Design of trajectory tracking system for DC motors with uncertain time-varying inertial loads

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ABSTRACT
We considered the problem in which a DC motor was controlled to track a given trajectory when the corresponding driven load was associated with uncertain time-varying mass moment of inertia. With the existence of such inertia variation, the corresponding system matrix and input matrix of the control system were simultaneously uncertain and time-varying. Accordingly, stability of the control system could not be guaranteed by simply locating all the poles of the linearized model in the LHP at all time. Based on Lyapunov stability theorem, we came up with a robust PID controller design technique that yielded satisfactory results for this problem. Our robust PID controller was easy to implement, and guaranteed uniform input-to-state stability for the system. It appeared in our investigation on a large Maxxon DC motor that our controller allowed as high as 100% variation of equivalent inertia loading with respect to rotor inertia. We provided a tool to facilitate controller tuning so that the resulting control signal stayed within practical bounds, while achieving a satisfactory level of performance. By selecting an appropriate transmission ratio, our tracking control system could be employed in demanding applications such as independent joint control of robots, and spindle control of modern machining machines.