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Improved Method of Fluorescence Spectroscopy using Monte Carlo Simulation for Medical Diagnostics

View U.S. Patent No. 7,818,154 in PDF format.

WARF: P06332US

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The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing an improved medical diagnostic technique of fluorescence spectroscopy using a Monte Carlo based simulation.

Overview

The early detection of disease or malignancy can greatly increase the probability of full recovery, especially in the case of cancers. Optical diagnostic techniques, such as diffuse reflectance and fluorescence spectroscopy, are emerging technologies in the field of medical diagnostics that can provide early detection of disease and other abnormalities in tissues. Recent advancements in optical technologies and the abundance of tissue specific optical property data are quickly accelerating the development of bio-optical devices and diagnostic techniques. However, the complex interactions of tissue absorption, scattering and fluorescence have made it difficult to interpret the spectral information acquired in optical diagnostics.

UW-Madison researchers previously have developed a method and apparatus for optimizing the geometry of fiber-optic probes used in diffuse reflectance spectroscopy (see WARF reference number P06032US). In this technique an algorithm transforms the acquired diffuse reflective data for particular probe geometry into optical property information that is compared to established optical properties of a specific tissue. The algorithm converges on the geometry that is most suitable for the particular application. This technology can assist in the diagnosis of pre-cancerous and cancerous tissues.
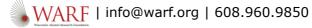
The Invention

UW-Madison researchers have developed an improved method for fluorescence spectroscopy using a Monte Carlo based simulation to extract intrinsic fluorescence spectra and detect abnormal cells. The improved method utilizes certain aspects of previous optical diagnostic technologies such as fiber-optic probe geometry optimization and diffuse reflectance spectroscopy. However, unlike previous methods of extracting optical data exclusively from diffuse reflectance spectra, the new fluorescence spectroscopy technique extracts intrinsic fluorescence from the raw tissue fluorescence and does not require empirical correction factors for the specific probe geometry and/or instrument configuration.

The optical properties of the tissue are first acquired through an established method of Monte Carlo based modeling of diffuse reflectance. Simulations are run to generate a three-dimensional grid of the amount of photon energy deposited per unit volume. Then the location and intensity of fluorescence can be calculated as a function of emission wavelength based on the probability of incident light causing fluorescence and the generated grid of deposited energy. Finally, the fluorescence location and intensity and probability of a photon escaping the medium surface are used to determine the concentration of the fluorophore and other intrinsic fluorescence properties that are independent of absorption and scattering.

The fluorophore concentration is the diagnostic metric used to determine the condition of a tissue. In such a case the bio-optical diagnostic would be compared to an optical property database to determine the types of cells in the region of interest. For example, pre-

cancerous and cancerous tissues contain a different concentration of fluorophores due to abnormal growth of the cells. Concentration of fluorescently labeled drugs or reporter genes can also be quantified *in vivo*. The new method of fluorescence spectroscopy provides the means to detect abnormalities in the tissue for the early detection of cancer and other diseases, which will increase the probability of successful treatment and full patient recovery.

Applications

- Early diagnosis of cancer and other diseases such as melanoma, breast cancer or mouth and throat cancer
- Monitor the effect of drugs, tumor progression and other perturbations on tissue
- Monitor uptake of fluorescently labeled drugs, nanoparticles, liposomes, or other macromolecules into tissue *in vivo*

Key Benefits

- Improves diagnostic accuracy
- Applicable to any fiber-optic geometry
- Capable of extracting intrinsic fluorescence properties of tissue
- Requires only one phantom measurement to adapt to any probe configuration and instrument

Stage of Development

The method was able to retrieve intrinsic fluorescence spectra of tissue phantoms to determine concentration of a fluorophore with an error of less than 10 percent. The method also has been applied to clinical data collected from breast cancer patients to obtain intrinsic fluorescence properties of the tissue.

Additional Information

Related Technologies
- For more information about optimizing probe geometry for spectroscopic measurement in turbid media, see WARF reference number P06032US.

Publications
- Palmer G.M. and Ramanujam N. 2008. Monte-Carlo-Based Model for the Extraction of Intrinsic Fluorescence from Turbid Media. J. Biomed. Opt. 13, 024017.
- Zhu C., Palmer G.M., Breslin T.M., Harter J. and Ramanujam N. 2008. Diagnosis of Breast Cancer Using Fluorescence and Diffuse Reflectance Spectroscopy: a Monte-Carlo-Model-Based Approach. J. Biomed. Opt. 13, 034015.
- Palmer G.M., Viola R.J., Schroeder T., Yarmolenko P.S. and Dewhirst M.W. 2009. Quantitative Diffuse Reflectance and Fluorescence Spectroscopy: Tool to Monitor Tumor Physiology *in Vivo*. J. Biomed. Opt. 14, 024010.

Tech Fields
- Medical Devices : Diagnostics & monitoring tools

For current licensing status, please contact Jeanine Burmania at jeanine@warf.org or 608-960-9846