

High Power Dual Rotor Piezoelectric Motor Operating in Hybrid Longitudinal-Bending Mode

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Piezoelectric motors are a preferential type of machine used for precision driving because of the simple structural design, short response time, high resolution, etc. This type of motor also can be used for high-performance applications, however particular vibration modes of the stator must be excited, and high-stiffness contacting surfaces of both stator and rotor must be used.

Novel high power dual rotor piezoelectric motor was proposed. The stator of the motor has a ring shape and includes three trapezoid teeth located on the top and bottom surface of the ring by the angle of $2/3\pi$. In addition, six Langevin-type transducers are mounted in the axial direction of the ring and are located on both sides of the teeth. Finally, alumina oxide contacting spheres are fixed on the top and bottom surfaces of the teeth. Two disc-shaped rotors are preloaded from both sides of the ring.

The operation principle of the motor is based on the excitation of two different resonant vibration modes. The circumferential vibration mode of the ring, as well as the first bending vibrations of the teeth, are excited by employing the first longitudinal vibrations of the Langevin transducers. Two different excitation schemes can be used for motor driving i.e. two electric signals with shifted phases by π can be applied to achieve inertial type driving mode, while two harmonic signals with phases shifted by $\pi/2$ are used to excited traveling wave motion of the contacting spheres.

A numerical investigation of the piezoelectric motor was performed. Results of the simulation showed that elliptical trajectories of the contacting spheres can be obtained and dimensions of the stator can be optimized to increase amplitudes of the contact point vibrations. A prototype piezoelectric motor was made and an experimental study was performed. Results were compared and analyzed. Moreover, experimental investigation of dynamic characteristics has shown that the motor can provide a maximum rotation speed of 5.1 RPM and torque of 0.368 Nm while the harmonic voltage of 50 V was applied.

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