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A piezoelectric travelling wave ultrasonic motor based on the shear effect

Ultrasonic motors have been adopted in high precision applications such as in the robotics, automotive industry, medical devices and autofocus of camera lenses. They are characterized by compact size, low speed with high torque and zero backlash. Since the shear piezoelectric coupling factor and the shear piezoelectric constant are higher than for the other piezoelectric effects, a relative higher torque and a better efficiency are also attained.

Special attention is paid to the kinematics and the geometry of the motor parts and to characteristics that influence efficiency and torque. The stator is of disc-type, made of piezoceramics and radially polarized. It is modelled as an annular Reissner-Mindlin plate with piezoelectric terms. Rayleigh-Ritz discretization is used to obtain eigenfrequencies and eigenmodes of the stator plate. In the laboratory, measured eigenfrequencies of the free vibrations of the plate corroborate the numerical method. Particularly, the generation of travelling waves requests the excitation of two degenerated vibration modes. This requires a specific electrode configuration.

A suitable vibration mode is chosen, so that the energy losses through friction in the radial direction are minimized. The transmission of load from stator to rotor occurs through a ring of teeth over the stator. The kinetic energy of the teeth set is formulated and taken into account in the equations of motion. Additionally, the conditions for the symmetry of the stator are stated with respect to the disposition and the number of teeth. In the contact model, point contact with a rigid rotor is assumed.

The present model, which is characterized by a few degrees of freedom, is able to deliver relevant characteristics of the motor. Performance parameters (at steady state) can be calculated. It allows a systematical optimization of the motor with respect to its geometry, its size, the number and disposition of the teeth, and the electric excitation.

Biography

Ana Costa Conrado has completed her PhD from the Technische Universität Darmstadt and worked in the industry. She returned to academia as master student. Currently, she is working as a research software engineer at the University of Oslo and teaches programming for researchers.

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