Comprehensive Visual Field Test and Diagnosis System for Acute and Routine Assessment of Vision, Visual Acuity, and Contrast Sensitivity in Military Environments

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PUBLIC ABSTRACT

Vision is the primary sense used by warfighters and civilians in daily life, and visual information is essential during all phases of military operations. Military environments have many significant effects on the visual and ocular system that can adversely affect warfighter performance, and may lead to long-term health consequences. Risks during military operations include possible corneal, lens, and retinal damage from military combat, UV exposure, retinal thermal damage from excessive visible light and IR exposure (laser exposure), intracranial and/or intraocular hypertension (e.g., due to explosions/blasts), and toxic environmental poisoning. Moreover, in civilian life there are many conditions that, if undetected or detected too late, may lead to irreversible visual field loss and eventually to blindness, such as glaucoma and macular degeneration, to name the two leading causes for blindness that are currently untreatable.

We will develop an innovative, non-invasive, Internet-based (or Intranet-based for field deployment) test and diagnosis system for the assessment, identification, characterization, and automated classification of visual field defects (including visual acuity and contrast sensitivity) caused by operations in military environments. This system will provide medical support personnel, both in hospitals and in the field, with a non-invasive, accurate, sensitive, and fast visual field test, a database for storing visual field patient data, and a software package of sophisticated analysis and classification algorithms to help classify and diagnose visual field defects. The system will be used to detect and diagnose conditions affecting the visual field of a warfighter (equally applicable also to other military personnel, their families, and especially veterans), allowing for the timely application of therapeutic countermeasures, before these conditions impair warfighter health or performance. Furthermore, the system will be applicable for routine assessment of vision and for admission purposes (i.e., recruitment), in particular for prospective pilots.

The core of the proposed test and diagnosis system will be the three-dimensional (3D) computer-automated threshold Amsler Grid test (3D-CTAG), jointly devised by Principal Investigator Dr. Wolfgang Fink at Caltech/JPL and Dr. Alfredo Sadun, consultant at the Doheny Eye Institute, Keck School of Medicine at USC. Using a computer-displayed Amsler grid and touch-screen technology, 3D-CTAG enables collection of 3D visual field data in a non-invasive, simple, five-minute procedure, compared to state-of-the-art standard automated perimetry methods, which are less accurate, tedious, and can take up to tens of minutes per eye. In multiple clinical studies, this novel test has proven to be innovative and successful for fast, easy (intuitive use of finger, touch pen, or mouse), accurate, non-invasive, and comprehensive visual field testing. Conditions such as glaucoma, ocular hypertension, macular degeneration, optic neuritis, anterior ischemic optic neuropathy, and ethambutol-induced optic neuropathy have been successfully detected and characterized by the 3D visual field test. Moreover, visual field defects undetectable by state-of-the-art standard automated perimetry (i.e., "Gold Standard") were repeatedly identified by 3D-CTAG.

Successful completion of this project would result in an integrated test and diagnosis system that is applicable to screening and

examining people on a regional to global scale, thanks to the worldwide accessibility of the Internet. As such, the automated visual field test and diagnosis system would assist physicians with an independent second opinion (not a physician replacement!) or provide expertise where otherwise not readily available (e.g., in remote areas), offering a promising perspective towards modern computer-assisted diagnosis in medicine and tele-medicine.

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