Multiphysics Simulation of an Ultrasonic Piezoelectric Motor

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Abstract

Operation in strong magnetic fields, vacuum or high precision positioning has often surpassed the limits of traditional actuators. Piezoelectric motors provide a suitable alternative in these applications where non-ferromagnetic based construction or low inertia may be required. We simulate and evaluate a model of an ultrasonic piezoelectric actuator. Piezoelectric simulations are inherently multi-physics; requiring both mechanical and electrical components. Ultrasonic piezoelectric motors consist of a stator with a bonded ceramic crystal and a rotor. Electrically driving the crystal through electrodes platted on its surface induce a vibration mode with a traveling wave that frictionally couples and torques the rotor. We first perform an eigenfrequency analysis of the stator structure in order to determine the resonant modes. We confirm the resonant modes with a frequency domain study. Then, we validate the motor performance through a time-domain simulation. We expect to use the results from the simulation to construct motors for driving MRI compatible surgical robots.