

ICAMPAM 2013
Featured Speakers and
Presentation Summaries





Stephen Intille

Associate Professor
College of Computer & Information Science and
Bouve College of Health Sciences
Northeastern University
Boston, Massachusetts

“Continuous Monitoring of Activity Using Mobile Phones with Real-Time Feedback”

Mobile phones are increasingly capable of measuring behavior using sophisticated, real-time information processing using internal sensors in the phone, such as accelerometers and GPS, and external sensors that communicate with phones using wireless networks. We have developed a system for continuous remote measurement of physical activity using portable wireless accelerometers and common mobile phones. The system permits not only data collection, but also automatically-detected, event-triggered prompts to encourage compliance. The system can support the development of prototype interventions that respond to physical activity or sedentary behavior immediately after it is measured by the mobile phone system. In this talk, challenges encountered when developing the system will be described, as well as the steps we have taken to overcome them. These challenges include dealing with noisy sensors to automatically detect certain types of physical behaviors, interface design considerations when developing for long-term wearability, power-management issues on mobile devices, and effective remote management and interpretation of data and subject behavior as a study is running.

Abby C. King

Professor, Health Research & Policy and Medicine
Stanford Prevention Research Center,
Stanford University School of Medicine
Palo Alto, California

“Harnessing the Power of Technology to Promote Population-Wide Physical Activity”

Across the past several decades, a substantial body of literature has emerged in the physical activity promotion field. Yet, many of the interventions that have been tested require a level of staffing as well as setting- and time-related resources that hinder translation, dissemination, and population reach. The explosion of communication technologies both in the U.S. and worldwide offers unparalleled potential for applying efficacious interventions, derived from behavioral science theory and evidence and tailored to an individual’s “real-time” needs, throughout a person’s day. This presentation will highlight some of the interactive technologies that have been applied in the physical activity promotion and sedentary behavior fields, including interactive voice response systems, mobile phone applications, and embodied conversational agents. The promise as well as the challenges facing the field will be explored, including how such technologies can be harnessed to advance health equity and diminish the “digital divide”. Finally, the potential of “citizen scientist” models in which state-of-the-art technologies can be used to promote healthier lifestyles across individual, organizational, environmental, and policy domains will be discussed.





I-Min Lee
Professor
Department of Epidemiology
Harvard Medical School and Harvard School of Public Health
Boston, Massachusetts

“Using Accelerometers to Measure Physical Activity in Large-Scale Epidemiologic Studies: Issues and Challenges”

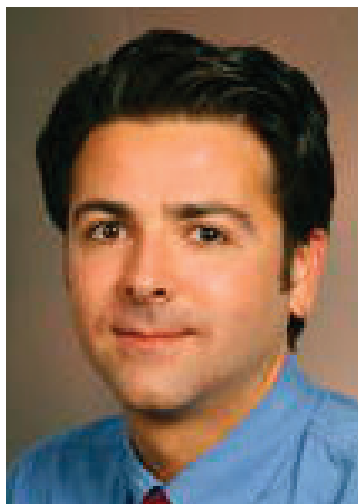
The cost of obtaining objective measures of physical activity using accelerometers has decreased recently, such that it is now feasible to do so in large studies of perhaps 10-20,000 subjects. In this presentation, we will discuss the issues and challenges related to assessing physical activity using accelerometers in a large epidemiologic study, the Women’s Health Study (WHS). The WHS was a randomized trial of aspirin and vitamin E for preventing cardiovascular disease and cancer among 39,876 healthy women, >45 years, conducted from 1992-2004. When the trial ended, 33,682 women (89% of those alive) consented to continue with observational follow-up. An ancillary study was funded to examine accelerometer-measured physical activity and health outcomes; data collection by mail began in 2011. Women are asked to wear an accelerometer (Actigraph GT3X+) on the hip during all waking hours for 7 days. We anticipate ~18,000 women will provide data. As of 15 February 2013, 10,067 women had returned their accelerometers. Preliminary data indicate that 98% of women have data on ≥ 10 hours for ≥ 1 day, and 93% on ≥ 10 hours for ≥ 4 days. The WHS experience indicates that it is possible to obtain good quality accelerometry data by mail in large numbers of subjects.

John Staudenmayer
Associate Professor, Department of Mathematics and Statistics
University of Massachusetts, Amherst, USA

“Estimating Physical Activity with Accelerometers: There has been acceleration; where have we made progress?”

Researchers have developed methods to use accelerometers to estimate various aspects of physical activity for several decades. Over the course of this history scientists in our fields have used a variety of devices, calibration protocols, body locations, and statistical / computational methods. There has been a great deal of research, and this talk will attempt to evaluate the progress that this research has made. What can be estimated validly and how accurately and precisely? We will describe some questions that seem under-answered, and we will conjecture about how additional progress can be made.





James Wyatt

Associate Professor of Behavioral Sciences, Rush Medical College
Director, Sleep Disorders Service and Research Center, Rush University Medical Center, Chicago, Illinois, USA

“Research and Clinical Use of Actigraphy in Measuring Sleep and Wake”

This presentation will review wrist actigraphic monitoring uses in human sleep research and sleep medicine. Research participants and sleep clinic patients are asked to wear an actigraph both day and night, for several days up to several weeks at a time. By storing measurements of gross physical activity across epochs of time, typically 1-minute intervals, algorithms estimate nightly total sleep time. Stability or variability parameters for bedtimes and wake-up times are useful in the assessment of insomnia and for verifying adherence to prescribed sleep schedules in research protocols or treatment protocols. Detection of sleep episodes outside of the major sleep episode (e.g., intentional or unintentional napping) allows quantification of daytime sleepiness. Sensors provide information on timing and intensity of light exposure, relevant to estimating circadian phase. Wrist actigraphs are commonly utilized in combinations with other sleep-wake assessments, including pencil-and-paper instruments (e.g., prospective daily sleep diaries, sleep questionnaires), a structured interview for taking a sleep history, or even ambulatory or laboratory polysomnography. Wrist actigraphs are also commonly used to assess sleep-wake patterns over time in patients who cannot communicate this information (e.g., young children, people with severe neurodevelopmental disorders, older adults with neurodegenerative disorders).



Alicia Carriquiry
Distinguished Professor
Department of Statistics, Iowa State University, Ames,
Iowa, USA

“A Measurement Error Model for Physical Activity Data”

(co-authors: Sarah Nusser, Greg Welk, Bryan Stanfill, and David Osthus)

As obesity-related disease rates increase, so has the interest in measuring the population’s physical activity level. Of particular interest is an individual’s “usual” or long-run average physical activity behavior as it relates to chronic diseases. Epidemiologists and physical activity researchers who are interested in estimating this quantity often do so with self-report activity logs that are prone to error, but do not take this into account when computing estimates. Using data composed of concurrent self-report and monitor readings on individuals, we develop models to measure the various sources of error in both devices. We also offer a method to estimate the usual activity distribution for a population through a measurement error model procedure. Finally, visualizations of model parameters are offered to impress upon practitioners the importance of taking measurement error into account when drawing conclusions from their studies.

Jean-Philippe Chaput

Assistant Professor, School of Human Kinetics, University of Ottawa,
Ottawa, ON, Canada
Junior Research Chair, Healthy Active Living and Obesity Research Group,
Children’s Hospital of Eastern Ontario Research Institute, Ottawa, ON,
Canada



“Measurement of Sleep in Research: Not a Waste of Time!”

Chronic sleep restriction is pervasive in modern societies, and there is increasing evidence supporting the role of insufficient sleep in contributing to obesity and chronic diseases. Lack of sleep has been reported to increase food intake and decrease physical activity in recent studies. An objective measure of sleep is important to accurately assess sleep duration and quality and to determine the true associations with health indicators. Further, physical activity, sedentary behavior and sleep are inter-connected and interact with each other. These behaviors do not occur in isolation and we need to use an integrated “full-day” or “24-hour” approach in our analyses to assess their contribution to health risk. Studies examining the associations between physical activity/ sedentary behavior and health outcomes also need to consider the confounding influence of “sleep” in their analyses. This presentation will address the inter-relationships between sleep, physical activity and sedentary behavior and their ability to predict health markers. Gaps in research will also be highlighted.



Ciprian M. Crainiceanu

Associate Professor, Department of Biostatistics,
Johns Hopkins Bloomberg School of Public Health,
Baltimore, Maryland, USA

“Coming to Our Sensors: Why Body Language is Harder to Decode than Natural Language”

Continuously worn accelerometers provide an unprecedented opportunity for studying when and, especially, how people move in their natural environments. I will introduce movelets, a method for predicting the type of movement using one or multiple tri-axial accelerometers. The fundamental idea is that high density accelerometer data can be partitioned into small time series, called movelets, that can then be easily clustered and recognized using simple statistical tools. The approach is inspired by the speech-recognition literature where each movelet is a word in the language of movement. I will point out the pitfalls of such prediction algorithms in the application to observational studies and propose strong design and calibration approaches to mitigate potential problems. I will also dispel the myth that prediction has to be a black box machine learning approach. Instead, I will show that understanding the measurement, having an appreciation for population-level variability, thinking, and building the predictor space are fundamental. I will also briefly discuss several other research topics of our research group: prediction of energy expenditure, association between measures of activity and health, and normalization methods for wearable devices.

Yannis Goulermas

Reader, Department of Electrical Engineering & Electronics, The University of Liverpool, Liverpool, UK

“Machine Learning and Pattern Analysis Techniques for Human Motion Automation and Monitoring”

In the recent years, there has been an exponential growth of work applying machine learning and pattern recognition algorithms to fields where the analysis and quantification of sensory input is valuable. Human motion, gait analysis and ambulatory activity monitoring are also areas that have benefited from such algorithmic processing of sensor signals. The presentation will overview various machine learning algorithms that have been used in this fields, either through a supervised or an unsupervised setup. It will also outline the different signal preprocessing and segmentation schemes that can be used to simplify, de-noise and extract salient features from the captured motion signals. The trends and popular algorithmic setups in the area will also be discussed along with future recommendation for the motion analysis community. Specific past and present works from our group will also be mentioned to demonstrate the applicability and usefulness of such analyses.



Invited Speakers



Jeffrey M. Hausdorff

Laboratory for Gait & Neurodynamics, Movement Disorders Unit, Department of Neurology, Tel Aviv Sourasky Medical Center, Israel
Department of Physical Therapy, Sackler School of Medicine, Tel Aviv University
Department of Medicine, Harvard Medical School

“What Happens When Body-Fixed Sensors Meet Parkinsonian Gait? A Look Back to the Future”

For about two decades now, researchers have been studying the walking pattern of patients with Parkinson’s disease (PD) using body-fixed sensors. The understanding of gait dynamics in PD has evolved over this period.

For example, it has been shown that certain features of the stride-to-stride fluctuations in gait are related to disease severity and how specific properties respond to therapeutic interventions. Associations between gait metrics and specific aspects of cognitive function have also been uncovered. Furthermore, insights into the debilitating episodic phenomenon known as freezing of gait have been achieved, along with discoveries on the role of genetic mutations. In parallel, the sensors and algorithms that have been used to evaluate gait dynamics have also evolved. Today, the traditional clinical examination of PD can be augmented by instrumenting clinical tests with small body-fixed sensors. The assessment of gait dynamics during community ambulation promises to further enhance our understanding of both the continuous and the episodic gait disturbances in PD, and fall risk. This lecture will take us on a brief tour of some of the advances made over the past twenty years in PD and related populations and speculate about where we are headed toward in the future.

Genevieve Healy

Senior Research Fellow, School of Population Health, The University of Queensland, QLD, Australia

“Going Beyond the Total to Understanding the How, What, When and Where of Sedentary Behaviour Change”

In a series of small workplace studies our group has consistently successfully reduced total sitting time at the workplace. However, in addition to total change, monitor data can provide a plethora of other information on how the change occurs. This can help to refine behaviour change messages. We can glean evidence on what actually changes (e.g., were there fewer bouts, or just shorter bouts of sitting?), when changes happens (e.g., evenly across the whole day or mostly in the morning), and where changes occur (e.g., exclusively at the workplace or also outside of the workplace). Using these workplace studies as examples, this presentation will describe how activity monitor data can be used to address these questions and the implications such findings can have for promoting behaviour change. data and subject behavior as a study is running.





Kathleen F. Janz

Professor, Department of Health and Human Physiology, Department of Epidemiology, University of Iowa, Iowa City, USA

“Understanding the Effect of Mechanical Loading to Bone Health via Physical Activity Monitoring”

Physical activity in childhood is one of the most powerful preventive strategies in the fight against osteoporosis. Considering that 60% of the risk of developing osteoporosis can be explained by the amount of bone mass accrued by early adulthood, engaging in appropriate physical activity in childhood is crucial to maintaining a healthy skeleton in adulthood. However, not all physical activities have equivalent influences on skeletal development. The osteogenic potential of a particular physical activity is dependent on the magnitude of the applied load, the rate at which the load is applied, the duration of the loading bout, and the novel nature of the load. The contemporary use of objective monitors, particularly accelerometers, is an important advancement in understanding these relationships. Accelerometers more directly measure the impact-loading characteristics of physical activity that influence adaptive bone modeling (when compared to other physical-activity measurement instruments). This presentation will review recent evidence from studies using accelerometers to examine dose-response relationships between physical activity and bone health outcomes. In addition, new accelerometers (GenActiv, Actigraph 3X plus), data analysis techniques (pattern recognition), and bone imaging techniques (pQCT, MDCT, finite analysis) will be discussed to show the value of objective monitoring in advancing bone health research.

James McClain

Risk Factor Monitoring and Methods Branch, National Cancer Institute, National Institutes of Health, Bethesda, Maryland, USA

“Developing Information and Infrastructure Resources for Collaboration in Ambulatory Monitoring Research”

The past twenty years of methodological development in accelerometer data processing has enhanced the research community’s understanding of how, when and why we should use sensor technology in ambulatory monitoring research. However, it has been challenging for the measurement community to develop or determine consensus or best practice recommendations for accelerometer data processing based on the diversity of published analytic methods. As a research community, we need to determine how to support more systematic methodological progress in sensor data processing as we transition towards high resolution raw data collection and a more complex set of analytic approaches. This talk will present a framework for information and infrastructure resources to support collaboration and accelerate systematic progress on analytic methods research, development and evaluation. The proposed information resources aim to support replication, comparison, cross-validation and dissemination of published analytic methods. The proposed infrastructure resources aim to support collaboration, potential data sharing or pooling, and access to centralized data resources and analytic tools for methods development.





Misha Pavel

Smart Health and Well Being, National Science Foundation, Arlington, Virginia, USA

“Monitoring and the Inference of Gait Based on Computational Models”

Transforming healthcare to be proactive and preventive is an increasingly important societal challenge. Consequently, one of the objectives of our laboratory is investigating how to keep individuals healthy with the best possible quality of life, in spite of aging and non-communicative diseases. A well-known and important determinant of quality of life and health is gait and its characteristics. In addition, there has been considerable empirical evidence suggesting strong ties between performance on cognitive tasks and aspects of gait. For example, empirical data suggest that longitudinal slowing of gait is associated with or even predictive of cognitive decline. Frequent or continuous monitoring and assessment of gait parameters may therefore yield very important behavioral markers of individuals’ wellbeing, as well as being a potential predictor of future states. We will argue, however, that effective utilization of the monitoring data requires the development of computational models that would enable efficient transformation of the data into actionable knowledge. We plan to illustrate the model-based approach on two examples, one using unobtrusive monitoring of elders and the other based on laboratory experiments. In the former case, we show that a set of very simple in-home sensors can be used to assess the speed of walking that in turn can be related to a variety of individuals’ states. In the latter example, we will suggest that modeling individuals’ constraints in terms of objective functions can explain, and possibly predict the choice of gait parameters as their capability change with changing health state.

Rebecca M. C. Spencer

Assistant Professor, Department of Psychology and Neuroscience and Behavior Program, University of Massachusetts, Amherst, Massachusetts, USA

“Using Wrist-Worn Actigraphs to Measure Sleep and Wake in Preschool Children”

Wrist-worn actigraphs provide stable and accurate measures of sleep quantity (total sleep time) and quality (e.g., wake after sleep onset, sleep efficiency). Actigraphy, as opposed to polysomnographic measures of sleep, has the advantage of capturing less predictable daytime sleep, circadian patterns of sleep-wake behavior, and sleep-wake correlations in dyads. In my work, we have been capitalizing on these capabilities of actigraphy in preschool children. During the preschool years, most children transition out of habitual daytime napping, thereby decreasing daytime sleep and increasing daytime activity. Given that family and school routines can influence this transition, we have also simultaneously monitored sleep and wake in a subset of mothers. This study will serve as an example of how sleep and wake should be considered in tandem and the current limitations of doing so.



Invited Speakers



Rick Troiano

Director Research Scientist, Risk Factor Monitoring and Methods Branch, National Cancer Institute, National Institutes of Health, Bethesda, Maryland, USA

“Physical Activity Monitoring in NHANES – Technological and Methodological Progress”

The National Health and Nutrition Examination Survey (NHANES) included an accelerometer component to measure physical activity in 2003-2006. These data on a nationally representative sample have been the basis of many research papers. In 2011-2014, accelerometers are again included in NHANES. The current component uses more advanced device technology based on triaxial raw data capture. The water-resistant device is being worn on the wrist, rather than the waist. The wrist location combined with water resistance allows 24-hour wear, which has improved wear compliance and provides the opportunity for objective assessment of sleep quantity and efficiency. Triaxial raw data supports the potential to obtain information on general activity categories as well as intensity. This presentation will describe the current NHANES protocol, discuss plans for data processing and release, and will present an evolving context for interpretation of accelerometer data.