

Modelling of Geared DC Motor and Position Control using Sliding Mode Controller and Fuzzy Sliding Mode Controller

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ABSTRACT

Geared DC motors can be controlled by many controllers which may include the conventional PID controllers and various other techniques. The sliding mode control is one of the good controllers which can be used for conditions like disturbances and parameter variations. The system responses are compared when PID controller is applied to the system. SMC methods yield nonlinear controllers which are robust against unmodelled dynamics and internal and external perturbations. Also, due to system uncertainties that can lead to chattering phenomena in control law which can excite non-modelled dynamics and may damage the process, different approaches, like intelligent techniques, are used to minimize these effects. In this paper, the FL will be considered in the design of SMC. Also, a PID will be used in the outer loop in the control law then the gains of the sliding term and PID term are tuned on-line by a fuzzy system, so the chattering is eliminated and response of system is improved against external load here. Presented simulation results make sure that the above proposal and demonstrate the performance improvement to the example of DC motor. The results obtained with SMC with changed gains are compared with the traditional PID controller and fuzzy sliding mode controller. The advantages and limitations of each method are discussed.

General Terms

Position control

Keywords

PID controller, Sliding Mode Controller, Fuzzy Sliding Mode Controller, Geared DC Motor.

1. INTRODUCTION

DC geared motors are essentially a DC shunt motor which has been specially designed for low inertia, symmetrical rotation and smooth low-speed characteristics. Geared motor is a motor with a closed feedback system in which the position of the motor will be communicated back to the control circuit in the motors.

Geared motors are formed from four different elements: a DC motor, a position-sensing device (a potentiometer), a gear reducing part and a control unit. All of these components work together to make the motor to accept control signals that represent the desired output of the motor shaft and power the DC motor until its shaft is turned to the right position. The shaft in geared motors doesn't rotate as freely as those in regular DC motors; it is only able to rotate around 200 degrees in both directions. The position-sensing device in a geared motor determines the rotation of the shaft and then

the way the motor needs to turn in order to arrive at the desired position.

The sliding mode control is robust to plant uncertainties and insensitive to external disturbances. It is commonly used to get good dynamic performance of controllable systems. Even then, the chattering phenomena due to the finite speed of the switching devices can affect the system behavior significantly. Besides, the sliding control needs the knowledge of mathematical model of the system with bounded uncertainties [4].

Reduced chattering may be achieved without sacrificing robust performance by combining the attractive features of fuzzy control with SMC. FL is a potent tool for controlling ill-defined or parameter-variant plants. By generalizing fuzzy rules, a FL controller can cope well with severe modelling mistakes. Fuzzy logic with excellent expressions for tuning can avoid the heavy computational burden [5].

DC motors are generally controlled by conventional PID controllers, since they can be designed and implemented easily, have minimal cost, low cost maintenance and effectiveness. It is important to know system's mathematical model or to make some experiments for tuning PID parameters. However, it has been well known that conventional PID controllers generally do not work well for non-linear applications, and especially complex systems that have no precise mathematical models [6].

To overcome these difficulties, various types of modified conventional PID controllers such as auto-tuning and adaptive PID controllers were developed lately. Also FLC can be used for this type of problems. When matching with the conventional controller, the main advantage of FL is that no mathematical modeling is required [7].

In this paper the combined solution we have proposed and designed a robust and efficient controller. Here we have used a PID outer loop in the control law then the gains of the sliding term and PID term are tuned on-line by a fuzzy system.

Computer simulations are performed to show the validity of the proposed system. The results obtained with SMC with changed gains are compared with the traditional PID controller and fuzzy sliding mode controller. The advantages and limitations of each method are discussed.

2. MODELLING AND SYSTEM DESCRIPTION [1]

A geared DC motor is used in a control system where an appreciable amount of shaft power is needed. The DC motors

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