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Design optimization, control and experimental characterization of flapper mechanism with amplified piezo actuator

Ihsan Burak Temelturk and **Melin Sahin**
Middle East Technical University, Turkey

Servovalves are critical sub components of hydraulic systems which are used in many fields such as aerospace and defense technologies. Conventional servovalves have torque motor which has a shortcoming of narrow bandwidth and long response time which result in a bulky behavior of the overall system. Usage piezoelectric actuator is a novel way to overcome this problem. In this study, design of a first stage flapper of a two stage servovalve involving a mechanically amplified piezo-stack actuator instead of a torque motor is done. In the design problem, flapper displacement and the force developed at the nozzle location are set as the design objectives. Thickness and the height of the flexure are the design variables regarding the flexure. Finite element method and mathematical modeling of piezo actuators and structures are utilized to build a model of the first stage of the servovalve with piezoelectric actuator. Design parameters of amplification mechanism of piezo actuator are verified by finite element analyses and experimental results. Dynamic behavior of flapper mechanism with piezo actuator is characterized using Bouc-Wen model and displacements of flapper is controlled and monitored with both laser displacement sensor and strain gage and also control methods with voltage amplifier are tested in Bouc-Wen model hysteresis compensator, close loop with PI controller and hybrid control in test setup. The hysteresis errors are compared with each others.

Biography

Ihsan Burak Temelturk has received his BS degree in Mechanical Engineering in 2012 and completed Master of Science degree from Aerospace Engineering Department in Middle East Technical University in Ankara, Turkey. He is currently a System Design Engineer in Turkey. His research interests include design, modeling and control of electromechanical systems. He has studied piezo materials, piezo actuators and its applications.

buraktemelturk@gmail.com

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