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OPTICAL COHERENCE TOMOGRAPHY

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ABSTRACT

This explains the state the art optical coherence tomography as efficient diagnostic imaging tool biomedical applications. It review the basic theory and modes of operation together with its applications and limitations. It examines the various kind of instruments, which are employed whole apparatus, addition to discussion on hardware and software methods to combat the sources of error. Optical coherence tomography is a recent technology that has gained momentum the medical and research fields. Its use and manipulation light to view live tissues within the body in real time is a suited to a variety of fields in the medical profession. Unlike a other medical imaging techniques, optical coherence tomography has better resolution, depth in penetration, quality. Although optical coherence tomography was a initially geared towards a ophthalmology, it had now expanded to many other fields in medicine. Through, new technological advancements, the OCT had increasingly improving its quality and resolution of imaging.

1. INTRODUCTION

Optical coherence tomography (OCT) is a fundamentally new type of optical imaging modality. OCT performs high-resolution, cross-sectional tomographic imaging of the internal microstructure in materials and biologic systems by measuring backscattered or back reflected light. OCT images are two-dimensional data sets which represent the optical backscattering in a cross-sectional plane through the tissue. Image resolutions of 1 to 15 µm can be achieved one to two orders of magnitude higher than conventional ultrasound. Imaging can be performed in situ and in real time. The unique features of this technology enable a broad range of research and clinical applications. This review article provides an overview of OCT technology, its background, and its potential biomedical and clinical applications. OCT, imaging the internal cross-sectional microstructure of tissues using measurements of optical backscattering or back reflection, was first demonstrated in 1991 . OCT imaging was performed in vitro in the human retina and in atherosclerotic plaque as examples of imaging in transparent, weakly scattering media and nontransparent, highly scattering media. OCT was initially applied for imaging in the eye and, to date, OCT has had the largest clinical impact in ophthalmology. The first in vivo tomograms of the human optic disc and macula were demonstrated in 1993 . OCT enables the noncontact, noninvasive imaging of the anterior eye as well as imaging of morphologic features of the human retina including the

Imaging studies have also been performed in vitro to investigate applications in dermatology, gastroenterology, urology, gynecology, surgery, neurosurgery, and rheumatology where conventional biopsy has an unacceptably high false negative rate because of sampling errors. For guidance of surgical interventional procedures. In this manuscript, we review the fundamental concepts of OCT technology and discuss potential applications to biomedical research and clinical medicine on Earth's surface.

A satellite could be illuminated over 99% of the time as it is always solar noon in space and full sun, and be in Earth's shadow a maximum of only 72 minutes per night at the spring and fall equinoxes at local midnight. Orbiting satellites can be exposed to a constantly high degree of solar radiation, generally for 24 hours per day, whereas earth surface solar panels currently collect power for an average of 29% of the day.

Power can be quickly redirected directly to areas that need it most. A collecting satellite can direct power on demand to different surface locations based on geographical base load or peak load power needs. Typical contracts would be for base load, continuous power, since peaking power is ephemeral.

With very large scale implementations, especially at lower altitudes, it potentially can reduce incoming solar radiation reaching earth's surface. This would be desirable for counteracting the effects of global warming.

2. METHODOLOGY

OCT imaging is somewhat analogous to ultrasound B mode imaging except that it uses light instead of sound. Because of the analogy between OCT and ultrasound, it is helpful to begin by considering the factors which govern OCT imaging compared to ultrasound imaging. There are several different embodiments of OCT, but in essence OCT performs imaging by measuring the echo time delay and intensity of backscattered or back reflected light from internal microstructure in materials or tissues. OCT images are a two- dimensional or three- dimensional data set which represent differences in optical backscattering or back reflection in a cross- sectional plane or volume.

3. LITERATURE REVIEW

Optical coherence tomography (OCT) is an emerging technology for performing high-resolution cross-sectional imaging. OCT is analogous to ultrasound imaging, except that it uses light instead of sound. OCT can provide cross-sectional images of tissue structure on the micron scale in situ and in real time. Using OCT in combination with catheters and endoscopes enables high resolution intraluminal imaging of organ systems. OCT can function as a type of optical biopsy and is a powerful imaging technology for medical diagnostics because unlike conventional histopathology which requires removal of a tissue specimen and processing for microscopic examination, OCT can provide images of tissue in situ and in real time. OCT can be used where standard excisional biopsy is hazardous or impossible we review OCT technology and describe its potential biomedical and clinical applications.

4. TECHNOLOGIES

(a) Fourier-domain OCT using quadrature detection device:

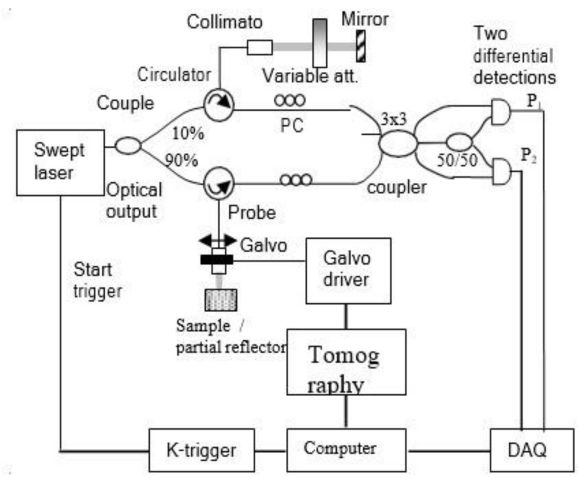

Fig 1: Fourier-domain quadrature detection OCT.

The first and second items are considered as DC components, the third item is the reconstructed tomography, and the last one is the mirror version of the tomography. shows the output. In which two DC components are removed, two mirrored images are overlapped . To completely remove the mirror image, we have introduced Fourier-domain quadrature detection OCT system. By introducing a 3x3 coupler and two deferential detectors, channel P1 and P2 can produce two outputs with a -/2 phase shift

(b) Fabrication of ultra small fibre probe:

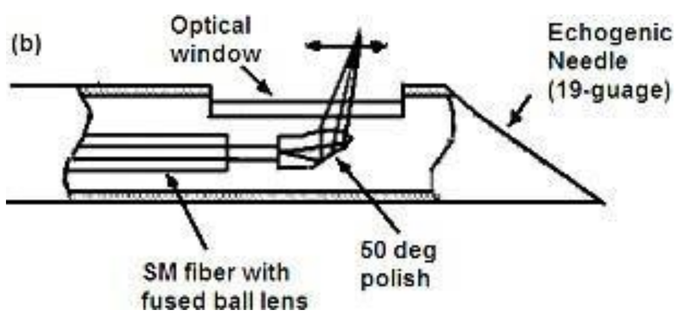

Fig 2: BALL lensed probe.

Unique technology and tools have been developed to fabricate the fiber probe for in vivo OCT imaging, including a GRIN or BALL lensed fiber tip, as well as linear scanning mechanism. The design specifications for those probes are: probe diameter: 125-250 µm; working distance: 0.4 -1.2 mm; depth of field: 0.3 – 1.5 mm; spot size: 10 – 25 µm. These probes have been successfully used to our some medical applications.

(c) Swept source full-field optical coherence microscopy:

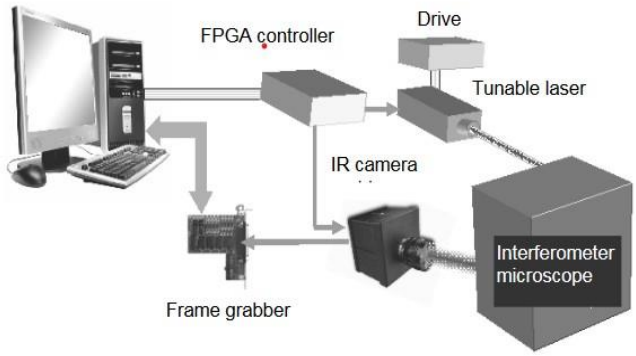

Fig 3: SSFF OCM

This system is built based on a SS FF OCT, with a imaging magnification of 60 times. It has no mechanical scanning at all. Specifications are: wavelength 1300nm; tuning range 110nm; output power 40 mW; acquisition speed >15 frames/second; microscope working distance 20 mm. This system was designed for bio-medical applications at the cell level.

(d) Typical set of a spectral domain OCT

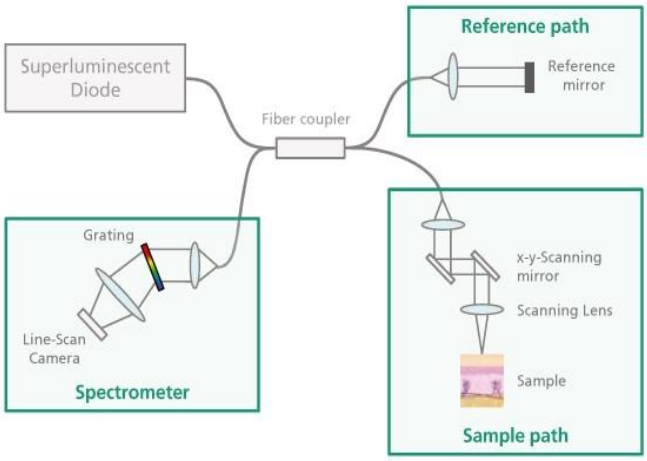

Fig 4: Typical set of a spectral domain OCT

The measuring principle of OCT is based on the interference of light. A typical OCT system consists of a short coherent light source, an interferometer with a reference path and a measurement path with x-y scan mirrors and a spectrometer. The depth information of a sample is obtained by recording and evaluating the interference from backscattered light of different sample depths as well as light from the reference path. A single scan, the so-called A-scan, shows the reflection profile of the measuring object in vertical direction. Using x-y scan.

APPLICATIONS:

- The numerous applications that OCT can be used for is remarkable.
- OCT has the potential to be used for a great number of medical fields and applications however, cancer and heart disease are two of the most pressing and promising areas of application.
- The imaging from the optical coherence tomography has the potential to improve the current cardiovascular therapies and procedures.
- Such as stenting and balloon angioplasty by means of providing vascular images in real time to guide stent placement and balloon inflation.

ADVANTAGES:

- OCT provides a faster and easier method for diagnosis.
- This technique gives results quicker as compared to other traditional medical diagnosing procedures.
- OCT is a computerized procedure.
- Since this is not operated mechanically, therefore chances of error are reduced.
- OCT gives a better image of the test results.
- This process follows higher number of scans and thus provides an image of higher resolution as the result of diagnosis.
- OCT provides broad and dynamic range of operations.

SUGESSTIONS:

- Need to develop with similar median wavelength, power, and bandwidth to those of the mode locked laser.
- Need more complex catheter/ endoscope designs to alleviate the focus falling off rapidly.
- video rate is anticipated with future embodiments.
- Optical coherence tomography is an emerging tool in the medical field.
- With the advanced technology and developed techniques, it is gaining popularity around the globe.
- However, the choice still depends on the client to decide what would be most suited to one.

5. CONCLUSION

It is unlikely that OCT can replace excisional biopsy and histology. However, from the viewpoint of screening and diagnosis of neoplasia, we expect that OCT may be used to guide standard excisional biopsy to reduce sampling errors and false negative results. This could improve the accuracy of biopsy as well as reduce the number of biopsies that are taken, resulting in cost savings. After more extensive clinical studies have been performed, it may be ultimately possible to use OCT to directly diagnose or grade early neoplastic changes in certain situations. This application will be more challenging because it implies making a diagnosis on the basis of OCT rather than conventional pathology and will only be possible in limited clinical situations. If these applications are successful, it would enable OCT diagnostic information to be immediately coupled to treatment decisions and it may be possible to find scenarios where OCT can be used for real- time surgical guidance. The integration of diagnosis and treatment could improve outcome and by reducing the number of patient visits, yield a reduction in health care costs.

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