OCT Line Camera Comparison

Degree programme: BSc in Micro- and Medical Technology | Specialisation: Optics and Photonics
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Optical Coherence Tomography (OCT) is a non-invasive image acquisition technology based on the principle of interferences of broad band infrared light. In this project, a Spectral Domain OCT (SD-OCT) module was developed, to which two different cameras were connected for comparison purposes.

Introduction

On the current market for OCT components, the line scan camera Octoplus from e2v has prevailed. Today, this camera is unrivalled in performance. Since fall 2021 a competing product from Hamamatsu, called C15821 is on the market. In this project, a SD-OCT shall be developed which is based on a Superluminescent Light Emitting Diode (SLED) source with a central wavelength of 832.5 nm and a bandwidth at Full Width Half Maximum (FWHM) of 50 nm.
The light source is coupled in an optical fiber and directed into the interferometer, where it is divided into two equal parts. One part of the light goes into the reference arm, which has a known length, and the other into the sample arm, in which the object to be scanned is inserted. The combined signal from the two arms is sent to a spectrometer. Each pixel of the spectrometer sees a different wavelength, so the system consists of a high number - 2048 in our case- of parallel wavelength shifted interferometers. A depth scan, called A-scan is achieved by applying Fourier transform to the spectrometer output signal. 3D scan of the object (B-scan and C-scan) is achieved by scanning with a galvo mirror.

Goals

The aim is to compare the characteristics of the two cameras. The project steps are:

- Assembly and optimal alignment of a SD-OCT with prefabricated elements and the Octoplus camera.
- Detailed characterization of the OCT performance of the device
- Design of an adapter for the C15821 camera. Integration of the camera in the LabView framework and identical characterization for comparison purpose.
- Develop a simple system to measure the non-linearity of the cameras.
- Comparison of the two cameras on sample measurements.

Methods

The tomogram of the object is achieved with the OCT post processing implemented in the programming language 'LabView'. The steps of signal processing are:

- DC Removal: DC-Offset removed from the signal.
- Resampling: The spectrum is non-equidistant sampled in wavenumber. The resampling procedure achieves a signal with equidistant sampling in the wavenumber. This is the prerequisite for the following FFT.
- Dispersion Compensation: Due to the wavelength dependency of the two optical paths the interference signal will be chirped. This phenomenon deteriorates the axial resolution. Therefore, a mathematically compensation is necessary.

Results

Both cameras have a maximal sensitivity of 102 dB. Figure 1 shows the influence of technology in an OCT measurement (Octoplus: CMOS, HAMATSU: CCD). The CMOS camera shows a slight non-linear optical power to signal behaviour, resulting in a ghost peak at his first harmornic position.

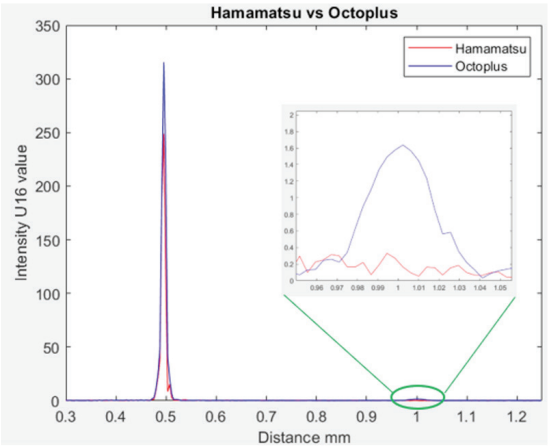

Fig. 1 Comparison of the Point Spread Function. Inlet: the "ghost peak" due to the non-linearity of the Octoplus camera.

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