Ali, Warsame H., “Design and Digital Implementation of Proportional-Integral-Derivative Controller for Nonlinear Motors”

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This dissertation presents the design and implementation of digital Proportional-Integral-Derivative (PID) controller for nonlinear motors. A new methodology is presented for the PID controller parameters to be systematically developed through system state-feedback and controller state-forward Linear Quadratic Regulator (LQR) approach, such that satisfactory performance with guaranteed closed-loop stability is achieved.

To deal with modeling error and input saturation in the developed approach, an Internal Modeling Controller (IMC) structure is utilized, such that robustness is improved. The disturbance rejection is achieved based on a multi-objective observer, in which observation error is purposely retained and utilized in load disturbance compensation. This makes disturbance rejection tuning independent of the adjustment for speed command tracking, and the disturbance compensation is an integrated part of the controller output, such that reducing the chance of input or state saturation. The digital implementation is obtained based on the above-developed controller, such that the resulting mixed-signal system performance will closely match that of the motor simulations.

The developed method is implemented using dSPACE DSP system interfaced with linear and nonlinear motors driven by switching power converter. The experimental result confirms its effectiveness.