

Topic 1: Wearable sensing for health and performance

Topic 1 Keywords: wearable sensing, machine learning, physiology, cardiovascular health, human performance

Topic 1 short abstract:

Recent advances in digital health technologies are enabling biomedical researchers to reframe health optimization and disease treatment in a patient-specific, personalized manner. Rather than a one-size-fits-all paradigm, the charge is for a particular profile to be fit to each patient, and for disease treatment (or wellness) strategies to then be tailored accordingly. Wearable sensing can play an important role in this effort by augmenting existing research in -omics and medical imaging towards better developing such personalized models and phenotypic assays for patients, and in continuously adjusting such models to optimize therapies in real-time to meet patients' changing needs. While in many instances the focus of such efforts is on disease treatment, optimizing performance for healthy individuals is also a compelling need. This talk will focus on research on non-invasive wearable sensing of human physiology, with application to biomechanics, cardiovascular, and pulmonary monitoring applications. A specific focus of the talk will be on recent technologies leveraging acoustics and vibration sensing for these applications, including the sounds emitted by the joints during movement, the vibrations of the body in response to the heartbeat, and lung sounds. Ultimately, such technologies can enable personalized titration of care and optimization of performance to reduce injuries and rehabilitation time for athletes and soldiers, improve the quality of life for patients with heart disease and chronic obstructive pulmonary disease, and reduce overall healthcare costs.

Topic 2: Mental health technologies

Topic 2 Keywords: computational psychiatry, neuromodulation, physiological biomarkers, stress, anxiety disorder, posttraumatic stress disorder

Topic 2 short abstract:

Advancing technology for mental health has been highlighted as one of the most important areas where technology can impact society. Currently, the assessment of patients with psychiatric disorders such as anxiety disorder, depression, and posttraumatic stress disorder are based heavily on subjective and patient-reported measures, and treatments—typically medications such as selective serotonin reuptake inhibitors—are limited in their effectiveness for the overall patient population. This talk will focus on recent technologies and studies based on digital health measures that can allow quantifiable biomarkers of mental health to be obtained ubiquitously, providing information for example on stressful stimuli encountered by patients in everyday life. Additionally, the focus will be on novel neuromodulation devices that offer a unique opportunity for non-pharmacologic therapies for such patients, particularly ones with stress-related anxiety disorders. Recent work from academia and industry in support of this important area of research will be presented, with a strong focus on efforts that have gleaned mechanistic insight into measurement and modulation tools based on clinical gold standard correlates (e.g., brain imaging and blood biomarkers). The concurrent scientific inquiry into mechanisms behind wearable sensing and neuromodulation of stress together with novel therapies resulting from such efforts can pave the way towards a more effective and accessible form of mental health assessment and treatment in the future.

Topic 3: Cardiogenic vibrations for health and performance: Seismocardiography and ballistocardiography

Topic 3 Keywords: ballistocardiography, seismocardiography, cardiovascular sensing, non-invasive sensing

Topic 3 short abstract:

Cardiovascular disease is the leading cause of death in the US, with more than 650,000 deaths per year. While technologies for monitoring the electrophysiological aspects of cardiovascular health are prevalent—namely electrocardiogram (ECG) measurement patches or Holter monitors—there are fewer devices and approaches available for measuring the mechanical aspects. Monitoring the mechanical aspects of cardiovascular health might be possible through the measurement of cardiogenic vibrations, the micro-movements of the body in response to the ejection of blood from the heart and the movement of blood through the vasculature. Such cardiogenic vibrations can be divided into two groups: chest wall vibrations measured locally with accelerometers and gyroscopes, and whole-body vibrations measured with tables, beds, and weighing scales. The past decade has seen substantial efforts in academia and industry to mature the understanding, measurement, and processing of cardiogenic vibrations. Moreover, such measurements have been obtained in relevant and diverse populations, such as in patients with heart failure, hypertension, coronary artery disease, and atrial fibrillation. This talk will discuss the recent trends in the field that have resulted from both academic groups and from industry, as well as future work that will be needed to make these measurement modalities more widely used in clinical practice.