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SPEED CONTROLLER STRATEGIES FOR DISTRIBUTED REAL-TIME OPERATION OF A BRUSHLESS DC MOTOR VIA ETHERNET

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Investigations on adapting Ethernet for distributed Real-Time control of time critical systems is nowadays a hot research area all around the world especially in the automation industry. This paper initiates with an introduction to the problems encountered in closing the speed control loop of a Brushless DC motor via an Ethernet network, which introduces stochastic delays. Depending on the level of stochastic nature, there can be many control system solutions to the latter problems in this time delayed first order system. The delays are observed first with a Hub connected network configuration, where traffic from different nodes may collide in attempting to access the communication media i.e., Ethernet bus. Secondly, the configuration replaced with Switched Ethernet, considerably avoids such collisions through virtual circuits. Both configurations under various network traffic conditions reveal that the delays are long compared to the sampling interval, but varies within five samples from average, except for a very few number of round trips.

Two controller strategies are then experimented first in simulation in Matlab / SIMULINK™ environment and next in a test rig. The first strategy involves a simple Proportional Integral (PI) controller modified for a first order time delayed system. Four design methods are tried to find the most suitable method as all of them assume a constant delay, but the system time delay is stochastic. One of them proved to be successful both in tolerating the stochastic delay as well as in maintaining stability under torque disturbances.

Then the PI speed controller structure is replaced with the standard Smith Predictor structure, which highly depends on the estimated parameters in the system model. As a result, the system goes unstable even for a minor deviation in the actual delay from the model delay. Application of Coefficient Diagram Method, found in the literature, improved the Smith Predictor so that it tolerates model errors in time delay to a much greater extent. Finally performance of both controller structures in the context of distributed Real-Time speed control of a Brushless DC motor via Ethernet is compared.