Transactions on Computer Science and Intelligent Systems Research
ISSN: 2960-1800, eISSN: 2960-2238 | Volume 1
AIEA 2023

Research on the Servo System of the Robot

Zhekai Zheng

Zhejiang University, Hangzhou, 310058, China

Abstract. Servo system is the core functional components of high-end equipment, intelligent manufacturing equipment to achieve automatic control, the robot's performance is greatly affected by the servo system, so the key performance indicators of the precision servo system has always been the primary factor in evaluating the advanced nature of the robot. This paper describes the servo system in the robot, first describes the simple composition of the servo system in detail, and then describes the more intelligent and complex servo system in-depth.

Keywords: Servo System; Robot.

1. Introduction

As a control technology with high precision, high speed and high stability, intelligent servo system has significant advantages in dexterous hand operation tasks. When designing a servo system, it is necessary to consider the specificities of the task, choose appropriate motors, and strengthen safety protection measures. By optimizing and improving related technologies and ensuring their security and reliability, the industrial intelligence process can be effectively promoted. Such control systems are widely used in industrial production, service robotics, medical devices and other fields, and continue to innovate to meet diverse needs.

2. Design of Servo Systems

Servo systems are common in numerous domains and have numerous applications in industrial robotics. Servo systems are technologies that monitor and control robots in real-time through multiple sensors, enabling high precision, high speed and high stability.

During my internship, I was exposed to content about dexterous hands. A dexterous hand is a device that mimics the structure and function of the human hand and can perform a variety of complex and delicate manipulation tasks. Compared to other industrial robots, dexterous hands are more demanding on servo systems, which are essentially servo systems under auxiliary artificial intelligence, which we call intelligent servo systems.

First, the task specificity required by the dexterous hand should be considered when designing the servo system. Since dexterous hands are commonly required to perform tiny and precise movements, servo systems must have high resolution and response speed, and be able to quickly and accurately adjust the motor output power to meet different operating requirements.

Secondly, it is also necessary to take care of the characteristics and requirements in the selection of motors suitable for dexterous hands. The motor must have excellent control performance, reliability and durability, as well as the dexterity required to perform complex and continuous movements. At the same time, the size and weight of the motor should be considered to ensure that the whole device is compact and easy to operate.

In addition, safety concerns should be fully considered when developing servo systems. Especially when it comes to direct interaction with humans or operating in tight spaces, safety precautions are critical. For instance, sensing techniques are used to detect the environment and avoid collisions; push the emergency stop button to cut off power at any time, etc.

In addition to the industrial sector, servo systems are widely used in service robots, medical devices, and other fields. For example, in service robots, servo systems can help robots perform a variety of

Content from this work may be used under the terms of CC BY-NC 4.0 licence (https://creativecommons.org/licenses/by-nc/4.0/).
Published by Warwick Evans Publishing.

complex tasks, such as grasping objects, opening and closing doors, and Windows. While in medical devices, servos can be used to enable precise positioning and manipulation of surgical robots.

In short, only by continuously optimizing and improving related technologies, and putting safety and reliability first, can we advance the industrial intelligence process and bring more possibilities and benefits to all walks of life. Under this pressure of demand, intelligent servo systems have emerged due to the continuous evolution and improvement of servo systems with the continuous progress and innovative development of science and technology. The robot's intelligent servo system is shown in figure 1:

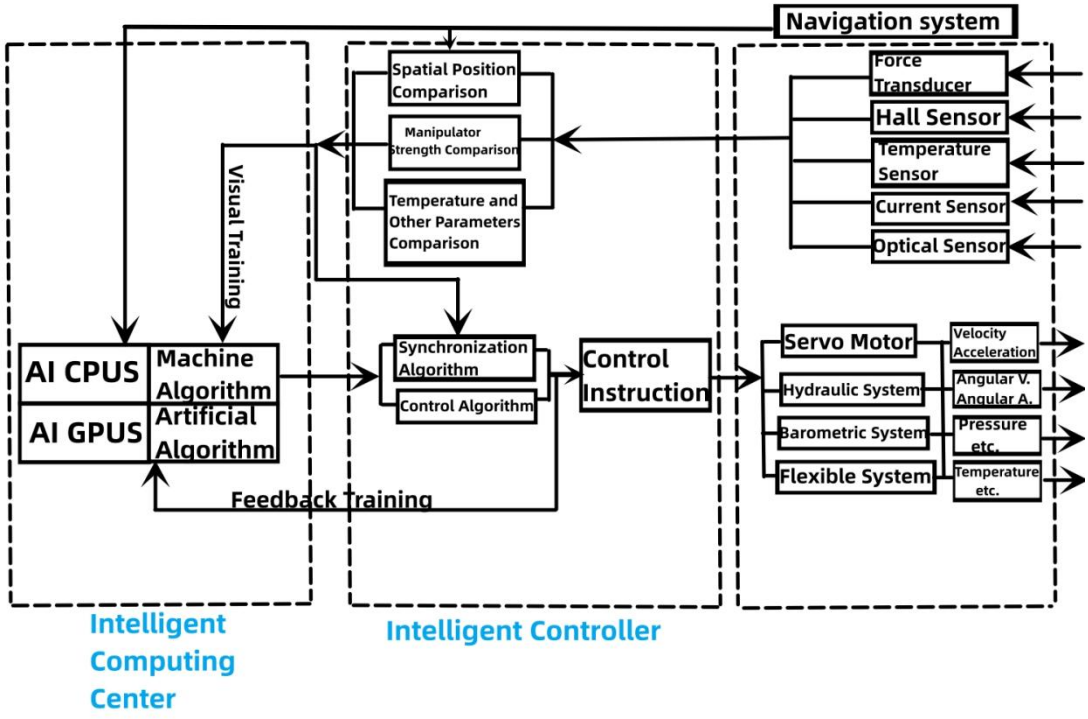

Figure 1. The robot's intelligent servo system

The development of sensor technology has made the inspection process more sensitive and reliable, and additional types of feedback information can be obtained. at the same time, there has been a tremendous breakthrough in control algorithms, from the original simple PID control to the more sophisticated and intelligent algorithmic applications that are now available.

In addition, more and more distinct execution components appear in the execution links. In addition to conventional motors, hydraulic and pneumatic actuators, emerging technologies such as acoustic actuators and deformable alloy actuators are gradually being applied to servo systems.

This controller, with the help of an intelligent computing center, is the core of the entire intelligent servo system. The object of control is to select the corresponding execution component according to the specific requirements of the exact operation. The detection link obtains feedback information through various sensors and provides it to the comparison link for computation. The comparison link obtains a bias signal based on the difference between the input command signal and the feedback signal and adjusts the actuator to achieve more accurate position control.

In summary, the five parts of the controller, the controlled object, the execution link, the detection link and the comparison link "assisted by the intelligent computing center" together constitute a complete and efficient and stable intelligent servo system. They cooperate with each other and bring a lot of convenience and innovation to various industries under the premise of ensuring safety, accuracy and stability.

For several of these steps, such as controller, execution, detection, and comparison, I have written in another paper a simple and introductory version, namely the most basic servo system implemented

by an operational amplifier. This basic servo system monitors and adjusts motor speed and position through the controller, converts input signals into corresponding actions in the execution link, and corrects through constant feedback information in the detection line. At the same time, the target value is compared to the current state in the comparison link, and the output signal is adjusted according to the difference.

However, in addition to this basic version, more complex and advanced servos exist. For example, on the controller side, more advanced digital signal processing techniques or embedded systems can be used to achieve more accurate and flexible control strategies; high performance and reliability driving devices and sensor devices can be used in the execution phase. In the detection link, more types and higher precision sensors can be introduced to obtain more comprehensive and accurate feedback information. in comparison links, advanced algorithms or artificial intelligence techniques can also be used for data analysis and decision making.

Moreover, with the continuous development and progress of science and technology, servo systems are gradually being applied in various fields. For example, in the field of industrial automation, servo systems are widely used in a variety of high-demand scenarios on production lines that require precise positioning, fast response and stable operation. In the aerospace sector, it needs to be characterized by super interference capability, extremely high reliability, and lightweight design. In the field of medical devices, low noise, low vibration, safety and reliability are required.

3. Conclusion

Both the most basic and sophisticated advanced servo systems have their own unique advantages and application scenarios. As science and technology continue to innovate and evolve, our understanding of servo systems will become more and more in-depth, and there will be more and more innovative products to meet the needs of all industries.

References

[1] Lunfei L, Houde L, Xinliang L, et al. Model-Based Coordinated Trajectory Tracking Control of Skid-Steer Mobile Robot with Timing-Belt Servo System[J]. Electronics,2023,12(3).

[2] Jing X, Caixia D, Youmin Z, et al. Correction to: Visual Servoing of Unknown Objects for Family Service Robots[J]. Journal of Intelligent & Robotic Systems,2022, 106(4).

[3] Edoardo I,Valentina M. Cable-Driven Parallel Robot Actuators: State of the Art and Novel Servo-Winch Concept[J]. Actuators, 2022,11(10).

[4] Tianxue Z,Hui Y L. A Visual Servo Controlled Robotic System for MRI-guided Breast Biopsy[J]. Journal of Intelligent & Robotic Systems,2022,105(4).