

Balanced Detection Common-Path Optical Coherence Tomography with Angiography Modality

Degree programme : BSc in Micro- and Medical Technology

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To improve safety during endoscopic brain surgery, a Common-Path Optical Coherence Tomography system is integrated into the probe to provide real-time tomographic imaging. This thesis investigates methods to enhance the system's sensitivity using balanced detection. It also explores angiographic capability to visualize and avoid damage to blood vessels.

Context

Brain surgery is a high-risk procedure requiring precise navigation and extensive pre-operative planning. Traditionally, surgeons rely on static pre-operative imaging, which does not reflect real-time brain dynamics during surgery. To address this limitation, Clee Medical has developed an endoscope equipped with a Swept-Source Common-Path Optical Coherence Tomography (SS-CP-OCT) system.

Goal

This thesis aims to investigate methods of enhancing the system's signal-to-noise ratio (SNR) and to test the potential of OCT-based angiography for avoiding damage to blood vessels.

Methods

OCT utilises interference patterns generated by a swept-wavelength laser source. In CP-OCT, interference occurs between multiple backscattering events in the measurement arm. While this configuration is compact, it has a limited dynamic range and is susceptible to common-mode noise due to the spectral function of the source.

In a balanced detection CP-OCT setup, a beam splitter diverts a small portion of light from the source. This light is then recombined with the measurement arm in a balanced detector (see Fig. 1).

Results and Discussion

Balanced detection enables higher optical power to be used without saturating the detector, thereby improving the isolation of the interference signal and, under these circumstances, enhancing the SNR. However, common-mode noise suppression is negligible.

Conclusion

Balanced detection in SS-CP-OCT improves image contrast by extending the detectable signal range.



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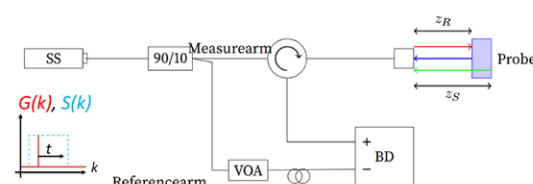


Fig. 1: Common-Path OCT with Balanced Detection.

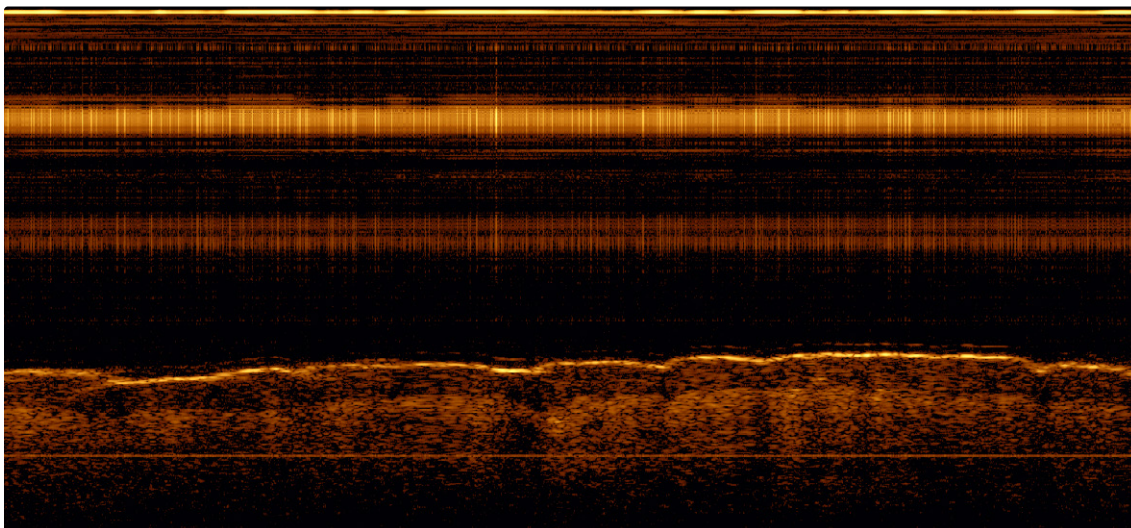


Fig. 2: This is an OCT image of a finger taken with the Clee Medical Probe with a Balanced Detection Common-Path OCT.