Gapped Spectrum OCT

Degree programme: BSc in Micro- and Medical Technology | Specialisation: Optics and Photonics
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The axial resolution of an optical coherence tomography device is defined by the spectral width of its laser source. To separate neighbouring layers in a sample a high resolution is needed, to reach this a broadband laser with a spectral width of several 100 nm comes into usage.

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Purpose

The design of spectrometer, which can process such a large bandwidth are complex and difficult to realize. In this case an approach which divides the spectrometer beam after the transmission grating and directs the two rays onto independent line cameras can potentially improve the performance of the spectrometer and therefore also the axial resolution of the OCT.

Methodology

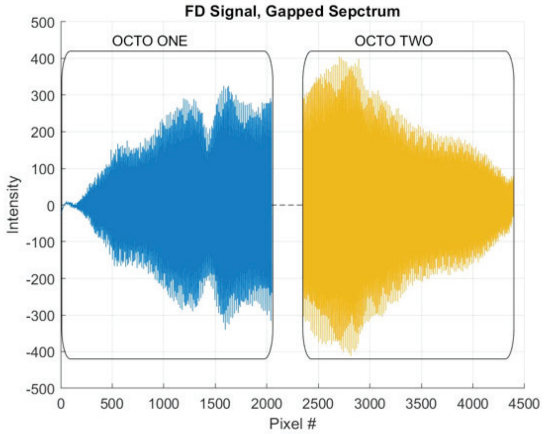
Given the idea of this approach, there were two objectives. Firstly, to develop a spectrometer concept based on the two independent line cameras. Therefore, a concept study was carried out and a final concept designed as a 3D model. Secondly, the MATLAB framework of the "optolab" research group had to be redesigned to be able to process two individual frequency domain signals from the line cameras and concatenate them.

Concept

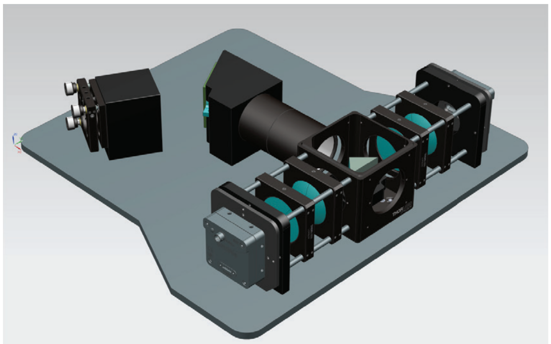
The final concept possesses the main body of a conventional spectrometer. At the location where usually the line camera is placed, the beam is divided by a knife-edge right angle prism mirror. The objective here is to minimize the loss of light in the middle of the beam. The separated rays are then refocused onto the individual line cameras.
The redesigned MATLAB Framework processes the two FD signals from the line cameras first individually, applies filter functions such as Background compensation, DC removal and windowing. In a second step the two FD signals are concatenated to one larger FD signal. Key to the concatenation is the known number of missing pixels between the signals (gap), this allows to reach a satisfying alignment. After the concatenation, the signal is transformed to the spatial domain via the Fourier Transformation.

Findings

The newly designed spectrometer shows great potential to separate the beam without an essential loss of light in the gap in the middle of the beam. In addition is the refocusing nearly on the same standard as the focusing of a single line camera spectrometer. The MATLAB framework is laid out for the gapped spectrum approach and it processed the artificial and real test files at the same rate as conventional OCT files. The interim results are very promising. The next state of the project, the construction of the spectrometer, is ready to be launched.



Concatenation of the Frequency Domain signal of the line cameras: OCTO ONE and OCTO TWO



CAD Model of the Gapped Spectrometer application