Multi-spectral MEMS Scanner based dual-axis microendoscope

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Abstract

MEMS based microendoscopes have become important imaging tools for early cancer diagnosis and precise tumor resection. Due to various technical challenges, few microendoscopes have been translated to clinics or applied to human patients. Through synergistic collaborations, we have developed novel MEMS scanner enabled microendoscopic multispectral (640nm to 780nm) three- dimensional dual-axis confocal fluorescent imaging system for translational applications, including early cancer detection and staging on colorectal cancer, molecular imaging guided surgical navigation on head and neck cancer. Based on dual-axis confocal microscopic architecture, we have miniaturized the imaging system with compact form-factor by integrating micro-optics and a patterned gold coated MEMS scanners, which have been custom-made and mass-produced in the nanofabrication foundry. The metal coating of the scanning mirror provides over 80% high reflectivity over near infra-red range. Both axes of the MEMS scanner could perform large tilting angle (> 6 degrees mechanical scan angle) at DC and resonant mode. By advanced computational imaging approach, we have achieved real-time cross-sectional imaging in either raster or lissajous pattern scanning with fast frame rate (> 10 Hz) with large field-of-view (> 600 microns). Advanced real-time mosaicing algorithm has been developed to achieve broader view in millimeter scale. By utilizing molecular contrast probes conjugated with fluorescence dye, we have successfully demonstrated multi-spectral *ex-vivo* and *in-vivo* imaging on small animal tumor models and human tissue specimens, aimed for both early cancer detection and molecular imaging guided surgical navigation.