NONLINEAR CONTROL AND ACTIVE DAMPING OF A FORCED-FEEDBACK METERING POPPET VALVE SYSTEM

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ABSTRACT

For a metering poppet valve which was developed at the University of Missouri (MU valve), the valve can be configured for performance at the cost of stability. It is desirable to achieve both performance and stability using electronic control. Presently, in the MU valve, the pilot poppet motion is damped by the flow of hydraulic fluid through a channel or orifice running through the poppet. In this research, it is proposed that the solenoid be used to provide damping (active damping) to the pilot poppet. The damping input signal to the solenoid is determined as a function of the pilot poppet velocity. In practice, the velocity is difficult to measure due to the MU valve's configuration and it is estimated according to the self-sensing actuator concept. Theoretical results demonstrated that a valve actuator could be designed with an emphasis on high speed performance while an electronic control system is used to damp unwanted oscillations. For flow control, several researchers have used feedback linearization to cancel part of a hydraulic system's nonlinearities in spool valves. In the case of the metering poppet valve, feedback linearization is an attractive approach since experimental studies have shown that poppet instabilities are caused by nonlinear mechanisms like flow forces. In this work, nonlinearities are cancelled in the input-output relationship of the metering poppet valve. The controller was shown to achieve robust tracking of a reference trajectory.