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A computer system integrating central fixation detection and optical coherence tomography for pediatric applications

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Optical coherence tomography (OCT) enables volumetric rendering and the generation of fundus images that precisely and register OCT images to fundus features. Yet, there is little data about how a child's retina develops. This limits our knowledge of how diseases affect a child's vision early in life and makes diagnosis of these diseases more difficult. The introduction of OCT to pediatric applications has been impeded by several factors, among them data acquisition and analysis speed, and difficulty in attaining stable fixation of the pediatric patient on a target over a period of time long enough to allow reliable analysis. The system described here integrates three major components: a computer-controlled video player that plays attention attracting movies and directs the subject's fixation to a central point target; a retinal birefringence scanning subsystem for fast detection of central fixation by detecting the position of the fovea, and; an optical coherence tomography subsystem for acquiring 3D images from the retina (mainly in the foveal region). From a main menu, the operator selects a suitable video to be played by a small monitor in the visual field of the child under programmatic control. The software then starts the birefringence scanning system that scans the area around the fovea using polarized light, and in a double-pass configuration, analyzes the changes of polarization caused by the Henle fibers around the fovea. This allows fast detection of central fixation. The OCT system is instructed by the central software to acquire data if and only if central fixation is detected. This significantly reduces data redundancy and the time needed for analysis of the OCT data, while improving the overall reliability of the system. The idea is applicable to handheld devices.

Recent Publications:

1. Gramatikov B I, Irsch K, Wu Y K and Guyton D L (2016) New pediatric vision screener, part II: electronics, software, signal processing and validation. Biomed Eng Online 15:15.
2. Gramatikov BI (2017) Detecting central fixation by means of artificial neural networks in a pediatric vision screener using retinal birefringence scanning. Biomed Eng Online 16(1):52.
3. Gramatikov B I, Rangarajan S, Irsch K and Guyton D L (2016) Attention attraction in an ophthalmic diagnostic device using sound-modulated fixation targets. Med Eng Phys. 38(8):818-21.
4. Carrasco-Zevallos O M, Qian R, Gahm N, Migacz J, Toth C A and Izatt J A (2016) Long working distance OCT with a compact 2f retinal scanning configuration for pediatric imaging. Opt Lett. 41:4891-4894.
5. LaRocca F, Nankivil D, DuBose T, Toth C, Farsiu S and Izatt J (2016) *In vivo* cellular-resolution retinal imaging in infants and children using an ultra-compact handheld probe. Nature Photonics 10:580–584.

Biography

Boris I Gramatikov has his areas of expertise which includes "Electronics, optoelectronics, computers, computer modeling, signal/image processing, data analysis, electronic instrumentation design, bio-photonics, ophthalmic optics, and biomedical optics, all applied to the development of diagnostic methods and devices for ophthalmology and vision research". His team has developed a series of pediatric vision screeners. Along with Dr. Cynthia Toth from Duke University, he is co-PI on a project for combining optical coherence tomography with retinal birefringence scanning, to enable OCT imaging in toddlers and young children. He has over 120 publications, 37 of which in high-impact peer-reviewed journals. He serves as a Reviewer and Editorial Board Member of a number of technical and medical journals.

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