

1. **SUBMIT TO:** Conference SS0S
2. **CONFERENCE TITLE:** Smart Structures and integrated Systems
3. **ABSTRACT TITLE:** Rotary Ultrasonic Motors Actuated By Traveling Flexural Waves,
CONF. CHAIR: Marc E. Regelbrugge, Lockheed Martin Palo Alto Advanced Technology Ctr.
4. **AUTHOR LISTING:** Y. Bar-Cohen^a, T. Bao^a, W. Grandia^b, and H. Loertscher^b

^aJet Propulsion Lab, California Inst. of Tech., Pasadena, CA, yosi@jpl.nasa.gov

^bQuality Material Inspection (QMI), Costa Mesa, CA 92627

5. **PRESENTATION:** Oral
6. **ABSTRACT:** Rotary ultrasonic motors (USMs) are being developed as actuators for potential operation of planetary manipulator arms, rovers as well as miniature spacecraft instruments and subsystems. The technology, which has emerged in commercial products, requires rigorous analytical tools for an effective design of such motors. Two analytical models were developed to examine the excitation of flexural plate wave traveling in a rotary piezoelectrically actuated motor, with one using annular finite elements. The models incorporate the details of the stator which include the teeth, piezoelectric crystals, stator geometry, etc. These models were used to predict the excitation frequency and modal response of the annular stator. Stators were fabricated using segmented piezoelectric crystals bonded with various sequences of polarization layouts. The theoretical predictions and the experimental corroboration showed a remarkable agreement. Parallel to this effort, the operation of USMS was tested at temperatures down to 120K and at pressure down to 16-mTorr vacuum. The motors showed capability to operate for several days at this harsh condition, where the full piezoelectric ring driven USM fails at the bondline. Moreover, USMS are being incorporated into a robotic arm and their practical operation is being tested.
7. **KEY WORDS:** Actuators, Active Materials, Piezoelectric Motors, Ultrasonic Motors, USM, Stators and Rotors, Modal Analysis
8. **BRIEF BIOGRAPHY:** Dr. Yoseph Bar-Cohen is the Principal investigator for NDE and Advanced Actuators at JPL, Pasadena, CA. He is developing ultrasonic NDE methods and systems, space-worthy high torque piezoelectric motors, electroactive polymeric muscle actuators, and high power ultrasonic techniques for medical applications. Dr. Bar-Cohen received his Ph. D. in physics (1979) from the Hebrew University at Jerusalem, Israel. He has been the pioneer in developing the leaky Lamb waves and ultrasonic polar backscattering. He is the author of more than 120 publications and holds many patents. He is an Adjunct Professor at the University of California, Los Angeles (UCLA) and a Fellow of the American Society of Nondestructive Testing.