The Static and Dynamic Behavior of MEMS Scanners

Subject: Optik
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A new generation of MEMS scanners facilitate fast optical beam steering across two axes in a quasi-static mode. The device can be operated over a wide bandwidth starting from DC up to a thousand Hertz. This broadband capability allows nearly arbitrary waveforms such as vector graphics and point-to-point step scanning. This opens new perspectives for OCT scanning patterns. The aim of this thesis is to analyze the scanner behavior and identify the transfer function. 1

Introduction
Micro-Electro-Mechanical-Systems (MEMS) are micro-devices or systems combining electro-mechanical components batch-fabricated using micromachining techniques. MEMS scanner are deflectable mirrors which enable a laser beam steering (figure 1). Until recently, the motion of MEMS scanners was limited to narrowband, sinusoidal trajectories by their operation near the resonant frequency. The combination of a resonant axis with a quasi-static axis allowed only a raster-scan trajectory. The newer generation of MEMS scanners provide two quasi-static axis that can be operated over a wide bandwidth of frequencies. This broadband capability allows nearly arbitrary waveforms such as vector graphics, constant velocity line scanning and point-to-point step scanning. This opens new perspectives for OCT scanning patterns. However, the smaller dynamics causes distortion of the scan geometry.

Goal
The goal of this thesis is to create a measurement setup to analyze the static and dynamic behavior of a quasi-static MEMS scanner in order to characterize the scan geometry and to identify the transfer function of the system. Moreover, a demo application has to be developed with the intention to show the functionality of the MEMS mirror.

Implementation
The measurement setup (figure 2) consists of a IR laser (835 nm), a 2D quasi-static MEMS scanner and a position sensitive detector (PSD). The mirror is controlled in open-loop mode by a LabView program, in which the trajectory geometry, the filter parameters and the frequency can be set. The mirror position in function of time is tracked with a position sensing detector and read-out with another LabView program.

Results
The time response and the frequency response have been tested. When driven by step signal, the overshoot of the mirror increases with the increase of the amplitude and the increase of the low-pass filter cut-off frequency (6th Order Bessel). The behavior of the micromirror correlates with a second order mass-spring-damper system.

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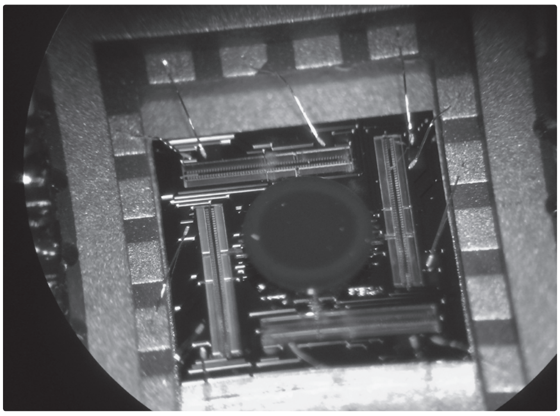

Figure 1: MEMS scanner

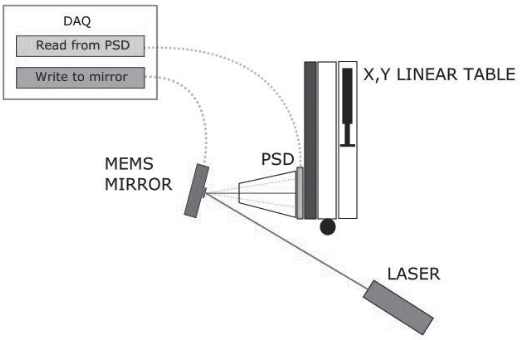

Figure 2: Measurement setup