Chapter 5
Control Algorithm Development:
A Real Control Problem Example

INTRODUCTION

In this chapter, we will show a real life control design example. This real motion control example covers several steps of the entire control algorithm development process from the beginning to the end. This problem is to control the scan speeds of a scanner in a multifunction printer. A low quality, cheap direct current (DC) motor is used to move the scan bar. The reason for using this low quality motor is cost savings as it is common for product development. For higher scan resolutions, the scan speeds are very low. At these low scan speeds, disturbances due to torque ripples and friction in the motor begin to have a major impact on the speed response and disturbance rejection becomes challenging. To begin with the control algorithm design, we need a model of the plant or the dynamic system under control. Modelling is the first step of control design. Physics based models can be developed such as nonlinear or linear differential equations. In industrial control development, usually simple low order models at some operating points of the product are derived for control algorithm design and simulation in the design phase. If it is too difficult or too expensive to build a physics based model, system identification methods can be applied to identify a model from data. We will begin the example with an approach to identify motor parameters using a speed step test data. A disturbance observer design is presented to show how

DOI: 10.4018/978-1-5225-2303-1.ch005

disturbance can be estimated based on an observer using state space control techniques. This disturbance estimator in effect introduces notch filter actions at disturbance natural frequencies, where notch filter is a familiar method used by industrial engineers to deal with resonances in motion control. An online disturbance estimation and feedforward compensation scheme is also given after this, showing a simple and effective way to attenuate disturbances. This idea is extended in a combined feedforward and feedback implementation of disturbance estimation and compensation, which is the solution for the speed regulation problem we considered here. At the end, it is shown how we can identify the drive mechanism dynamics which also affects the speed response of the scan bar, and how including this drive dynamics can further improve the closed-loop control speed performance at the scan bar.

All approaches presented were developed by the author while working on scanner speed control problem. System identification, physical modeling, algorithm design, rapid prototyping and experimental testing were applied to develop the control solutions. This example shows that many skills are required for developing a successful control algorithm. It is hoped that this real control problem example gives readers some insight on how to solve a real world control problem and benefits their learning and careers.

SYSTEM IDENTIFICATION

DC motors have wide applications in industrial control systems because they are easy to control and model. For analytical control system design and optimization, sometimes, a precise model of the DC motor used in a control system may be needed. In this case, the values of the motor parameters given in the motor specifications for reference, usually provided by the motor manufacturer may not be considered precise enough, especially for cheaper DC motors which tend to have relatively large tolerances in their electrical and mechanical parameters. General system identification methods proposed by Ljung (1999), Unbehauen and Rao (1998), Franklin, Powell, and Workman (1990), Basilio and Moreira (2004) can be alied to DC motor model identification. In particular, various methods have been applied to DC motor parameter identification, i.e., Mamani, Becedas, Sira-Ramirez, and Feliu-Batlle (2007), Mamani, Becedas, and Feliu-Batlle (2008), used the algebraic identification method, Krneta, Antic, and Stojanoviv (2005) used the recursive least square method, Hadef and Mekideche (2009) applied the inverse theory, Ruderman, Krettek, Hoffman, and Betran (2008) used the

Related Content