts high demands on the development and design of robots. In this regard, we hope to design a wheeled logistics robot that can be applied to manufacturing and daily life, replacing people to complete some of the physical labor such as transporting and picking up items.

According to the specific environment, we hope that the robot can realize the following functions: first, it can move on the ground arbitrarily and complete the basic functions such as straight line and turn; second, it can pick up objects according to the instructions and transport them to the specified position.

Description of the Logistics Robot

How to work

The whole robot is divided into two parts: waist and wheel legs. During the movement of the robot, the servo arranged on the waist is responsible for regulating the movement of the thighs. The driving wheels are arranged directly at the end of the robot's legs, adopting a two-wheeled self-balancing motion, which can realize dynamic movement like a two-wheeled inverted pendulum robot. Through the cooperation of the servo and drive motor, the robot can move on the ground arbitrarily and complete the basic functions such as turning straight ahead.

How to create -- Structure design

1. Adjustable Angle 3D printed cantilever

The robot is initially designed to fulfill the needs of people to carry objects on a daily basis, and at the same time, it has excellent human-robot interaction capabilities. With the goal of meeting the appeal needs, the bipedal wheeled robot must have basic motion functions such as balance, steering, movement and attitude adjustment. The structure of the robot should be based on the principle of simplicity, reducing the number of degrees of freedom while maintaining functionality in order to reduce the complexity of design and control. The overall mass of the robot also needs to be kept lightweight in order to better suit the production and living areas.

The wheel leg part is designed as a four-link mechanism, which has a simple structure, relatively low manufacturing cost and maintenance cost, and can realize the conversion of multiple forms of motion to meet different motion requirements. The driving wheel is directly arranged at the end of the robot's calf, adopting the program of wheel-leg fusion, and the power of the motor is directly output to the driving wheel, so that the calf has a reasonable size and compact structure.

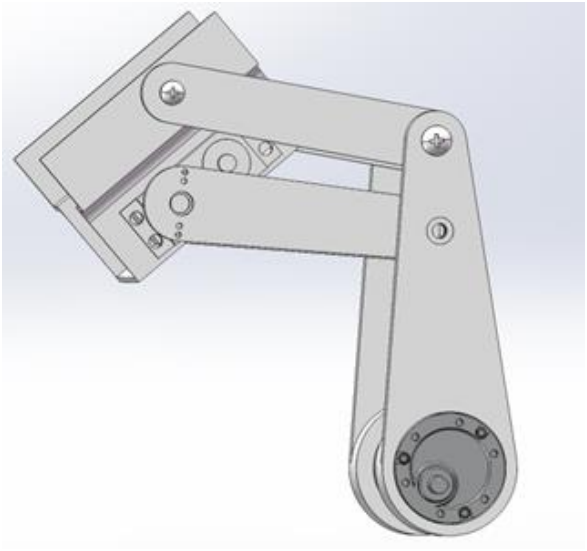

Figure 1. Mechanical structure of wheel legs

The waist section is mainly used for arranging the electrical modules, including the main control chip, sensors, communication hardware and batteries. In order to facilitate the installation, the two ends of the waist part are designed to be stepped to connect with the legs. Considering the self-weight to the robot, the waist part is made of hard and lightweight material.

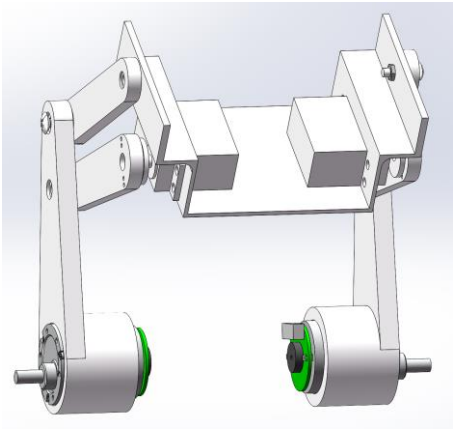

Figure2. Waist section

The whole machine has four degrees of freedom, of which the arm joint and wheel joint on one side have one degree of freedom each. Considering the strength and hardness requirements of the robot, the temperature of the working environment, and the cost, we chose JLC BLACK resin material for 3D printing, which has a load deflection temperature of up to 65°C to better meet the performance requirements under high temperature conditions, and also has excellent toughness and low shrinkage. These characteristics ensure that it can stably maintain its shape and performance in a regular working environment.

Figure3. 3D printed parts

How to create -- Electronic control system design

The electronic control system mainly consists of four major modules: the main control chip, sensor data acquisition module, power supply module and communication module. The main control chip is the brain of the electronic control system, which is mainly responsible for processing the data collected by sensors such as encoders and gyroscopes, the control of the drive wheel motor driver, and the calculation of the robot's motion program and other tasks.

Based on the functional requirements of the robot, STM32F103RCT6 is chosen as the main control chip of the robot in this project. We used the JY62 sensor module and encoder in order to obtain information about the robot's position and speed to ensure that it realizes the function of balance control.

The JY62 is a six-axis sensor module that can simultaneously measure three-axis acceleration and three-axis angular velocity data, which provides rich information for obtaining the attitude and motion state of the object, and adjusts the output of the motors in time to keep the robot in a stable standing and traveling state. The encoder can determine the angle and motion speed of each joint.

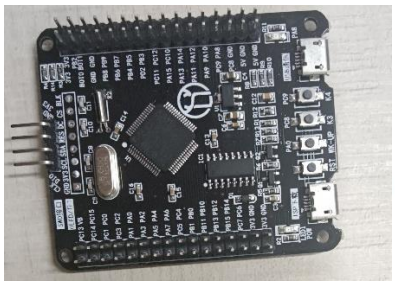

Figure4. motherboards

figure5.JY62

In order to realize the debugging and wireless control of the robot by computer and joystick, we added a Bluetooth serial module. Finally, we chose a 12V lithium battery to provide a stable and reliable power supply for the power system and the whole control system. The software part consists of transmission initialization, sensor data collection and acquisition, communication and PID control algorithm.

II. Conclusion

This project is aimed at the current situation that most of the wheeled robots on the market are limited to professional fields and lack of universality, to design a wheeled logistics robot that can be applied to manufacturing and daily life, replacing people to complete part of the physical labor such as transporting and picking up items. The bipedal wheeled balanced logistics robot can realize arbitrary movement on the ground, complete the basic functions such as turning straight ahead and maintaining balance, and according to the instructions of the object clamped and transported to the designated location to realize. These functions can bring a lot of convenience for the production of production life, has a broad application prospect.

This research was partly supported by 2024 ShanghaiInnovation and Entrepreneurship Training Program for College Students of China. Project Number: cx2401017.

Reference

[1] Principles Of Automatic Control [M]. Hu Shousong, Ed. National Defense Industry Press. 1984 Wang Weirong. Electrical And Electronic Technology. Electrical Technology And Computer Simulation (2nd Edition)[M].

[2] Tong Bai Shi, Hua Chengying. Basic Of Analog Electronic Technology [M]. Beijing: Higher Education Press, 2006(04).

[3] Computer Control Theory And Applications [M]. Edited By Sun Zengqi. Tsinghua University Press.1989