DOI:10.18686/ahe.v7i24.10055

Design of Magnetic-controlled Microrobot System with a Mechanical Electromagnetic Hybrid Drive

Hongjin Zeng
Guangzhou Huali College,511325

Abstract: With the rapid development of science and technology,microrobots are more and more widely used in various fields,especially in minimally invasive surgery,biomedicine,environmental monitoring and other fields.This design scheme aims to realize the autonomous navigation,operation and control of microrobots in various complex environments.By adopting a mechanical electromagnetic hybrid drive,we can improve the adaptability and mobility of microrobots while maintaining high accuracy and stability.In addition,the use of magnetic control technology enables the microrobot to achieve precise control in a friction-free environment,which reduces the dependence on external power supplies and improves the reliability of the system.
Keywords: Machinery;Electromagnetic hybrid drive;Robot system

1. Basic Principle of Magnetic-controlled Microrobot

The motion of magnetic-controlled microrobot mainly depends on the action of magnetic field.By setting up permanent magnets or electromagnets of different polarity,magnetic fields of different intensity can be generated,so as to realize the control of microrobots. The motion trajectory of the magnetic-controlled microrobot is usually guided by the magnetic field.By changing the distribution and intensity of the magnetic field,the precise positioning and control of the microrobot can be realized.The interaction between the magnetic-controlled microrobot and the working environment is mainly realized through magnetic adhesion.Magnetic adhesion refers to the attraction force between a microrobot and a magnetic substance.By adjusting the polarity and position of the magnet,the attraction or repulsion of the microrobot can be realized,so as to realize the movement and operation of the microrobot in the working environment.The magnetic-controlled microrobot is usually equipped with a drive system,including a motor,a driver and other components,which is used to drive the movement of the microrobot.These drive systems need to be designed and selected according to the motion requirements of microrobots.

2. Design of Drive System for Magnetic-controlled Microrobots

2.1 Driving mode

The design of the driving system of the magnetic-controlled microrobots is the core part of the whole robot,and its design directly affects the motion performance and work efficiency of the robot.According to the motion requirements of the magnetic-controlled microrobot,the appropriate driving mode is selected.Common driving methods are linear motor drive,spiral motor drive,stepper motor drive,servo motor drive and so on.Linear and spiral motors are suitable for linear or spiral motion,and stepper and servo motors are suitable for precise position control.

2.2 Selection of drive motor

According to the motion performance requirements of the magnetic-controlled microrobot,the appropriate motor is selected. It is necessary to consider the power,speed,torque,inertia,noise and other performance parameters of the motor,as well as the cost,size,weight and other dimensional parameters of the motor.

Proper motor performance parameters are the cornerstone of magnetic-controlled microrobot.We need to meet the performance requirements while taking into account other size parameters.Various performance and size parameters need to be weighed to ensure the efficient operation of the micro-robot.In the field of micro-robot,the selection of motor performance parameters directly affects the operating efficiency and stability of the whole system.

2.3 The control mode of the drive motor

According to the motion control requirements of the magnetic-controlled microrobot,the appropriate control mode is selected. Common control methods include pulse width modulation(PWM)control,position control,speed control and so on.PWM control is suitable for simple speed control.Position control is suitable for precise position control.And speed control is suitable for high-speed movement.

According to the motion requirements of the magnetic-controlled microrobot and the performance parameters of the drive motor,the structure of the drive system is designed.It is necessary to consider the weight,size,stiffness,strength and other performance parameters of the drive system to ensure the stability and reliability of the drive system.

3. Design Requirements of Magnetic-controlled Microrobot System with a Mechanical and Electromagnetic Hybrid Drive

The structural design of magnetic-controlled microrobot with a mechanical electromagnetic hybrid drive needs to consider the cooperative work between the electromagnetic and mechanical drive components.At the same time,it is also necessary to consider the kinematic performance,stability and flexibility of the robot.The structural design needs to have good stiffness,strength and wear resistance to ensure that the robot can work properly in a variety of environments.The drive system of magnetic-controlled microrobot with a mechanical electromagnetic hybrid drive needs to realize the effective control of the electromagnetic drive components and the mechanical drive components.The drive system needs to have good response speed,accuracy and stability to meet the needs of high-speed movement and precise control of the robot.The control system of magnetic microrobot with a mechanical electromagnetic hybrid drive needs to realize the precise control of the robot,and the control system needs to have the characteristics of high precision,high stability and real-time,so as to ensure that the robot can achieve accurate positioning and control in a complex environment.The sensor system of magnetic-controlled microrobot with a mechanical electromagnetic hybrid drive needs to achieve efficient acquisition of environmental information.The sensor system needs to have the characteristics of high sensitivity,high stability and low noise to ensure that the robot can achieve accurate perception and positioning in various environments.The control algorithm of magnetic-controlled microrobot with a mechanical electromagnetic hybrid drive needs to realize the cooperative control of the electromagnetic and mechanical drive components.The control algorithm needs to have the characteristics of high precision,high stability and real-time to ensure that the robot can achieve accurate positioning and control in the complex environment.

4. Implementation and Debugging of Mechanical Drive System

4.1 Design stage

The realization and debugging of mechanical drive system is a process involving many links,including design,manufacture,in stallation,debugging and so on.In the design stage,it is necessary to determine the type of drive system(such as DC motor,stepper motor,servo motor,etc.),drive mode(such as open loop control,closed loop control,etc.),motion mode(such as jogging,continuous motion,etc.)and motion accuracy and speed requirements.At the same time,you need to select the appropriate transmission mode(such as gear drive and chain drive)according to the actual application scenario.

4.2 Manufacturing stage

In the manufacturing stage,the various components such as motors,retarders,sensors required for the drive system need to be manufactured according to the design drawings.At the same time,it is necessary to ensure that the quality and performance of these components meet the design requirements.In the manufacturing stage,we need to strictly follow the design drawings to manufacture the various components required for the drive system such as high-efficiency motors,precision retarders and sensitive sensors.These components not only need to meet design requirements in terms of specifications and performance,but also need to be industry-leading in quality.

4.3 Installation stage

In the installation stage,it is necessary to install the manufactured drive system components into the actual application scenario,such as installing the motor on the device,installing the sensor on the workbench.During the installation process,it is necessary to ensure that the connection between the various components is solid and reliable and factors such as installation space and operation convenience need to be taken into account.During the installation process,we need to ensure that the connection between the various components is strong and reliable to prevent failure during actual operation.In addition,we also need to consider factors such as installation space and operation convenience to ensure that the equipment can operate normally in a limited space,while facilitating the operator to carry out daily maintenance and overhaul.

4.4 Debugging stage

In the debugging stage,a series of tests and adjustments are needed to ensure that the drive system can meet the design requirements.The debugging process usually includes the following aspects:a.Performance test:testing the performance parameters of the motor,reducer,sensor and other components,such as the motor speed,torque,sensor resolution,etc.,is to ensure that they can meet the design requirements.b.Control system test:testing the performance parameters of the control system,such as control accuracy,response speed,etc.,is to ensure that the control system can achieve effective control of the drive system.c.System integration test:testing the overall performance of the drive system,such as motion accuracy,speed,stability,etc.,is to ensure that the drive system can run stably in practical application scenarios.d.Troubleshooting and repair:During the debugging process,some faults or problems may be found,and these problems need to be investigated and repaired to ensure the normal operation of the drive system.

5. Optimization and Improvement

After the debugging is completed,the drive system is further optimized and perfected according to the actual operation to improve its performance and reliability.It may include adjusting control parameters,improving the transmission mode,replacing parts,etc.The realization and debugging of mechanical drive system is a process involving many links,which needs to be considered and operated from many aspects such as design,manufacturing,installation and debugging.Only through continuous testing and optimization can the mechanical drive system meet the design requirements and achieve stable and reliable operation.

6. Conclusion

The design of magnetic-controlled microrobot system with a mechanical electromagnetic hybrid drive is a technological innovation with wide application prospect.It combines traditional mechanical drive with advanced electromagnetic drive to achieve precise control and efficient drive of microrobots.Through the optimization design,the autonomous navigation and task execution of the microrobot in the complex environment are realized.In addition,the energy management and fault detection of the robot are also considered in this paper,which improves the reliability and safety of the system.In future studies,more possibilities will continue to be explored to improve the performance and application range of microrobots and open up new possibilities for research and practical applications in the micro and nano field.

References:

[1]Qingwei Li,Dongqin Xu,Fuzhou Niu et al.System Design of Magnetic-controlled Microrobot with a Mechanical Electromagnetic Hybrid Drive[J].Machine Design and Manufacturing Engineering,2023,52(02):9-13.

[2]Xiuqing Ma,Kaixin Sun,Yiqiang Fan.Research Progress and Application of Magnetic Field Generation in Magnetic-controlled Microfluidic Chips[J].Micronanoelectronic Technology,2020,57(10):810-817+822.

[3]Qingwei Li,Dong-Qin Xu,Fuzhou Niu et al.System Design of Magnetic-controlled Microrobot with a Mechanical Electromagnetic Hybrid Drive[J].Machine Design and Manufacturing Engineering,2023,52(02):9-13.