Automated Dietary Monitoring 2019
ADM '19
The grand challenge from lab to real-life systems

Special Session & Workshop
In conjunction with BSN 2019 (May 19-22) Chicago

The objective of ADM is unobtrusive, continuous long-term diet monitoring as well as supporting sustainable diet change. Investigations on body-worn sensors and related analysis algorithms to monitor dietary behavior have gained wide interest in the BSN community. Several early business ventures are picking up ideas. And still, unobtrusive monitoring and intervention systems for diet management are broadly lacking. The technology must be made ready for free-living everyday use, while capturing various behavioral aspects related to intake.

ADM'19 will address the following non-exhaustive list of topics:

- ADM community development, addressing terminology, frameworks, benchmark datasets & challenges, etc.
- Intake recognition and pattern analysis algorithms (online and offline) leveraging wearable systems, including intake timing, intake material, amount, and further variables.
- Studies on, and methodologies for technology-supported situative dietary coaching and guidance towards lifestyle changes.
- Trustworthy evaluation methodologies, in particular those that generalize onto free-living.
- Opinions of dietitian and coaches on supportive technology and requirements.
- Presentations of relevant datasets available to other researchers.

Based on the success of the previous years, ADM'19 will again serve as a scientific exchange, discussion, and networking event. ADM'19 will bring together researchers and students actively developing dietary monitoring technology, practitioners, clinicians, and coaches looking for monitoring systems, and everyone interested in the area. The workshop will feature technical and medical/coaching discussion time. A best student contribution will be awarded. In addition, posters and preparation of a position paper will make ADM'19 an exiting event.

Organizers

Oliver Amft, Friedrich Alexander University Erlangen-Nürnberg (FAU)
Samantha Kleinberg, Stevens Institute of Technology
Benny Lo, Imperial College London
Edison Thomaz, University of Texas at Austin

Automated Dietary Monitoring 2019
ADM '19

Workshop on May 19, 2019

Agenda

1:30pm – 1:45pm	Welcome and introduction	Organizers
1:45pm – 2:10pm	Automated Dietary Monitoring: A Practitioner's Perspective	Andrea Deierlein, New York University
2:10pm – 2:35pm	Detecting Eating and Estimating Calorie Consumption in Individuals with and without Obesity: Results from a Field Study	Nabil Alshurafa, Northwestern University, Chicago
2:35pm – 3:00pm	The Impact of Secondary Activities on Automated Detection of Meals	Adam Hoover, Clemson University
3:00pm – 3:30pm	Break	
3:30pm – 3:55pm	Egocentric vision and wearable sensors for capture and modification of eating behavior in the wild	Edward Sazonov, University of Alabama
3:55pm – 4:20pm	Food Volume Estimation from a Single Image	Wenyan Jia, University of Pittsburgh
4:20pm – 4:45pm	Dietary Monitoring Beyond Meal Times	Samantha Kleinberg, Stevens Institute of Technology
4:45pm – 4:55pm	Break	
4:55pm – 5:25pm	ADM terminology and framework	Organizers
5:25pm – 5:55pm	ADM website and datasets	Organizers
5:55pm – 6:10pm	Planning and conclusion	Organizers
7:00pm – 8:30pm	ADM joint dinner + planning	

Talks: 15 min + 10 min discussion

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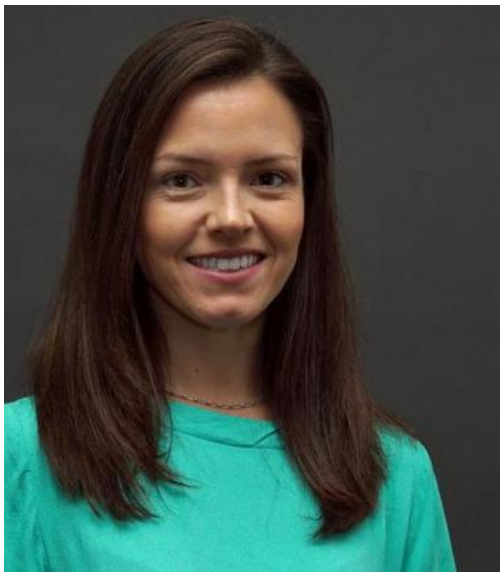
Automated Dietary Monitoring: A Practitioner's Perspective



Dr. Andrea Deierlein PhD MPH
Assistant Professor of Public Health Nutrition
College of Global Public Health
New York University

Abstract

Diet plays an integral role in health and well-being throughout the lifespan. Clinicians, researchers, and other nutrition practitioners require methods to measure intakes of specific nutrients and to assess overall diet quality. This type of information is critical for a range of outcomes, from understanding biological mechanisms to diagnosing and treating health conditions to setting health policies. Current dietary assessment tools available to practitioners include journals, 24-hour recalls, and food frequency/diet history questionnaires. Though these tools are useful, they have limitations related to patients' memory, literacy level, cognitive ability, culture, and behaviors. Additionally, they may not accurately capture portion sizes, brand information, preparation methods, or timing/patterns of meals. Advancements in automated dietary monitoring technologies have the potential to address many of these limitations. The objective of this talk is to present the varied perspectives of nutrition practitioners regarding the use of automated dietary monitoring in free-living populations. Specific examples of clinical/wellness applications will be reviewed.

Short bio

Dr. Deierlein is a formally-trained nutritional epidemiologist with a focus on maternal, perinatal, and pediatric health. Much of her research investigates the influence of diet, maternal obesity, and gestational weight gain on adverse maternal, infant, and childhood metabolic health outcomes. She also has an interest in understanding the influence of environmental chemical exposures on associations of nutrition and chronic disease risk.

Detecting Eating and Estimating Calorie Consumption in Individuals with and without Obesity: Results from a Field Study

Nabil Alshurafa, Ph.D.
Assistant Professor of Preventive Medicine
Assistant Professor of Computer Science
Feinberg School of Medicine &
McCormick School of Engineering
Northwestern University

Abstract

Understanding what factors most influence calorie consumption is essential to understand the behavior of overeating resulting in overweight. Furthermore, understanding predictors of calorie consumption can inform just in time interventions to prevent or temper overeating. Advances in wearable sensors may provide a means of passively detecting and characterizing eating episodes, but it is unknown what passively detectable characteristics are most predictive of a higher calorie meal. This talk will discuss the BeYourself Study, which conducted an experiment to identify what behaviors in natural settings best estimate calorie consumption in participants with and without obesity. A wearable video camera with a fish-eye lens was placed around the shoulder of 19 participants (10 obese, 5 normal, and 4 overweight BMI) for 14 days to visually observe physical behaviors during eating episodes. Trained video annotators labeled the start and end time of meals, along with the fine-grained start and end time of each feeding gesture. Regression models resulted in three models that significantly estimated caloric intake: one incorporating all the participant meals, one incorporating meals only from participants with obesity, and another excluding participants with obesity. Findings regarding what features are most essential for estimating calorie intake will be discussed, which can hopefully begin to inform what behaviors and ultimately what sensors are most meaningful in estimating calorie consumption. Further study in larger samples is warranted to determine if there are individual differences in the observed patterns and if changing these behaviors result in weight loss. Moreover, challenges regarding acceptability and feasibility of wearing different sensors to detect eating episodes in free-living populations will be addressed.

Short bio

Nabil Alshurafa is an Assistant Professor of Preventive Medicine and of Computer Science at Northwestern University. He received his Ph.D. in Computer Science at the University of California Los Angeles (UCLA) in 2015, where his dissertation was awarded the Computer Science outstanding graduating student award, and the Symantec outstanding research award. In 2015, Popular Science magazine highlighted his research on designing a wearable neck-worn sensor *WearSens* to distinguish between solid and liquid foods consumed. He currently directs the HABits Lab at Northwestern, which aims to bridge between computer science and behavioral science research. His current research seeks to transform our understanding of health constructs by designing objective verifiable wearable sensor measures, to more effectively design interventions that improve lifestyle habits. In 2018, he was awarded a five-year NIDDK NIH Career award, to develop expertise in obesity-related research and advance passive sensing of problematic eating behaviors. He is currently directing the *SenseWhy* study, which aims to lay the foundation for studying overeating behaviors among participants with obesity through passive wearable sensors.

The Impact of Secondary Activities on Automated Detection of Meals

Adam Hoover, PhD
Professor
Electrical and Computer Engineering Department
Clemson University

Abstract

People can conduct secondary activities while eating, such as watching television, talking with other people, walking to retrieve more food, or resting for a few minutes before resuming consumption. These secondary activities cause body motion patterns that are different from body motions specifically used for consumption. The overlap of these activities creates challenges for methods designed to track body parts and classify periods of time as eating activities. This talk will describe the collection of a new large dataset from 408 subjects recorded for a full day each during free living. The total duration recorded was 4,680 hours, containing 229 total hours of eating across 1,133 separate eating episodes (meals, snacks). Of these eating episodes, 317 (28%) were reportedly consumed without any secondary activity, 281(25%) were consumed while talking to company, and 535 (47%) were consumed while performing a secondary activity (watching, working, driving, talking, walking or unknown). We demonstrate methods designed to detect secondary activities during eating episodes and their impact on classification accuracy.

Short bio

Adam Hoover is a Professor of Electrical and Computer Engineering at Clemson University. His research focuses on tracking systems. Tracking can refer to physical problems, such as locating where things are in the world, and also signal problems, such as identifying the relative health of an individual's blood pressure over time. Image and signal processing, mHealth, state space modeling, filtering, and embedded computing form the background. His group works with many types of sensors and often builds embedded systems that prototype novel tracking ideas. He is currently an Associate Editor for the IEEE Journal of Biomedical and Health Informatics.

Egocentric vision and wearable sensors for capture and modification of eating behavior in the wild

Edward Sazonov
Professor
Electrical and Computer Engineering
University of Alabama

Abstract

Achievement of changes in eating behaviors toward those that facilitate long-term maintenance of weight loss is elusive. Emerging wearable sensor technology combined with egocentric vision and image recognition allow for accurate and objective measurement of ingestive behavior. Real-time analysis of the sensor data paves the way for development of individually tailored Just-In-Time Adaptive Interventions based on behavior change strategies for weight control. This talk will cover an introduction to food intake detection using wearable sensors with a focus on our work in developing and using the Automatic Ingestion Monitor. Results from the studies on food intake detection, meal microstructure characterization and eating behavior modification will be reported.

Short bio

Edward Sazonov (IEEE M'02, SM'11) received the diploma of systems engineer from Khabarovsk State University of Technology, Russia, in 1993, and his doctorate in computer engineering from West Virginia University in Morgantown, West Virginia, in 2002. Currently he is a professor in the electrical and computer engineering department at The University of Alabama College of Engineering in Tuscaloosa, Alabama, and the head of the Computer Laboratory of Ambient and Wearable Systems. His research interests span wireless, ambient and wearable devices, and methods of biomedical signal processing and pattern recognition. Devices developed in his laboratory include a wearable sensor for objective detection and characterization of food intake, a highly accurate physical activity and gait monitor integrated into a shoe insole, a wearable sensor system for monitoring of cigarette smoking, and others. His research has been supported by the National Science Foundation, National Institutes of Health, National Academies of Science, as well as by state agencies and private industry and foundations.

Food Volume Estimation from a Single Image

Wenyan Jia, PhD
Research Assistant Professor
Departments of Electrical and Computer Engineering
University of Pittsburgh, Pittsburgh, PA

Abstract

Image-based dietary assessment has been paid great attention in the field of dietetics. However, it has been a difficult problem to estimate food volume from a single image. Our group has investigated an approach to estimate the orientation and location of a circular plate and then project a 3D shape model to match the food in the plate. However, the plate size has to be known to serve as a reference. Recently we propose a new method to estimate the diameter of dining plates according to the periodic motion of the body during an eating event as long as the size of one plate is known. This approach simplifies the dietary assessment procedure since only one plate should be measured and no fiducial marker is required. In addition, we have studied the volume estimation problem when a bowl is used as the food container. We present a new method involving the use of a patterned tape and an image processing algorithm to reconstruct the interior shape of the bowl in 3D. Our preliminary experiments have indicated that this method is convenient and accurate.

Short bio

Wenyan Jia is a Research Assistant Professor of Electrical and Computer Engineering at the University of Pittsburgh. Dr Jia received her PhD degree in Biomedical Engineering from Tsinghua University, China. Her current research interests include biomedical signal and image processing, wearable electronic devices, and implementation of mobile technology in health care.

Dietary Monitoring Beyond Meal Times

Samantha Kleinberg, Ph.D.
Associate Professor
Computer Science
Stevens Institute of Technology

Abstract

Automated dietary monitoring has mainly focused on recognizing meal times and, recently, doing so in unconstrained environments in daily life. However knowing only when someone is eating without knowing what they are consuming or how does not yet allow individuals to replace manual food logs, or provide the detail nutritionists require. Work in lab environments has shown the possibility of identifying food type from body-worn sensors, but has done so with constrained foods rather than realistic meals. In this work I discuss recent progress toward automated detection of foods consumed in unconstrained environments with full meals, showing that this can be reliably automated even with complex meals (e.g. pizza, salad, burger and fries). While knowing what people are eating is critical, I also discuss other facets of diet that have been unexplored in ADM and could potentially be inferred automatically.

Short bio

Samantha Kleinberg is an Associate Professor of Computer Science at Stevens Institute of Technology. She received her PhD in Computer Science from New York University and was a Computing Innovation Fellow at Columbia University in the Department of Biomedical informatics. She is the recipient of NSF CAREER and JSMF Complex Systems Scholar Awards and is a 2016 Kavli Fellow of the National Academy of Sciences. She is the author of “Causality, Probability, and Time” (Cambridge University Press, 2012) and “Why: A Guide to Finding and Using Causes” (O’Reilly Media, 2015).

Organizers

Oliver Amft, Friedrich Alexander University Erlangen-Nürnberg (FAU)

Oliver Amft is the founding director of the Chair of Digital Health at FAU Erlangen-Nürnberg, Germany. His main interest include unobtrusive sensor design, multi-modal context recognition, wearable computing and biomedical engineering. Oliver is an Associate Editor of Frontiers in ICT, the Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies (IMWUT), the IEEE Journal of Biomedical and Health Informatics (J-BHI), and board member of IEEE Pervasive.

Samantha Kleinberg, Stevens Institute of Technology

Samantha Kleinberg is an Associate Professor of Computer Science at Stevens Institute of Technology. She received her PhD in Computer Science from New York University and was a Computing Innovation Fellow at Columbia University in the Department of Biomedical informatics. She is the recipient of NSF CAREER and JSMF Complex Systems Scholar Awards and is a 2016 Kavli Fellow of the National Academy of Sciences. She is the author of “Causality, Probability, and Time” (Cambridge University Press, 2012) and “Why: A Guide to Finding and Using Causes” (O’Reilly Media, 2015).

Benny Lo, Imperial College London

Benny Lo, PhD., is a Senior Lecturer of the Hamlyn Centre at Imperial College London. His research mainly focuses on Body Sensor Networks (BSN), Machine Learning, Microelectronics, Pervasive Sensing and Computer vision. He is an Associate Editor of the IEEE Journal of Biomedical Health Informatics, vice-chair of the IEEE EMBS Wearable Biomedical Sensors and Systems Technical Committee, and a member of the IEEE EMBS Standards Committee.

Edison Thomaz, University of Texas at Austin

Edison Thomaz is an Assistant Professor in the ECE department and the School of Information at The University of Texas at Austin. I hold a bachelor's degree in Computer Science from UT Austin, a master's from the MIT Media Lab and a Ph.D. in Human-Centered Computing from Georgia Tech. He develops and studies systems and computational methods for sensing, recognizing and modelling the entire span of people's everyday activities and context.