Friction Compensation For High Precision Control of Servo Systems Using Adaptive Neural Network

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ABSTRACT

An adaptive neural network compensator for stick-slip friction phenomena in servo systems is proposed to supplement the traditionally available position and velocity control loops for precise motion control. The neural network compensator plays a role of canceling the effect of nonlinear slipping friction force. This enables the mechatronic systems more precise control and realistic design in the digital computer. It was confirmed that the control accuracy is more improved near zero velocity and the points of changing the moving direction through numerical simulation

1. INTRODUCTION

Stick-slip friction is natural resistance phenomena to relative motion between two contacting bodies in the mechatronic servo systems such as industrial robot arms and numerical control (NC) machine tools. It is commonly composed of Coulomb friction, static friction, and viscous frictions, etc., but it has highly nonlinear characteristics. In many motion control systems, this friction phenomenon becomes a dominant factor near zero velocity that prevents the high-precise control of the servo system because of its nonlinear nature and difficulties in handling effectively it and compensating adequately it with the linear feedback control system. In order to achieve high precision motion control, these frictions must be accurately compensated to cancel the effects in the real time control system.

Much work has been discussed in the literatures[1-3] in terms of formulating a friction model, identifying its parameters, and effectively compensating methods. But it is reported the difficulty in predicting and finding exact models because this phenomenon is discontinuous at zero velocity and depends on several nonlinear factors. Due to these reasons, most literatures have adopted unrealistic ways to get over this phenomenon. Even if some papers were reported to be successful, it has still questions to realize it in the traditional position and velocity control loop.

In our work, we approached to resolve this issue by the more realistic way to supplement compensator design to the traditional position and velocity controller. Using artificial neural network on the point that the neural network being able to implement in the digital computer has superior performance to approximate the nonlinear function and to be robust in the varying operating conditions. To demonstrate our proposal, the numerical simulation has been done for 1-DOF(one degree of freedom) X-Y table and the results have been compared with those of laboratory experiment on X-Y table system.

2. FRICTION MODEL

2.1 Industrial Mechatronic Servo System

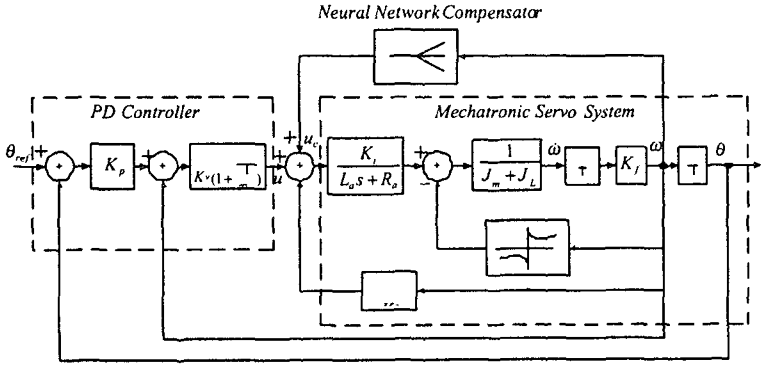

Fig.1 Block Diagram Of A Mechatronic Servo System