UNIVERSITÄT ZU LÜBECK

TECHNISCHE HOCHSCHULE LÜBECK

Master thesis

Topic: Development of a beam scanning system based on a brushless DC motor for MHz-Optical Coherence Tomography

Summary:

Optical Coherence Tomography (OCT) is an imaging modality with a wide range of applications in medicine due to its high resolution and non-invasiveness. Enhancing the imaging speed of OCT is valuable for clinical applications as it enables faster scanning of large areas, minimizing motion artifacts due to patient movement, and displaying dynamic processes in real time. Up to date, imaging rates of up to 13 MHz can be achieved in a swept-source OCT system when utilizing a Fourier Domain Mode Locking (FDML) laser.

To traverse the beam over a sample, galvanometric scanners are typically used. They present the limiting factor for image acquisition speed when using fast swept sources. Thus, information backscattered by the sample may be oversampled. Galvanometric scanners not only limit the image acquisition speed, but also the angular field of view (AFOV) of the scanned area. Therefore, a novel approach based on a BLDC motor is adopted to achieve an AFOV that surpasses the capabilities of galvanometric scanning systems regarding their scanning angle.

In this thesis, a line scanner was developed that rotates 360° with a frequency of 1 kHz. The custom-built scanner consists of a sensorless BLDC motor, a 3D printed mirror mount, and a planar mirror. A test series with different motors and motor drivers was conducted to find a configuration that allows for timing jitter below the acquisition time of one A-Scan. The final configuration employed in the scanner exhibits a timing jitter of 140 ns at 926 Hz. For synchronization with the FDML laser, a trigger was derived from the back electromotive force (BEMF) of the motor.

To enhance the scanning frequency capabilities of the scanner, a multi-beam scanning setup capable of switching between four beam paths within one rotation was developed. By adequate angular placement of four collimators around the scanner, a 37.4° AFOV with telecentric scanning is achieved for each collimator. The multi-beam scanning setup is evaluated by *in-vivo* skin imaging with a 3.2 MHz FDML laser.

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