Miniature Robotic Spacecraft for Inspecting Other Spacecraft

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A report discusses the Miniature Autonomous Extravehicular Robotic Camera (Mini AERCam) — a compact robotic spacecraft intended to be released from a larger spacecraft for exterior visual inspection of the larger spacecraft. The Mini AERCam is a successor to the AERCam Sprint — a prior miniature robotic inspection spacecraft that was demonstrated in a space-shuttle flight experiment in 1997. The prototype of the Mini AERCam is a demonstration unit having approximately the form and function of a flight system. The Mini AERCam is approximately spherical with a diameter of about 7.5 in. (≈19 cm) and a weight of about 10 lb (≈4.5 kg), yet it has significant additional capabilities, relative to the 14-in. (36-cm), 35-lb (16-kg) AERCam Sprint. The Mini AERCam includes miniaturized avionics, instrumentation, communications, navigation, imaging, power, and propulsion subsystems, including two digital video cameras and a high-resolution still camera. The Mini AERCam is designed for either remote piloting or supervised autonomous operations, including station keeping and point-to-point maneuvering. The prototype has been tested on an air-bearing table and in a hardware-in-the-loop orbital simulation of the dynamics of maneuvering in proximity to the International Space Station.

This work was done by Steven Fredrickson, Larry Abbott, Steve Duran, Robert Goode, Nathan Howard, David Jochim, Steve Rickman, Tim Straube, Bill Studak, Jennifer Wagenknecht, Matthew Lemke, Randall Wade, Scott Wheeler, and Clinton Baggerman of **Johnson Space Center**. *Further information is contained in a TSP (see page 1).MSC-23669*

Miniature Ring-Shaped Peristaltic Pump

Piezoelectrically excited fluid-transport volumes travel around a ring.

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An experimental miniature peristaltic pump exploits piezoelectrically excited flexural waves that travel around a ring: A fluid is carried in the containers formed in the valleys between the peaks of the flexural waves (see Figure 1). The basic action of this pump is similar to that described in "Piezoelectric Flexural-Traveling-Wave Pumps" (NPO-19737), *NASA Tech Briefs*, Vol. 21, No. 4 (April 1997), page 66.

What sets the present pump apart from other pumps that exploit piezoelectrically excited flexural waves is the ring shape, which makes it possible to take advantage of some of the desirable characteristics of previously developed piezoelectric rotary motors. A major advantage of the circular (in contradistinction to a straight-line) wave path is that the flexural waves do not come to a stop and, instead, keep propagating around the ring. Hence, a significant portion of the excitation energy supplied during each cycle is reused during the next cycle, with the result that the pump operates more effectively than it otherwise would.

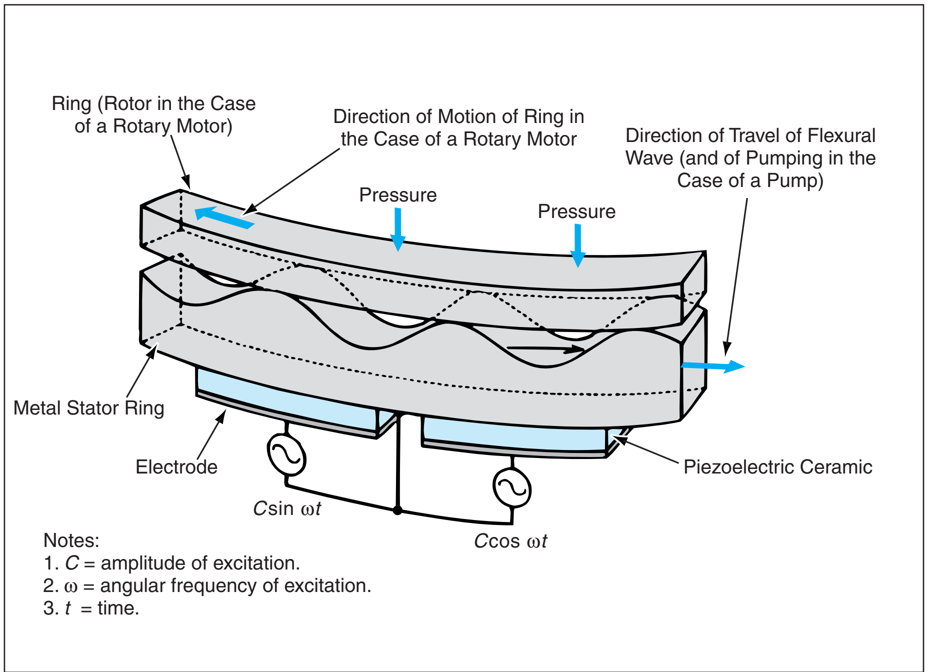

Figure 1. **Traveling Flexural Waves** similar to those in a piezoelectric rotary motor are exploited for pumping. Fluid is carried around a circle in the troughs of the waves.

The principal components of this pump (see Figure 2) include a cover and segmented-ring piezoelectric actuator bonded to one face of a brass ring. The other face of the brass ring is pressed against the cover and against silicone rubber seals that protrude slightly from grooves in the cover. The protrusion is sufficient to maintain sealing at the maximum flexural-wave amplitude expected to occur during operation of the pump. The pattern of grooves and seals is chosen, in conjunction with the pattern of inlet and outlet holes in the