An Electro-Optical System with a Computation Model for Scanning Human Body

Tech ID: 28842 / UC Case 2016-458-0

BRIEF DESCRIPTION

The invention describes an Electro-Optical instrument and a computational model for functional scanning of human body and recovering its chromophores (water, lipid, oxygenated hemoglobin, and deoxygenated hemoglobin). It is a low cost portable system that integrates frequency domain and continuous wave domain for real time spectroscopic imaging of human tissue.

FULL DESCRIPTION

Background:

§ Diffuse Optical Spectroscopic imaging (DOSI) is a non-invasive technique that utilize light in the near infrared spectral region (650-1000) nm to measure the optical properties of physiological tissue. It provides information about tissue function and structure through detection of four major components found in tissue: oxygenated hemoglobin, deoxygenated hemoglobin, water and lipids. Three main modalities currently exist for measuring optical properties: continuous wave (CW), frequency domain (FD) and time domain (TD) imaging.

§ Continuous Wave (time –unresolved) method provides qualitative information by measuring only relative changes in tissue components. This technique provides fast measurements and simple circuit designs.

§ TD and FD methods provide quantitative approaches to optical imaging by separating absorption from scattering.

§ Frequency domain imaging and time domain imaging both has limited spectral bandwidth. However, Frequency domain imaging overcomes limitations posed by other two modalities in terms of reducing system complexity, size and cost.

Problem:

§ Continuous Wave (time –unresolved) methods are unable to separate scattering from absorption in single measurement. Also, these techniques assume constant scattering and neglect possible changes in scattering occurring during a continuous measurement. This assumption can introduce significant errors while accurately calculating absorber concentrations in the tissue.

§ Time domain's optoelectronic high cost and complex circuitry reduces spectral bandwidth, due to which in applications like breast cancer, information about water and fat content are inaccessible.

Solution:

§ To overcome limitations posed by Continuous Wave (time –unresolved) and time resolved techniques, a hybrid system has been developed that utilizes both modalities in tandem to extract near-infrared absorber concentrations accurately.

§ The quantitative information is provided by the Frequency Domain Photon Migration module while large spectral bandwidth from 650 nm to 998 nm with step of 0.5 nm is provided by steady state module. Four tissue chromophores are extracted from broadband spectra.

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OTHER INFORMATION

CATEGORIZED AS

- **Optics and Photonics**
  - All Optics and Photonics
- **Imaging**
  - Medical
- **Medical**
  - Devices
  - Diagnostics
  - Screening
- **Sensors & Instrumentation**
  - Medical

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ADVANTAGES

§ It is a hybrid system that uses both time-resolved and time unresolved imaging techniques for real-time spectroscopic imaging of human tissue.

§ The system is low cost and portable.

§ This system enables continuous scanning of surfaces which can replace discrete measurements on grid pattern used in earlier systems.

§ This system outperforms the current system's data acquisition speed by 2 orders of magnitude while reducing the overall cost by $9000.

§ The extremely fast data acquisition enables high resolution characterization of the pulsatile waveform.

§ The CW module has a large dynamic range, enabling measurements in tissue with source detector spacing upto 4 cm.

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	10,653,346	05/19/2020	2016-458

STATE OF DEVELOPMENT

Simulations were performed prior to hardware development in order to check the feasibility of this technique. In initial steps, commercial systems were used for source and detector platforms. Next, a bench-top prototype is developed that replaced commercial source and detector systems with this custom-designed boards. Algorithms have been developed to calibrate the system measurements and recover tissue optical properties and chromophore concentrations. Currently, work is going on for further miniaturization of the system footprint and development of new probes.

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