High Speed Biaxial Piezoelectric MEMS Micromirror with Varifocal Tunability

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Abstract: MEMS micromirrors have a wide variety of applications in optics for imaging in microscopy and Light Detection And Ranging (LiDAR) as well as for creating images in augmented/virtual reality systems. These devices typically operate with limited speeds giving either low frame-rate or low-density images that cannot meet higher image resolutions at a reasonable refresh speed (>30Hz). Moreover, extra overhead on the optical system may be required to focus into or defocus out of a sample for imaging, or to focus an image onto a plane for image generation. Here, a single-device, doubly-resonant MEMS mirror featuring scanning speeds of 24.1kHz and 25.8kHz is presented. The MEMS mirror has a mirror plate size of 0.8mm and utilizes a piezoelectric AlN layer for actuation, with the overall size of the mirror footprint including the actuators being 2.5x2.5mm. The mirror plate itself also contains an AlN layer which is used for varying the device curvature, offering a change in curvature ranging from $0m^{-1}$ to $16m^{-1}$ at microsecond settling speeds. Measurements on the mechanical and optical performance were performed. This device is the fastest 2D scanner that also features varifocal tuning.