En-face OCT microscope at 1060 nm wavelength

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We present an OCT microscope systems, which implements a highly efficient power configuration, using a broadband laser source centred at 1060 nm wavelength. The configuration consists in an optical circulator and at least two couplers in a symmetric arrangement for the object and reference arm. The OCT microscope system is driven by a broadband light source (Multiwave Photonics) centred on 1060 nm. The OCT microscope systems are based on Mack-Zennder interferometer configurations. Each arm contains a fibre acousto-optic modulator. One of fibre acousto optic modulator is driven at a fixed frequency and the other via an RF Function Generation. In this way, the carrier frequency can be conveniently changed in the range 100 kHz to 1.5 MHz. The circulator is placed in the sample arm. Light retroreflected by the sample is sent to a balanced coupler where it interferes with the reference beam. The result is photodetected using two photodetectors followed by a differential amplifier. We acquired optical coherence tomography *en-face* images as well as cross section images from drosofila melanogaster in second larval stage. The acquisition speed was 1 Hz-frame rate using an InGaAs balance detector.

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Introduction

-A microscope system has been devised which implements a dual channel OCT and confocal microscope. The configuration is driven by a novel broadband fibre source centred at 1060 nm wavelength (Multiwave Photonics). The dual channel configuration has been designed and constructed to acquire live images from scattering biological samples

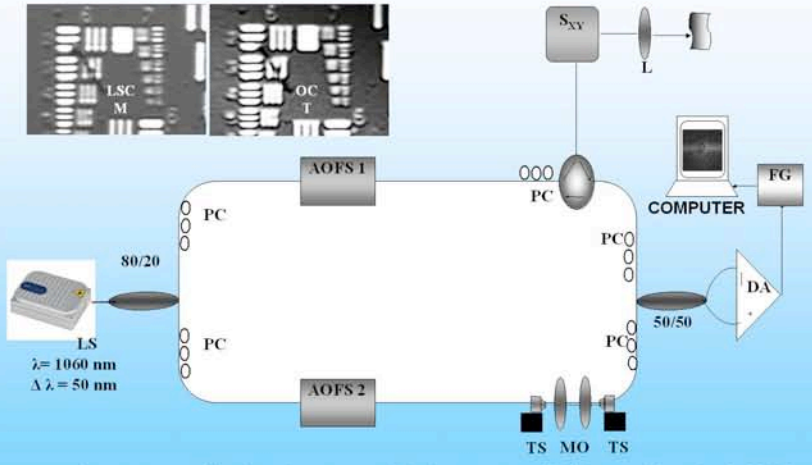
-The configuration consists in an optical circulator and at least two couplers in a symmetric arrangement for the object and reference arm

-The OCT channel microscope is based on a Mach-Zehnder interferometer configuration. The photodetector unit is provided with a summator circuit and a high gain amplifier. When the reference ram is blocked, a second channel in the frame grabber display the confocal microscopy channel image. Such two image of the USAF chart are shon on the right.

-Each arm of the interferometer contains an in- fibre acousto-optic modulator. One of the in-fibre acousto optic modulator is driven at a fixed frequency of 40 MHz and the other via an RF Function Generation, with adjustable frequency. In this way, the carrier frequency can be conveniently changed in the range 100 kHz to 1.5 MHz.

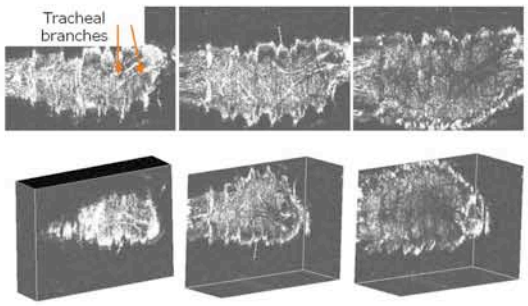
- Light retroreflected by the sample is sent to a balanced coupler where it interferes with the reference beam. The interference signal is photodetected using two photodetectors followed by a differential amplifier.

Schematic diagram of the system



Components of the imaging system: LS: Laser source (Multiwave Photonics); 80/20: coupler, 50/50- couplers; PC: polarisation controller; I: isolator; AOFS:- acousto-optic frequency shifter; TS: 3D translation stages, MO: X10 microscope objectives; FG: frame grabber.

En-face OCT images from Drosophila Melanogaster larval stage (instar3)

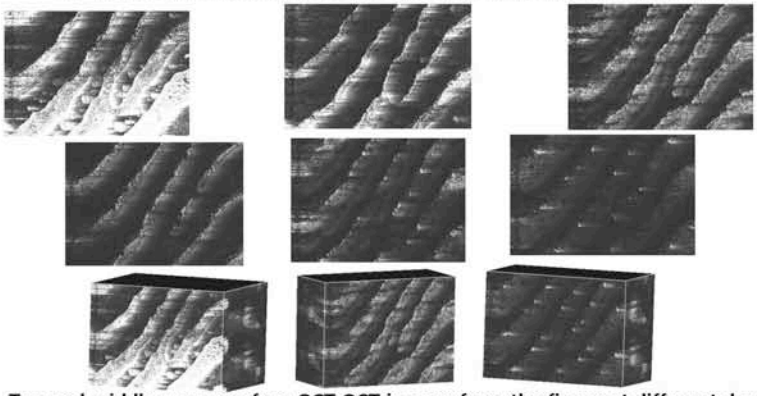


Top raw: En-face OCT images from different depths.

Bottom raw: 3D images.

The size of the images was 2.15 x 1.1 mm (frequency of the sifbal driving the horizontal and vertical scanners were fx=700 Hz, respectively fy=1.69 Hz) The depth range in the 3D images is 700µm

En-face OCT images collected from a human volunteer finger



Top and middle raws: en-face OCT OCT images from the finger at different depths.

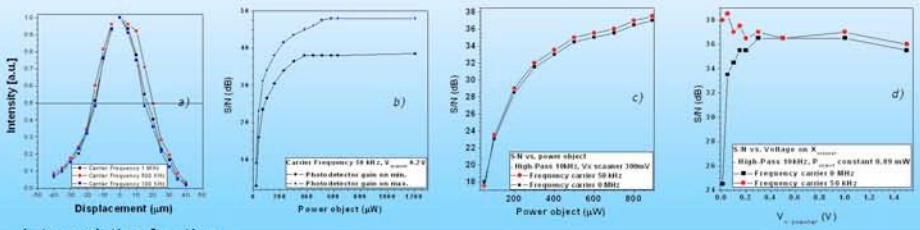
Bottom raw: 3D images, 2 mm depth range

The size of the images is: 3 x 2 mm, l frequency of the driving signal of the horisontal scanner, fx=700 Hz, frequency of the driving signal of the vertical scanner fy=1.69 Hz)

Characteristics of the system

- The graph a) shows the axial resolution of the interferometer, 30 microns.

- Diagrams b), c) shows the signal to noise ratio versus power from object for different photodetector amplification(a), for different carrier signal (b) and diagram (d) represents the signal to noise ratio versus
voltage applied to the X scanner



Autocorelation function of the system

Conclusions

--*En-face* optical coherence tomography images as well as cross section images from drosophila melanogaster in second larval stage were achieved at 1 Hz frame rate;

--En-face OCT images can be assembled to display 3D views to explore the volume of the embryos

-- At this wavelength, good penetration is achievable, of up to 2 mm in the embryo structure.

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