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Using Fixed Probe Geometries with OBI Systems During Measurements from Subjects with Different Forehead Angulations

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Extended Abstract

Optical brain imaging (OBI) relies on optic physics to monitor cerebral activity, thereby enabling to understand brain functions and track neurological disorders [1,2]. Optical brain imaging systems are fundamentally made up of light sources and light detectors which are found on head probe part. During the measurement, head probe is positioned on subjects' forehead; first, 735 nm and 850 nm wavelength light waves are emitted by light sources. Then, emitted light are absorbed, reflected and/or scattered by the target tissues. Last, reflected and/or scattered light waves are sensed by light detectors which are sensitive to specific wavelengths [3,4]. One design related problem is the fixed light source-light detector distances that yield variations in inter-individual measurement accuracy. This is primarily caused by anthropometric differences between individuals such as; head size, tissue thickness, head circumference and forehead angulation differences [3,5,6]. This study focuses on examining and evaluating effect of forehead angulation differences on measurement accuracy with a 1.5 cm fixed light source- light detector distance probe, which has one outer sensor channel and one inner sensor channel positioned 1.5 cm apart from the light source. FEM modelling is used via COMSOL Multiphysics 5.5 software to simulate behaviour of an optical brain imaging system on two separate heads which correspond to average male and female heads, therefore have different forehead angulations. Five femtosecond ray tracing simulation studies focused on tracking time-dependent spatial positions of ten thousand light rays with 735 nm wavelength emitted by one light source. In these probabilistic male and female head models; for the outer sensor channel, only 0.85% and 0.57% of total emitted light waves are sensed, respectively; for the inner sensor channel, only 0.51% and 0.49% of total emitted light waves are sensed, respectively. Compared to the male head, these correspond to 33% and 4% less reflected light sensed by the female head, therefore reduced signal-to-noise ratio. Results indicate optimization requirement for light source-light detector distances on an individual basis.

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