AN EDUCATIONAL TOOL FOR PI CONTROL OF BRUSHLESS DC MOTORS UNDER DIFFERENT LOAD CONDITIONS

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Abstract

There are many electromechanical systems where it is important to precisely control their torque, speed, and position. Some of these, are elevators in high-rise buildings, mechanical robots in automated factories, pumps and compressors systems, harnessing of renewable energy resources such as wind-electric systems, clean transportation in the form of hybrid-electric and electric vehicles, biomedical applications such as heart pumps, and many others. In most of these applications, increasing efficiency requires producing maximum torque per ampere. It also requires controlling the electromagnetic toque, as quickly and as precisely as possible, where the load torque may change continuously. In any speed and position control application, torque is the fundamental variable that needs to be controlled. The ability to produce a step change in torque on command represents total control over the drives for high performance speed and position control. My attempt in this paper is to present an example of the modeling, analysis, and control of a kind of AC electric machines, brushless DC motor, as simply and concisely as possible. To do so, I have chosen a two-step approach: first, provide a "physical" picture without resorting to mathematical transformations for easy visualization, and then confirm this physics-based analysis mathematically. For discussion of all topics in this example and others like this, computer simulations are a necessity. For this purpose, I have chosen MATLAB/Simulink® for the following reasons: a student-version that is more than sufficient for our purposes is available at a very reasonable price, and it takes extremely short time to become proficient in its use. Moreover, this same software simplifies the development of a real-time controller of drives in the hardware laboratory for student experimentation. The purpose of this paper is to analyze brushless DC machines in a way that can be interfaced to well-known power electronic converters and controlled using the simplest control scheme, a single loop proportional-integral speed control, based on the principle of advanced conduction of phase current, which is used in this paper. The results of simulations in MATLAB/Simulink show that the chosen approach helps the students' skills in developing real time controllers of brushless DC drives demanding changeable patterns of their load profile.

Keywords: *BLDC, PI control, load condition, speed control, torque control.*