Design of a Magnetostrictive Actuator

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There is an increasing demand on precision linear stage because of advances in various technologies, especially in nanotechnology. The stage for the application to nanotechnology requires fast response, high precision, and no parasitic motion. Usually a piezoelectric actuator are used for actuating the stage. Although the piezoelctric actuator is popular, it has some disadvantages such as the use of high voltage, and the fatigue. To overcome these problems, this paper presents the development of the precision stage with a new actuator, i.e., a magnetostictive actuator. It can produce a higher force output, comparable displacement, much lower voltage, and no fatigue, compared with a piezoelectric actuator. The ampificaion of the resonable displacement is needed for the engineering application, and can be achieved by using a flexure guide mechniasm.

Flexure guide mechanism which adopts leaf-spring hinges must optimized assuming the output force of the actuator is known. A mathematical model for the stage is developed and simulated through the use of the finite element analysis (FEA). The natural frequency for the stage is estimated as 192.76Hz with the developed model, and 208.37Hz with the FEA, respectively. Also, the design parameters for the stage are optimized by using the FEA.

The optimized design parameters are used to make the stage monolithically, which is fabricated by using a wire EDM on an aluminum plate. The magnetostrictive actuator is characterized experimentally first, and then the stage actuated by the magnetostrictive actuator is characterized. The experimental results show that the magnetostrictive actuator has some level of hystersis, and that it produces 6 μm in displacement for 1.25 amperes of current. Also, the experimental results show that the maximum stroke of the stage reaches at the frequency of 200Hz. It means that this frequency is the natural frequency and that it agrees well with the estimated ones.

References

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