Human Oculomotor Plant Signature Modeling: are there unique and person specific physiological and behavioral features in oculomotor plant eye movement parameters?

Since September 11, 2001, the United States government has become a strong advocate of biometrics with the increase in security concerns in recent years [10]. According to the National Science & Technology Council's (NSTC) subcommittee on biometrics and identity management, current tools for biometric identifications vary from physiological to behavioral classification traits. In biometric characterization, physiological properties relate to the shape of the body, and behavioral properties to the behavior of a person, such as eye movements. Technological approaches defined in NSTC, such as palm print, fingerprint, vascular pattern, face/iris and voice recognition, falls into each of the stated classifications and none of them play a dual role for both forms of identification.

The proposed research is based on the two-dimensional oculomotor plant signature model (2DOPSM) and is capable of generating an eye movement signature matrix on a two-dimensional plane. The key feature of the model is a design that is geared towards a unique and linearly capable vector model, possible to integrate into a real-time human identification system while providing behavioral and physiological measurements. The proposed model represents a mathematical matrix system created by a set of linear mechanical components, representing major anatomical properties of extraocular muscles and the eye globe: muscle location, elasticity, viscosity, eye-globe rotational inertia, muscle active state tension, length tension and force velocity relationships. Detailed computation of the oculomotor plant signature model requires accurate modeling of each of the previously stated components inside of an extraocular muscle. Linearity is a key point, ensuring a real-time performance in an online implementation of the model with mathematical representation providing a close match to the eye's anatomical structure.

Previous work in our lab has investigated oculomotor function using two dimensional oculomotor plant mathematical model (2DOPMM) [8], and found that twelve order eye movement parameters (horizontal and vertical eye rotation, horizontal and vertical velocity, muscle forces and displacements from four eye muscles) uniquely and closely describe the human physiological and behavioral properties. I will further investigate the identified eye movement features to extract person specific and unique features, which might be a part of the unique oculomotor plant signature that can be used for biometrics. I will analyze subject data provided by Tobii x120 Eye Tracker which will have the following performance characteristics: accuracy - 0.5°, spatial resolution - 0.2°, drift - 0.3°, and sampling rate - 120 Hz. The proposed research work will derive signature coefficients by processing eye movement signal through the 2DOPMM model. As a result, an individual vector with all the coefficients will be available to plug into already established classification or identification models. It is hypothesized that the 2DOPMM consists of uniquely identifiable physiological and behavioral eye movement characteristics. This work will support a larger study as a practical application of security systems as person identification, and incorporate eye's anatomical properties to model a unique human signature with physiological and behavioral eye movement characteristics.

Budget

Item and Description	Purpose	Unit Cost	Total
Travel Funds (Primary research location: LBNL) Available from Delta Airlines.	Travel to and from Lawrence Berkeley National Laboratory, Berkeley, CA Research supervisor: Dr. Cecilia Aragon Duration: 06/07/09-08/01/09	$456.00 +43.00 (tax and fees)	$499.00
Proposed 2DOPSM internal clock works on the millisecond time interval providing millions of data points as a result of the recording, therefore fast processing speed and high speed I/O device (SSD hardware) requested.			
Intel Core i7 2.93GHz Quad-Core Processor Available from Newegg, inc	Fast data processing by the proposed model	1x $559.99	559.99
OCZ's 1TB Z SSD Drive	High speed I/O	1x$1400.00	$1400.00
Tobii x120 eye tracker	**Provided by the HCI Laboratory, TSU CS Department		
All other lab materials	**Jointly provided by Lawrence Berkeley National Laboratory and TSU CS department		
Total amount of funding requested			**$2458.99**

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