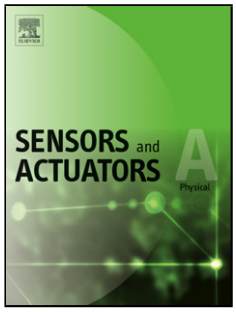

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Dynamic Modeling and Analysis of Stack Giant Magnetostrictive Actuator

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Highlight

- A novel GMA with linear arrayed permanent magnets is developed for modern electro hydraulic servo valve;
- A compound modeling method based on magnetic loop model and Biot-Savart Law is proposed to analyze the specific magnetic field of stack GMA;
- A multi-DOF dynamic model is established to describe the dynamic performance of SGMA;
- Both numeric simulation and experimentation are conducted to test the proposed model and the dynamic performance of SGMA.

Abstract

Since a bidirectional stroke is often required in the novel applications, an appropriate method to provide a sufficient bias field with minimum power and spare consumption is crucial to enhance the performance of giant magnetostrictive actuator (GMA). In this paper, a specific stack GMA (SGMA) is designed, which is distinguished by the alternatively arranged short giant magnetostrictive material (GMM) rods and permanent magnets (PMs). Due to the special structure, some peculiar properties need considering when the overall performance of SGMA is investigated. Therefore, this work concerns the dynamic modeling and analysis of SGMA. Firstly, the magnetic field is modeled through the loop analysis and the Biot-Savart Law. Then the dynamic J-A model and quadratic domain rotation model are employed to depict the strain distribution along the GMM rod. Moreover, a multi-DOF vibration model is set up to account for the dynamic properties of SGMA. Finally, a prototype is fabricated to verify the theoretical study. Simulation and experiment results prove that the proposed model is valid in dynamic analysis for SGMA and the actuator performs well when it is excited by different signals.