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Design and manufacture of a piezoelectric motor based on unimorph arms

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ABSTRACT

For motors at small scales, on the order of a millimeter to a centimeter, the torque that can be developed is of interest as it mitigates the need for gears, which are difficult to manufacture and integrate at small scales. A number of fabrication and actuation challenges also occur at this scale. To address these challenges, one fabrication methodology that stands out is that of ultraviolet laser micromachining. For the challenge of actuation, piezoelectric materials represent one possible solution as they are materials that strain when an electric field is applied across them. At small scales in particular, actuation via the piezoelectric effect becomes favourable. This research revisits a previous design of a piezoelectric motor based on multiple unimorph arms, where the arms are a single piezoelectric slab bonded to a passive layer. In contrast to conventional traveling wave piezoelectric motors, which require relatively complex circuitry, high drive frequencies, and segmented piezoelectrics to create the traveling wave that drives them, the unimorph based piezoelectric motor is simpler to construct and requires only a single drive source at a lower frequency. In addition, by varying the drive frequency, polarity, and flatspring prestress, bidirectional motion has now been shown to be possible for this type of motor. The piezoelectric motor has been designed to facilitate fabrication via planar ultraviolet laser micromachining at low cost. In this work, the design and modeling are presented along with the prototype motor.