Optical MEMS Devices

Numerous MEMS mirrors have been developed for displays and optical communications. However, there exist a few limitations for bioimaging:
1. High driving voltage (~100V), which raises safety concern
2. Small rotation angle (<30°), resulting in low imaging efficiency
3. Relatively small aperture size (~0.5mm), resulting in low image resolution
4. Small linear displacement (<45μm), resulting in low imaging depth for confocal imaging
5. Limited degree-of-freedom (DOF), Multiple DOF desired

Our Solutions

1. Driving Voltage: < 20V, lowest among devices with similar scanning range
2. Angular rotation is compensated by two bimorphs with the same length but calculated lengths, lateral shift is also diminished with the directional reciprocity

Optical Bioimaging Applications

Optical biopsy provides high-resolution, cross-sectional imaging of tissue non-invasively. There are several optical biopsy techniques including optical coherence tomography (OCT), nonlinear optical (NLO) imaging and confocal imaging.

1. MEMS Endoscopic OCT Imaging — Application of 1-D scanning micro mirror
   Collaborator: Dr. Pan of SUNY Stony Brook
   - Large scanning angle
   - Fast scanning speed
   - Low operating voltage
   - High resolution
   - Small size

2. Nonlinear Optical Imaging — Application of 2-D scanning micro mirror
   Collaborator: Dr. Gu of Swinburne University of Technology
   - Two-Photon Excitation Fluorescence Imaging
   - Second Harmonic Generation Microscopy
   - Imaging Resolution: ~1 μm

3. Confocal Microscopic Imaging — Application of LVD / LSF-LVD mirror
   - Single mode fiber point detection
   - Axial scanning lens
   - Non invasive
   - Axial Resolution: ~1 μm

Optical MEMS Devices and Their Applications in Optical Biomedical Imaging

Optical Biomedical Imaging

- Much higher resolutions than ultrasound imaging, so early cancer detection possible
- Much safer and much lower cost than CT and MRI, leading to affordable cancer screening to save millions of lives
- Noninvasive or minimally invasive imaging, enabling real-time surgery monitoring to significantly reduce mortality
- But still bulky and slow, limiting their applications in internal organ where most of cancers occur
- Our solution: The small size and high speed of MEMS devices — Miniature Catheters for in vivo Endoscopic Imaging

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