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Improving Pressure Valve Precision using Finite-time Prescribed Performance with Fractional-Order Proportional, Integral and Derivative Control

Mohd Iskandar Putra Azahar *and* ***Addie Irawan***
Faculty of Electrical & Electronics Engineering, Universiti Malaysia Pahang, 26600 Pekan, Pahang
**Corresponding Author*: iskandarputra1995@gmail.com, addieirawan@ump.edu.my

Abstract
The paper presents the improvement of precision control on pneumatic system pressure using Finite-time Prescribed Performance Control with the Fractional-Order Proportional, Integral, and Derivative (FOPID-FTPPC) control. The control strategy is proposed to overcome the nonlinearity produced by the pneumatic system in regulating the pressure on positioning operation. The study was conducted through several experiments with a 5/3-way pneumatic proportional valve that configured with pressure transducers as feedback responses. The study was done with two different types of common input trajectories: step and sinusoidal inputs. The proposed FOPID-FTPPC controller outperforms the FOPID controller by 26% in terms of minimizing the overshoot of the step input trajectory. On the other hand, the proposed controller exhibits significant performance with a sine wave input trajectory, and the advantage of its integration with FTCPPC frameworks allows it to achieve steady state performance even more quickly. The findings demonstrate that the proposed the proposed FOPID-FTPPC controller can regulate the pneumatic systems pressures while eliminating steady-state errors, fast response as well as reducing the overshoot.

Keyword: Pneumatic system; Prescribed performance control; Pressure control; Finite time.