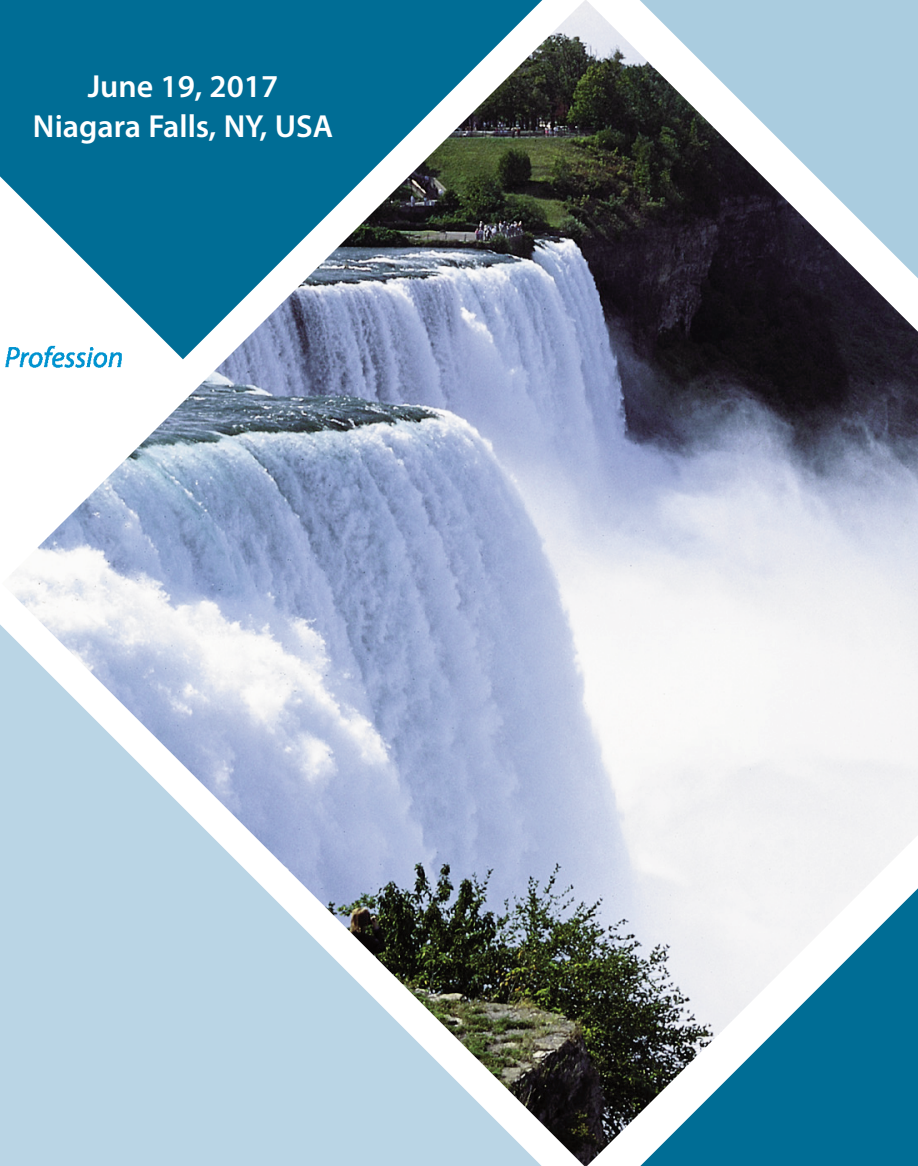


June 19, 2017  
Niagara Falls, NY, USA



Association for  
Computing Machinery

*Advancing Computing as a Science & Profession*



# WearSys'17

Proceedings of the 2017 Workshop on  
Wearable Systems and Applications

*Sponsored by:*

**ACM SIGMOBILE**

*In-cooperation with:*

**ACM SIGOPS**

*Co-located with:*

**MobiSys 2017**



**Association for  
Computing Machinery**

*Advancing Computing as a Science & Profession*

**The Association for Computing Machinery**  
**2 Penn Plaza, Suite 701**  
**New York, New York 10121-0701**

Copyright © 2017 by the Association for Computing Machinery, Inc. (ACM). Permission to make digital or hard copies of portions of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyright for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, to republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permission to republish from: [permissions@acm.org](mailto:permissions@acm.org) or Fax +1 (212) 869-0481.

For other copying of articles that carry a code at the bottom of the first or last page, copying is permitted provided that the per-copy fee indicated in the code is paid through [www.copyright.com](http://www.copyright.com).

**ISBN:** 978-1-4503-4959-8

Additional copies may be ordered prepaid from:

**ACM Order Department**  
PO Box 30777  
New York, NY 10087-0777, USA

Phone: 1-800-342-6626 (USA and Canada)  
+1-212-626-0500 (Global)  
Fax: +1-212-944-1318  
E-mail: [acmhelp@acm.org](mailto:acmhelp@acm.org)  
Hours of Operation: 8:30 am – 4:30 pm ET

Printed in the USA.

# WearSys'17 Chairs' Welcome

It is our great pleasure to welcome you to *The 3rd ACM Workshop on Wearable Systems and Applications – WearSys'2017*. The WearSys workshop is inspired by the fact that wearables are spearheading advancements in technology through inter-disciplinary research among a broad spectrum of disciplines such as mobile health, fashion, energy, just to name a few. The 3<sup>rd</sup> ACM Workshop on wearable systems and applications, *WearSys'2017*, is focused on how wearable technologies can shape mobile computing, systems and applications research. The goal of this workshop is to provide a forum to bring together researchers and design experts to discuss how wearable technologies have, and can, complement mobile systems research, and vice-versa. It also aims to provide a launchpad for bold and visionary ideas for wearable systems research.

The call for papers attracted a total of 9 submissions from all over the world. The program committee reviewed and accepted 8 full papers and 1 poster. The reviewing process was double-blind.

| <i>Venue or Track</i> | <i>Number</i> |
|-----------------------|---------------|
| Total submissions     | 9             |
| Accepted              | 9             |
| Acceptance %          | 100 %         |

WearSys 2017 will uniquely include two keynote talks. We also encourage attendees to attend the panel session on *mHealth* that will feature eminent academic and industry personalities working in wearable technologies for mobile healthcare research.

Putting together *WearSys'2017* was a team effort. We first thank the authors for providing the content of the program. We are grateful to the program committee who worked very hard in reviewing papers and providing feedback for authors. We thank the MobiSys'2017 workshop chairs and general chairs in providing the necessary inputs in the form of feedback and arranging the infrastructure enabling to put together a wonderful program. Finally, we thank our primary sponsors ACM and SigMobile.

We hope that this workshop will serve as a catalyst for advancements in mobile and wearable systems technology as well as provoke disruptive ideas for the research community to proceed in this space. We hope that you will find this program interesting, fun and thought-provoking. Welcome to *WearSys'2017*!

**Dr. Ashwin Ashok**  
*WearSys'2017 Program Chair*  
*Georgia State University, USA*

**Dr. Mi Zhang**  
*WearSys'2017 Program Chair*  
*Michigan State University, USA*

# Table of Contents

|   |           |
|---|-----------|
| <b>WearSys 2017 Organization List .....</b> | <b>vi</b> |
|---|-----------|

## Keynote Talks

|  |          |
|--|----------|
| • <b>mSelf – Using Mobile Sensors to Self-monitor and Improve Health, Wellness, and Performance.....</b> | <b>1</b> |
| Santosh Kumar ( <i>University of Memphis</i> )   |          |
| • <b>Challenges and Opportunities in Wearable Systems .....</b>  | <b>3</b> |
| David Kotz ( <i>Dartmouth College</i> )  |          |

## Session 1: Wearable Interaction

|  |           |
|--|-----------|
| • <b>AuthoRing: Wearable User-presence Authentication .....</b>  | <b>5</b>  |
| Xiaohui Liang ( <i>University of Massachusetts Boston</i> ), David Kotz ( <i>Dartmouth College</i> )   |           |
| • <b>Capacitive Sensing 3D-printed Wristband for Enriched Hand Gesture Recognition .....</b>   | <b>11</b> |
| Hoang Truong, Phuc Nguyen, Anh Nguyen, Nam Bui, Tam Vu ( <i>University of Colorado Boulder</i> )   |           |
| • <b>Toward a Wearable Sensor for Eating Detection .....</b>   | <b>17</b> |
| Shengjie Bi, Tao Wang, Ellen Davenport, Ronald Peterson, Ryan Halter ( <i>Dartmouth College</i> ), Jacob Sorber ( <i>Clemson University</i> ), David Kotz ( <i>Dartmouth College</i> ) |           |

## Session 2: Wearable Healthcare

|   |           |
|---|-----------|
| • <b>A Photoplethysmograph Based Practical Heart Rate Estimation Algorithm for Wearable Platforms .....</b>   | <b>23</b> |
| Shalini Mukhopadhyay, Nasim Ahmed, Dibyanshu Jaiswal, Arijit Sinharay, Avik Ghose, Tapas Chakravarty, Arpan Pal ( <i>Tata Consultancy Services Ltd.</i> ) |           |
| • <b>Detecting Compensatory Trunk Movements in Stroke Survivors using a Wearable System .....</b>   | <b>29</b> |
| Rajiv Ranganathan, Rui Wang, Rani Gebara, Subir Biswas ( <i>Michigan State University</i> )   |           |
| • <b>Poster: Understanding Long-Term Adoption of Wearable Activity Trackers Among Older Adults .....</b>  | <b>33</b> |
| Lin Li, Wei Peng, Kendra Kamp, Marie Bowen, Shelia R. Cotton, R.V. Rikard, Anastasia Kononova ( <i>Michigan State University</i> )                        |           |

## Session 3: Wearable Performance

|  |           |
|--|-----------|
| • <b>Distributed Adaptive Model Predictive Control of a Cluster of Autonomous and Context-Sensitive Body Cameras .....</b> | <b>35</b> |
| Shiwei Fang, Ketan Mayer-Patel, Shahriar Nirjon ( <i>University of North Carolina at Chapel Hill</i> )                     |           |
| • <b>Toward Accurate and Efficient Feature Selection for Speaker Recognition on Wearables .....</b>                        | <b>41</b> |
| Rui Liu, Reza Rawassizadeh, David Kotz ( <i>Dartmouth College</i> )  |           |
| • <b>Rethink Phone-Wearable Collaboration From the Networking Perspective .....</b>  | <b>47</b> |
| Xing Liu, Yunsheng Yao, Feng Qian ( <i>Indiana University Bloomington</i> )  |           |

|                          |           |
|--------------------------|-----------|
| <b>Author Index.....</b> | <b>53</b> |
|--------------------------|-----------|

# WearSys 2017 Workshop Organization

**Program Co-Chairs:** Mi Zhang (*Michigan State University, USA*)  
Ashwin Ashok (*Georgia State University, USA*)

**Program Committee:** Ardalan Amiri Sani (*University of California Irvine, USA*)  
Chenren Xu (*Carnegie Mellon University, USA*)  
Felix Xiaozhu Lin (*Purdue University, USA*)  
Guan-Hua Tu (*Michigan State University*)  
Haithem Hassanieh (*University of Illinois Urbana Champaign, USA*)  
Hassan Ghazsemzadeh (*Washington State University, USA*)  
Hsin-Mu Tsai (*National Taiwan University, Taiwan*)  
Mahbubur Rahman (*Nokia Digital Health Labs, USA*)  
Pengyu Zhang (*Stanford University, USA*)  
Robert LiKamWa (*Rice University, USA*)  
Robin Kravets (*UIUC, USA*)  
Roozbeh Jafari (*TAMU, USA*)  
Shubham Jain (*Rutgers University, USA*)  
Shyamnath Gollakota (*University of Washington, USA*)  
Tam Vu (*University of Colorado, Denver, USA*)  
Wenjun Hu (*Yale University, USA*)  
Wenyao Xu (*University at Buffalo, USA*)  
Xia Zhou (*Dartmouth College, USA*)

**Steering Committee:** Ashwin Ashok (*Georgia State University*)  
Jie Liu (*Microsoft Research, USA*)  
Suman Banerjee (*University of Wisconsin, Madison, USA*)  
Mahadev Satyanarayanan (*Carnegie Mellon University, USA*)

**Sponsors:**

