Chromophore Concentrations, Absorption and Scattering Properties of Human Skin In-vivo

Tech ID: 19367 / UC Case 2008-220-0

BRIEF DESCRIPTION

The invention is a method and probe design for obtaining quantitative optical properties and chromophore concentrations of tissue components in-vivo at superficial depths and "short" source-detector separations.

FULL DESCRIPTION

The invention is a method and probe design for obtaining quantitative optical properties and chromophore concentrations of tissue components in-vivo at superficial depths and “short” source-detector separations. The probe is amenable to use in free space or for quantitative measurements of chromophores in tissues that can be reached by endoscope or similar. This domain, in which the source and detector are in relatively close proximity with one another, has, up until now, been a significant challenge for quantitative optical methods.

We present a novel method to reduce source-detector separation while maintaining the validity of the diffusion approximation. In this approach, we effectively increase the photon path length and allow the source-detector separation to be made arbitrarily small. In order to demonstrate feasibility, we have carried out frequency domain measurements at several wavelengths to recover the optical properties of tissue phantoms, using a model for which the optical properties and thickness of the upper, highly scattering layer are known. In a sense, the invention “forces” diffusive light propagation on the sample of interest.

The new approach has the following advantages:

- expanded wavelength range
- endoscope compatible probe
- depth sectioning capability
- self-calibrating probe.

Tissue depths of interest for quantitative characterization of epithelial malignant transformation range from a few tens of microns to a few hundreds of microns. In order to improve our ability to interrogate tissues at these superficial thicknesses, we have developed a method for quantification of superficial optical properties and chromophore concentrations in which we employ a specific model. Using this approach the errors of recovered ma and ms’ are small (~10%) and is robust to large variations in the magnitude of the initial guess in order to recover optical properties.

Similarly, tissue depths for determining interstitial tissue glucose concentration/distribution range from a few tens of microns to a few hundreds of microns depending on body site probed.

Similarly, if delivered intravascularly (via catheter), tissue depths of interest for characterization of vulnerable plaque range from a few tens of microns to a few hundreds of microns. We have the capacity to detect inflammatory changes in addition to subsurface pools of lipid which seem to characterize this pathology.

The source and detection fibers may be adjacent to each other, permitting the use of the probe in endoscopic applications. Similarly, this design may be made small enough (diameter) to be used in a hollow core needle, as is employed for breast cancer biopsy. Can also potentially be delivered to prostate or bladder, in transureathral fashion.

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OTHER INFORMATION

CATEGORIZED AS

- **Optics and Photonics**
  - All Optics and Photonics
- **Imaging**
  - Medical
  - Molecular
  - Other
- **Medical**
  - Devices
  - Diagnostics
  - Disease: Blood and Lymphatic System
  - Disease: Cancer
  - Disease: Cardiovascular and Circulatory System
  - Imaging

SUGGESTED USES

Detection and diagnosis of epithelial malignancy, interstitial tissue glucose concentration/distribution, and vulnerable plaques.

RELATED CASES

2008-220-0

ADVANTAGES

The novelty of the design is that it will enable the use of diffusion based modeling techniques for source-detector separations in which diffusion based descriptions of light propagation are typically not valid.

This method does not require the development of a representative, physiologically relevant “training set” of calibration samples and the related analyte concentrations. This multivariate approach has been one of the sticking points of the non-invasive blood glucose industry. It is difficult, time consuming and costly to develop an empirical model based on multivariate approaches that will be stable for any individual for any reasonable period of time (weeks).

Expanded Wavelength range; we demonstrate this here with data over the range 500-1000 nm.

Endoscope compatible probe; we substantiate this with Monte Carlo simulation here that indicate plausibility and design aspects.

Depth sectioning capability; this is new; using more than a single source-detector pair will confer the capability of depth sectioning with each source detector pair sensitive to different volumes of tissue.

Self-Calibrating probe; we are able to circumvent the need for (or at least reduce dependence on) an external calibration phantom as is currently used for hand-held SSFDPM measurements. This is a significant advance insofar as it makes the process of collecting meaningful data from a widely varying (in terms of optical properties) sample set such as that one might encounter when doing skin studies using subjects of various skin types (Caucasian, Asian, African descent).

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	8,301,216	10/30/2012	2008-220

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