

CLOSED LOOP SPEED REGULATION OF DC MOTOR USING PHASE CONTROLLED THYRISTOR CONVERTER

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ABSTRACT

This paper describes the speed regulation of DC Drive by closed loop method. Single quadrant, armature voltage control. Armature voltage control can regulate speed below base speed. DC drive is composed of fully controlled thyristor bridge converter, a control system, to control and minimize the speed errors. To achieve a good speed regulation cascade control structure is used. Inner fast current loop, which also limits the current to safer limit operation of motor and converter, and slower outer speed loop. PI controllers are used in current controller and speed controller to achieve a good dynamic response of the system with fast transient response, minimum overshoot and zero steady state error. The system is designed with respective subsystem models and transfer functions. Finally integrated prototype model is developed using MATLAB SIMULINK and simulated to achieve the desired results.

Keywords: – Speed control, DC Drive, PI controller, thyristor converter, armature control, cascade control

Introduction

In manufacturing industries the quality of a product is of high concern. A flexible, reliable, robust system is necessary to carry out the process. An electrical drive can be defined as a power conversion means characterized by its capability to efficiently convert electrical power from an electrical power source (voltage and current) into mechanical power (torque and speed) to control a mechanical load or process. Electrical drives form the link between the energy supply and the mechanical processes. Variable speed DC Drive consists of the power electronic converters (phase controlled thyristor), control unit for control and operation purposes. Although AC motors are mainly used in industry for high speed operation (over 2500 rpm) because they are smaller, lighter, less expensive, require virtually no maintenance comparing to their DC counterparts, the latter are still used. The reasons for this are that they exhibit wide speed range, good speed regulation, starting and accelerating torques in excess of 400% of rated, less complex control and usually less expensive drive. Inherently straight forward operating characteristics, flexible performance and efficiency encouraged the use of DC motors in many types of industrial drive application. Most multi-purpose production machines benefit from adjustable speed control, since frequently their speeds must change to optimize the machine process or adapt it to various tasks for improved product quality, production speed. Developments in the design of controlled rectifiers and DC-DC converters, has made the realization of control of DC motors easier. Today, DC motors are still used in several applications as in industrial production and processing of paper pulp, textile industries.

Speed Regulation of DC Motor

The speed regulation is achieved by varying the applied armature voltage. To supply a required DC voltage to the armature a variable speed DC drive is designed. Since it is voltage controlled, the field supply is kept constant. Closed loop method with cascade control structure is used. Cascade control is used to achieve fast rejection of disturbance before it propagates to the other parts of the loop. The overall closed-loop system is as shown below. The design of control loop starts from the innermost (fastest) current loop and proceeds to the slowest outer speed loop. The performance of the outer loop is dependent on the inner loop; therefore the tuning of the inner loop has to precede the design and tuning of the outer loop. By this the dynamics of the inner loop can be simplified and the impact of the outer loop on its performance could be reduced.

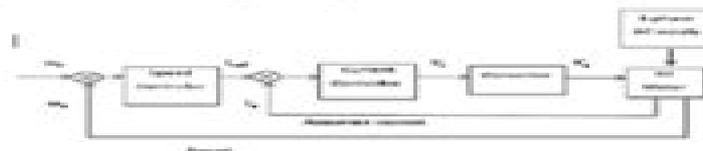


Figure 1- block diagram of closed loop speed control DC Drive

System design

The overall closed-loop system is as shown below. Accuracy and the dynamic responses are better in a closed loop system. In the closed loop system, acceleration and the deceleration of the motor can be controlled

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