SCHOOL OF INFORMATICS AND COMPUTING

Intelligent Systems Engineering Colloquium Series

Greg Lewis

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2 PM

Indiana Memorial Union (IMU)
Dogwood Room

A Neuroscience Informed Approach to Sensor Development and Signal Processing

Abstract: Physiological signals acquired in vivo are composites of multiple sources. The history of bioengineering has been to match cutting-edge technologies from material sciences to design new sensors with robust techniques from electrical engineering to extract the relevant signal features. Recent advances in these disciplines have led to an explosion in the marketplace of small inexpensive biosensors. However, without an informed approach to interpret these new signals, the information may mask the embedded and important neural contributions. By contrast, my approach to bioengineering integrates knowledge from neuroscience to increase the efficiency of sensing technologies. By understanding the principle features that distinguish signal from noise, systems may be optimized to detect specific features of physiological signals that reflect the dynamic changes in neural regulation of peripheral physiological structures (e.g., neural regulation of heart). I will use three examples from my research experience to highlight the benefits of this approach: 1) extraction of the features of heart rate variability that reflect brainstem regulatory mechanisms that support social behavior and cognitive function, 2) development of a prototype noncontact real-time physiological monitoring system, and 3) a reconceptualization of vocalization analysis to extract features that reflect the shared regulatory pathways between vocal intonation and heart rate. All results will be interpreted with regards to the application of the technologies to the study of complex human behaviors, such as disease progression, accumulated stress, disruption in autonomic function following trauma or illness, cognitive processing, and social engagement behaviors.

Biography: Dr. Lewis is a Research Assistant Professor in the Department of Psychiatry at UNC-Chapel Hill. Dr. Lewis is the partnering PI on the project, "Evaluation of HRV Biofeedback as a Resilience-Building Intervention in the Reserve Component" (Department of Defense, Peer Reviewed Medical Research Program PR151616P1). In this role he applies his expertise in human physiology, mathematical modeling, system development, and signal processing to develop a comprehensive model of the individual differences in physical and mental health status that impact the effectiveness of HRV biofeedback. Dr. Lewis will also be supporting a Defense Threat Reduction Agency project, "Pre-Symptomatic Detection by Autonomic Signatures from Wearable Physiological Sensors" (Defense Threat Reduction Agency, HDTRA1-14-CHEM-BIO-BAA). In this project, Dr. Lewis and his colleagues at the Brain-Body Center for Psychophysiology and Bioengineering will be supporting a joint multi-site project to design a continuous monitoring system for first responders to infectious outbreak situations. Dr. Lewis is designing the within subject model of dynamic physiological regulation, in order to detect the rapid shift in physiological resources that precedes symptom development following infection. The goal of the project is to build a "wear and forget" platform that would alert the user to potentially hazardous infectious state up to 24 hours prior to the development of fever or other over symptoms. Dr. Lewis has supported several NIH funded studies, served as the project manager for a university team developing a prototype noncontact polygraph system for the U.S. government, and supported a project to enhance the capability of a noncontact heart rate monitor with support from DARPA. This effort led to ongoing collaborations with the Johns Hopkins University Applied Physics Laboratory to test this and other cardiovascular measurement systems in applications for monitoring cognitive demand and mental adaptability in military training settings. His research on the statistical properties of extracted physiological variables led to a publication contrasting psychophysiological measures of heart rate variability. His published research areas include heart rate variability, peripheral sensory systems, autonomic regulation, acoustic processing, autism spectrum disorders, post-traumatic stress, language development and understanding physiological systems through their evolutionary development.

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