Perspective

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Mathematical Model of the Hydraulic Quadruped Robot Position System

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Description

The structure for the mathematical model of the hydraulic quadruped robot position system is obvious, but the model parameters are uncertain and time-varying. Due to errors in the machining process, the flow gains of the servo valves of the same model are different. Therefore, if the mathematical model of the servo valve is determined according to the nominal value of the flow gain, the mathematical model is not accurate. However, for the design of high-precision controllers and the analysis of system performance, an accurate mathematical model is essential. Therefore, the effective way to solve the above problems is to identify the control system.

At present, the research on the model identification method of the hydraulic valve control cylinder system is very extensive. Lazim IM proposed a predictive function control algorithm and used the system identification method to obtain the linear transfer function of the electro-hydraulic servo system in the discrete form. Zhou RX used the direct identification method to solve the mathematical model of the DC motor, and the results showed that the accuracy of the model was significantly improved. Researchers such as Ziaei K established the discrete linear model of the hydraulic servo control system and completed the parameter identification work. The results show that the model has a good single-step prediction effect. Although the above research has improved the accuracy of the identification model to a certain extent, it is mainly used for the identification of linear models. It fails to adjust the parameters of the nonlinear model or uses the direct identification method, which requires more stringent conditions.

Identification of the Position Model

The feedback channel model for the position control system of the hydraulic quadruped robot is known. In order not to damage the experimental platform of the robot, this paper adopts the closed-loop indirect identification method to identify the position control system of the robot hydraulic servo drive unit.

Therefore, in order to obtain the precise mathematical model of the hydraulic quadruped robot position system, this paper uses the closed-loop indirect identification method to identify the valve control lever servo system of the hydraulic quadruped robot. In the joint position control system of a hydraulic quadruped robot, different motion stages have different requirements for system parameters. When the end of the foot begins to fall, the running speed is relatively high, and the system has high requirements for response speed. When the end of the foot is close to the ground, the running speed is slow, requiring the system to quickly enter the error band without steady-state error. Therefore, in order to meet the above requirements, a higher performance control method is required. In recent years, the high-performance control of hydraulic servo systems has attracted more attention, and many scholars have carried out research work on valvecontrolled cylinder control methods. Zhu JT added a feedforward control algorithm based on the position loop proportional control, which effectively improved the dynamic performance of the digital valve. Wang YL proposed an improved feedforward digital PID position compound control method, which improved the stability, rapidity, and accuracy of the control system. Zhang XN proposed a model-referenced variable gain adaptive control algorithm to compensate for asymmetric hydraulic cylinders, which improved the robot's motion stability and control accuracy. The above several methods are representative of high-performance control and have been improved compared to the original control method. Although certain results have been achieved, none of the above methods can respond quickly to changes in position and speed. Therefore, this article adopts speed PID for position control and obtains satisfactory contact by controlling the final deformation and contact speed.

Model Identification Process

The system can realize rapid and accurate positioning of the robot according to the changes of different speeds. When identifying the joint position control system model of the hydraulic quadruped robot, it must be ensured that the input excitation signals of each joint of its legs are random signals that are not related to each other. Moreover, the amplitude or power of the excitation signal of each joint cannot be too small or too large. This is because the excitation signal must be larger than the dead zone voltage of the servo valve, but it must be prevented from entering the saturation zone of the servo valve. At the same time, in order to excite the robot system, the input excitation signal of each joint should have enough bandwidth, but it should not cause damage to the components of the system. System identification usually uses sequence, inverse sequence, and sine sweep signal as input excitation signals, but these excitation signals are more suitable for single channel system identification. However, when the hydraulic quadruped robot system is identified, it must be ensured that the input excitation signals of the three joints of the legs are not related to each other. Therefore, in the identification of the hydraulic quadruped robot system model, the abovementioned input excitation signal is not applicable.

Because the PID controller has the advantages of simple structure, easy tuning, convenient use, and good stability. Throughout the development history of automatic control, PID control has the longest history and the strongest control performance, PID controller can adapt to different control objects by adjusting PID parameters, and its adjusted performance indicators are not sensitive to slight changes in the characteristics of the controlled object, which greatly guarantees the effectiveness of the control. At the same time, the PID controller can be used to compensate the system through parameter adjustment to meet most of the system's quality indicator. So far, PID controllers are still widely used in the field of industrial control in the world, becoming a very versatile controller with very strong applicability.