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Study on Control Algorithm of 3-DOF Parallel Robot

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Abstract. In order to improve control affect of 3-DOF parallel robot, the structure and work principle are presented in brief, control algorithm is introduced in great detail, three controller, which are PID controller , fuzzy logic control and robust control,are established, research of compare experiment show that robust control in hydraulic servo system is better than the other control algorithms.

Introduction

The 3-DOF(3-DEGREE-OF-FREEDOM) sport simulators again weigh the 3- DOF parallel robots, it is in recent years in great demand of robot studies. The organization of parallel robot , imitate vitality weapons, aerospace, marine project, military affairs and traffic and other aspect to have extensive prospect. The systematic size that can produce active force as well as the rigidity of deformed, deformed size and system under the role of outside force relevant. Because the rigidity development property of system that affects it and the location precision under load condition so, rigidity analysis is very important for system.

In this study, the structure and work principle of 3-DOF parallel robot are presented, on the basis of that control algorithm is introduced, compare experiment is done and the result is analyzed. The base composition of 3-DOF parallel robot is shown in Fig.1, which can obtain electro-hydraulic position control, position servo control system include the computer, D/A, servo amplifier, servo valve, hydraulic cylinder, A/D, displacement sensor.

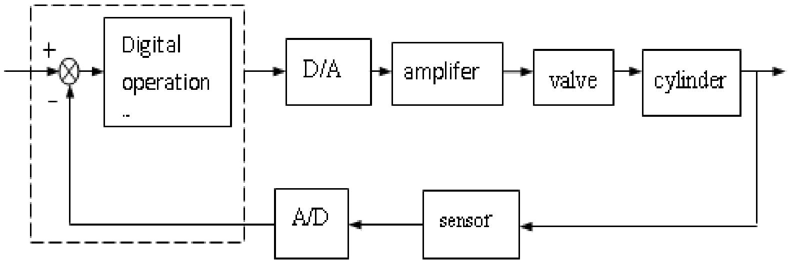

Figure.1 control system

Controller Design

It is difficult for parallel robot platform to directly be measured, therefore, three hydraulic cylinder is used for decentralized control, control systems aim is control performance and robustness, the design of three control and comparison study.

PID controller is a technical mature and widely used regulator. Which is simple and easy to adjust, stability, reliability and have been accumulated rich experience in the long-term applications, it is widely used in various industrial processes of control. in theory and automation control of the development of technological leap forward, still has its strong vitality.

In industrial process control, It is difficult for control of the object to establish accurate mathematic models, modern control of theoretical analysis is used to requires a comprehensive, pattern recognition and price higher; PID control based on experience on the whole will be more satisfactory control effect. as computer technology development , PID digital control algorithm is easy, because of the software for flexibility, therefore, PID control still is the base control, which can be written as following:

$$u(t)=K_p\left[e(t)+\frac{1}{T_i}\int_0^t e(t)dt+T_d\frac{de(t)}{dt}\right] \tag{1}$$

By the above-mentioned control laws, schematic diagram of PID is shown Fig.2

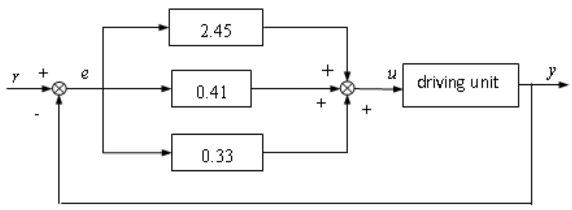

Figure.2 design diagram of PID

Fuzzy logic control is an active and intelligent control method, and conventional control depend on the design of different parameters, the fuzzy logic controller is dependent on the operators experience. the skill, the practice of the sum and description of experience and use of computers in words. Controller of a two-dimensional vague the system errors and error rate, the better control properties. parallel robots all hydraulic cylinder displacement control system to a single input, output, according to documents [2], a more suitable for use as a controller. two-dimensional collisions

Fuzzy control in applications usually look up the table. check the basic ideas is through the calculated to a vague control tables and, in the computer memory. when my work when the computer is directly based on sample of the error and error rate for the current time to quantify the value of control output and d a server control and valves on the server contain output of a control, control of the displacement of the jar. design is fuzzy to constitute a form of control. according to the tank location server control system, as a controller of the work process see information.

By hydraulic pressure tank location server control system of some of the important parameters (system damping, the volume of the elastic modulus, the existence of uncertainty), and in the course of my work load of inertia, the traditional way of the design of the controller may not be on practical application. In addition, the movement's position is the drive units displacement, pace and acceleration of the nonlinear functions, the passage of the nonlinear coupling between serious interference with the traditional methods designed to meet in parallel with the design robot. lu great control method to solve these problems.

The 3-dof parallel robots in motion, every driver in the cylinder load is constantly changing, in order to curb the interference effects, the interference in the process of the frequency range of at least it contains a link to the function, so performance is at least it contains one integration process.

The simple form of interference from the power to function performance can be expressed as:

$$W_P(s) = \lambda \frac{s+\rho}{s} \tag{2}$$

Where λ and ρ are chosen by the performance acquirement

The robust control of hydraulic cylinder position servo control by application H∞ design can be given as:

$$K(s) = \frac{233(s+8.5)(s^2+115s+8500)}{s(s+1303)(s+1350)} \tag{3}$$

Experience and Discussion

The 3-DOF parallel robot all the similarities, we can get a driver units experiment. in the same pressures and load to control system design of different algorithms. this experiment is the purpose of the experiment verify the text proposed by the vague control algorithms, not a control the effectiveness of the method to control and pid, vague control and control such as lu great control algorithms are. take for the pressure, test curves are shown in Fig.3.

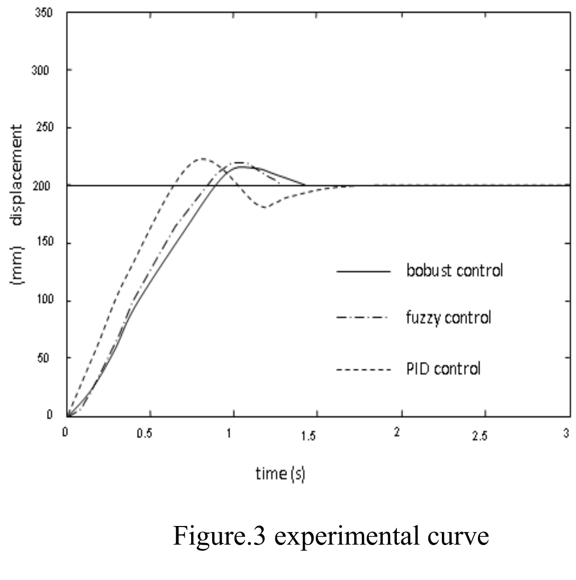

Figure.3 experimental curve

Through the experiment the conclusions is as following: firstly, there is the different response rate in different stages of hydraulic servo system and there is the good effect of control with fuzzy logic control, secondly, there is good stability with robust control; lastly, System pressure control of the effect of system affect the larger, the pressure increases, the system became so bad in quality control to meet the circumstances should try to choose low pressure.

summary

In this paper, the structure and work principle are presented, control algorithm is introduced in great detail, firstly, PID control is the mature and reliable technology used in the cylinder position servo control, but parameters and interference is more sensitive to PID control. Secondly, fuzzy control has the merit of speed and robustness, and without a static error, applied to the cylinder position servo control be very satisfactory results. Lastly, robust control is not sensitive to outside interferencet, quick to restore its former state applies to interfere with the environment, therefore, particularly for 3-DOF parallel robot.Acknowledgment

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