Computational Intelligence:
From Biometrics to Biomedicine

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Abstract

Research at the Computational Biomedicine Laboratory (CBL, www.cbl.uh.edu) is motivated by fundamental open problems in the broad areas of computational intelligence, computer vision, pattern recognition and machine learning, with an emphasis on applications that address some of society's greatest challenges. Application domains include face recognition, computational behavior analysis, cardiovascular informatics, and neuro-informatics.

First, I will present our biometrics research including 3D face recognition (FR), 3D-FR for partial data, 3D-aided 2D FR, and profile-based face recognition. In this presentation, I will highlight the main element of our approach, which is an Annotated Face Model (AFM) to describe the facial data. The AFM is fitted to the data using a subdivision-based deformable model framework. The deformed model captures the details of an individual's face and represents this 3D geometry information in an efficient 2D structure by utilizing the model's UV parameterization. CBL's face recognition software ranked first in the 3D-shape section of the 2007 Face Recognition Vendor Test (FRVT) organized by NIST, while our 3D-2D method outperforms the state of the art 2D face recognition methods. The presentation will highlight important, outstanding issues, which need consideration.

Then, I will present our research in the area of biomedical image computing with emphasis on the mining of information from cardiovascular imaging data for the detection of persons with a high likelihood of developing a heart attack in the near future (vulnerable patients). Specifically, I will present methods for detection and segmentation of anatomical structures, and shape- and motion-estimation of dynamic organs. The left ventricle in non-invasive cardiac MRI (Magnetic Resonance Imaging) data is extracted using a new multi-class, multi-feature fuzzy connectedness method and deformable models will be/are used for shape and volume estimation. In non-invasive cardiac CT (Computed Tomography) data, the thoracic fat is detected using a relaxed version of the multi-class, multi-feature fuzzy connectedness method. Additionally, the calcified lesions in the coronary arteries are identified and quantified using a hierarchical supervised learning framework from the CT data. In non-invasive contrast-enhanced CT, the coronary arteries are detected using our tubular shape detection method for motion estimation and, possibly, for non-calcified lesion detection. In invasive IVUS (IntraVascular UltraSound) imaging, our team has developed a unique IVUS acquisition protocol and novel signal/image analysis methods for the detection (for the first time in-vivo) of "vasa vasorum". The expected impact of our work stems from the fact that sudden

heart attack remains the number one cause of death in the US, and unpredicted heart attacks account for the majority of the $280 billion burden of cardiovascular diseases.

Biography

Ioannis A. Kakadiaris is a Hugh Roy and Lillie Cranz Cullen University Professor of Computer Science, Electrical & Computer Engineering, and Biomedical Engineering at the University of Houston (UH). He joined UH in August 1997 after a postdoctoral fellowship at the University of Pennsylvania. Ioannis earned his B.Sc. in physics at the University of Athens in Greece, his M.Sc. in computer science from Northeastern University, and his Ph.D. at the University of Pennsylvania. He is the founder of the Computational Biomedicine Lab (www.cbl.uh.edu) and in 2008 he directed the Methodist-University of Houston-Weill Cornell Medical College Institute for Biomedical Imaging Sciences (IBIS) (ibis.uh.edu). His research interests include biomedical image computing, computer vision, pattern recognition with application on cardiovascular informatics, cancer informatics, neuro-informatics., face recognition, non-verbal human behavior understanding, and energy informatics. Dr. Kakadiaris is the recipient of a number of awards, including the NSF Early Career Development Award, Schlumberger Technical Foundation Award, UH Computer Science Research Excellence Award, UH Enron Teaching Excellence Award, and the James Muller Vulnerable Plaque Young Investigator Prize. His research has been featured on The Discovery Channel, National Public Radio, KPRC NBC News, KTRH ABC News, and KHOU CBS News.