
PUCAA: 1st International Workshop on Pervasive Urban Crowdsensing Architecture and Applications

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Abstract

Recently, as the community and businesses have begun to realize the power of jointly harnessing nomadic mobile sensing and selective infrastructure-based ambient sensing, we are beginning to see the emergence of a class of “urban crowdsensing” platforms that perform pervasive sensing in a more coordinated fashion. Such combined sensing opens up the possibilities for new exciting applications in a variety of urban spaces.

Driven by these trends, PUCAA is an annual workshop that seeks to bring together researchers and practitioners working in the areas of urban and crowd-driven sensing. The workshop provides a forum for the researchers to discuss large/innovative crowdsensing architectures, systems and platforms and their experiences on developing crowdsensing applications impacting urban lifestyles in a variety of areas such as personal & public healthcare, retail & commerce, transportation, public safety, crowd management, and utility services.

Author Keywords

Urban Sensing, Crowdsensing, Smartphone Sensing,
PUCAA 2013, UbiComp 2013

ACM Classification Keywords

H.4 [Information Systems Applications]: Mobile Sensing, Communications Applications; J.4 [Computer Applications]: Social and Behavior Sciences.

General Terms

Algorithms, Design, Architecture, Infrastructure, Experimentation, Applications

INTRODUCTION

Over the past few years, there has been an explosion in the use of sensors to gain real-time awareness of the “state” of various urban spaces. Such real-time data collection and offline longitudinal analytics are now widely viewed as crucial factors in ensuring the sustainability and effective operation of large urban centers across the globe. Initially, such sensor instrumentation was largely on the infrastructure side (e.g., RFID readers to monitor traffic flows in subways, video cameras to monitor congestion on roads and environmental sensors to monitor pollution levels in different residential areas). More recently, the rapid adoption of smartphone platforms and the increasing sophistication and variety of sensors embedded in such platforms have opened up the exciting possibility of a large-scale distributed sensing substrate that: (i) Is significantly cheaper to operate and maintain compared to a large-scale infrastructure deployment; (ii) Can tailor its sensing coverage and behavior to the movement and occupancy patterns of the urban citizenry.

In its initial wave, such large-scale mobile sensing was largely participatory in nature, lacking any notion of centralized control and often depending on the altruism and enthusiasm of participants. Over the last 18 months or so, as the community and businesses have begun to realize the power of jointly harnessing such nomadic

mobile sensing and selective infrastructure-based ambient sensing, we are beginning to see the emergence of a class of “urban crowdsensing” platforms that perform such sensing in a more coordinated fashion. Such combined sensing opens up the possibilities for exciting new applications in a variety of urban spaces, both outdoors (e.g., crowd coordination in theme parks, public safety monitoring in major public events and public health management [6]) and indoors (e.g., healthcare, intelligent retail and promotions in shopping malls [5] & energy-efficient building operations management [2]).

Driven by these trends, this proposed workshop seeks to bring together researchers and practitioners working in the areas of urban and crowd-driven sensing. In this workshop, we would like to focus on crowdsensing architectures, systems and platforms and their experiences on developing crowdsensing applications impacting urban lifestyles in a variety of areas. Such areas include *personal (mHealth) and public health, retail & commerce, transportation, public safety, healthcare, crowd management, utility services*, etc. There is a strong necessity for researchers and industry to understand how to develop such large-scale city-scale sensing architectures from organic, unstructured and a mixed breed of infrastructure and community sensed data.

The topics of interests are detailed in the call for papers. In summary, we would like to focus on: a) understanding scalable architectures that can provide useful sensing-based information by combining infrastructure and citizen-supplied mobile data; b) investigating the data management, privacy and resource-related challenges that need to be addressed for large-scale urban deployments; and c) discussing innovative applications that attest to

the promise of urban crowdsensing in different market verticals.

RATIONALE AND OBJECTIVES

Sensor computing has been an active area of research over the last few years resulting in a number of conferences and workshops. Taken in isolation, both urban and mobile sensing have been investigated in recent years, and are clearly relevant to the broad ubiquitous and pervasive computing, and hence UbiComp. Mobile sensing has been a very active and rapidly maturing area of research in recent years (PhoneSense [3] is a well regarded workshop in ACM Sensys in this space). However, the principal focus has been on extracting detailed personal context (e.g., using sensors such as accelerometers, microphone and light sensors to understand a person's activity, location and even emotional state). Conversely, urban sensing has largely dealt with large-scale infrastructural deployments.

However, we feel that there is a definitive need for a forum to discuss and share research findings specifically related to the increasing activity at the confluence of the urban crowdsensing paradigms. So far, urban and crowdsensing as topics have only been addressed in isolated conference tracks [4] or in workshops [3, 8, 10]. The urban crowdsensing paradigm increasingly focuses on harnessing the power of mobile sensing in an aggregate fashion, and on combining such sensor streams with available infrastructural sensors, to extract "collective intelligence" about the overall public space or market vertical, rather than focusing on individual context extraction. In particular, with the evolution and continued development of the sensors that come either integrated with personal devices such as smartphones, tablets or as auxiliary devices such as sensordrone, and the deployment

of large scale sensor infrastructures in cities, new avenues are continually opening up for more sophisticated and intelligent urban and crowdsensing applications and services. Under these circumstances, we felt the need of providing an exclusive annual forum for the researchers to report their visions and work on urban and crowdsensing architecture and applications to an elite and very relevant audience at UbiComp. More specifically, urban crowdsensing is no longer about the intrinsic sensing capability, but is tied to aspects such as the mobility patterns of users (which decides the spatiotemporal variation in coverage density), the time-varying accuracy of the sensed context, the ability to extract collective context while preserving individual privacy, etc. It is important to point out that our selection of UbiComp is not accidental, but driven by our desire to bring together both the mobile/sensing systems community and the applications researchers. In particular, we believe that a forum such as our workshop can expose applications researchers to the often under-appreciated advances in mobile and pervasive sensing, and thus help catalyze the next wave of urban sensing applications.

TOPICS (CALL FOR PAPERS)

The PUCAA workshop provides a general forum for researchers on presenting and discussing all topics related to urban crowdsensing, in particular on building blocks about infrastructures and applications. The topics of interests broadly include, but are not limited to, the following three main aspects:

Data sourcing and aggregation:

- Innovative use of the sensors to capture real world phenomenon

- Energy efficient sensing
- Utility oriented sensing
- Cognitive-load sensitivity
- Data model
- Data aggregation
- Incentive models
- Privacy concerns

System or Platform Architecture

- Data processing and analysis
- Contextual/Semantic interpretation of sensor data
- Security models
- Real-time stream computing
- Cloud-based platforms
- Crowdsensing middleware platforms

Applications

- Innovative applications impacting urban lives
- User interface for crowdsensing applications
- Case studies around applying crowdsensing to a particular domain, such as retail, healthcare (mHealth), transportation, governance, etc.

- Tools, technologies and programming abstractions for developing crowdsensing applications
- Cross leveraging social networks for effective crowdsensing

ORGANIZATION AND COMMITTEE

We have rigorously evaluated the scope of plan for organizing this workshop and have established a strong committee to successfully conduct the workshop.

Organizers and Their Backgrounds

We have formed a strong organizing committee by bringing in researchers who are actively working in the space of research issues related to urban and crowdsensing architectures, as well as looking into the commercial and large-scale platforms being proposed by Industry to address the market needs. Notably, the organizers have been actively involved in prior data collection projects exploiting the community (e.g. OpenSense project at EPFL in Switzerland [1, 9, 7], LiveLabs at Singapore Management University, Nokias Mobile Data Collection project, PPMIM, FitSens, Mobile Personal Sensing, and PICK from UCLA). They are currently engaged in researching as well as carrying out feasibility studies of installing large-scale pilots in different parts of the world. In order to manage the workshop, program committee, publicity, we propose to have clear and well-defined roles for different organizers. Hence, we have intentionally kept 2 general chairs (*Archan Misra, Mani Srivastava*), 2 TPC chairs (*Zhixian Yan, Nilanjan Banerjee*), 1 steering chair (*Dipanjan Chakraborty*), and 1 publicity chair (*Sumit Mittal*).

Archan Misra is currently an Associate Professor of Information Systems at Singapore Management University

(SMU), and a Director of the LiveLabs Research Center there (www.livelabs.smu.edu.sg), which is deploying a large-scale mobile-centric sensing and lifestyle services experimentation platform at multiple urban spaces in Singapore. As part of his previous industry career with IBM Research and Telcordia Technologies, he has worked and published extensively in the areas of wireless networks, pervasive computing and mobile data management and is a co-author on papers that received the Best Paper awards in EUC 2008, ACM WOWMOM 2002 and IEEE MILCOM 2001. His research interests presently related to pervasive computing & mobile systems, with specific focus on energy-efficient mobile sensing & analytics, data mining for semantic activity recognition and advanced indoor localization.. He is presently an Editor of the IEEE Transactions on Mobile Computing and chaired the IEEE Computer Society's Technical Committee on Computer Communications (TCCC) from 2005-2007. He has served as General Chair & TPC Chair for several conferences (e.g., COMSNETS 2011, IEEE MASS 2008, IEEE WOWMOM 2006 and Mobiquitous 2009).

Mani Srivastava is on the faculty at UCLA where he is a Professor in the Electrical Engineering Department, and is also affiliated with the Computer Science Department. Prior to joining UCLA in 1992, he received his PhD from UC Berkeley in 1992, and worked at Bell Labs Research for a few years. He is a Fellow of the IEEE, has previously served as the Editor-in-Chief of the IEEE Transactions on Mobile Computing, and currently chairs its Steering Committee. His research interests are in embedded wireless systems, power-aware systems, wireless networks, and pervasive sensing. More details can be found at <http://nesl.ee.ucla.edu>.

Zhixian Yan is currently a research staff at Samsung Research located in San Jose, CA, USA. Before joining Samsung, he was a postdoctoral researcher at the Swiss Federal Institute of Technology - Lausanne (EPFL) in Switzerland, where he also received his Ph.D. in computer sciences in 2011. His primary research interests across mobile sensing, mobile data management, stream data processing and data mining, sensor network, mobile computing, semantic web, and web services. He has published over 30 peer-reviewed papers in top conferences and journals. In 2012, He got three best paper (nomination or honorable mention) awards at MobiDE'12, ISWC'12, MDM'12, respectively. He is also on server as the technical committee of several intentional conferences & workshops and journal reviewers.

Nilanjan Banerjee is a Research Scientist in the Telecom Research Innovation Center of IBM Research - India. His research interests are in the area of mobile-enabled industry solutions, specifically in creating context-aware applications, services and middleware for converged communication and collaboration; cloud computing; and optimization of dynamic systems. He received his Ph.D. degree in Computer Science from the University of Texas at Arlington. Nilanjan has been a part of the organization committee for MDM 2013 and MNCNA 2007.

Dipanjan Chakraborty currently works as an Advisory Researcher at IBM Research India. He has over 12+ years of experience in Research and Innovation. His primary research interests are in Mobile and Context-aware Computing and Services, Social Networks; Sensor Networks, and more recently on cloud-coordinated mobile sensing, semantic knowledge inferencing and behavior models of community sensing. Till date he has co-authored above 70 peer-reviewed publications. His

work has received above 2500 citations. He has filed 21 patents and has 8 issued patents. At IBM, he has received multiple prestigious research division accomplishment awards for his work in the area of Context-aware services. He has been involved in key roles in organizing several international conferences and workshops such as Mobile Data Management, Percom, Comsnets, International Conference on Pervasive Services, etc.

Sumit Mittal is a Research Engineer with IBM Research - India, working for the past several years in various aspects of Telecom and mobile computing, with strong focus on service composition, location based services, and context aware applications. Currently, Sumit's focus revolves around using the mobile phone as a platform for gathering rich contextual attributes of a user, and exposing the same for real-world applications in domains such as commerce, healthcare, etc. Sumit has a Bachelors degree in Computer Science and Engineering from Indian Institute of Technology, Kharagpur, India and a Masters degree in Computer Science from Rice University, USA.

Committee formation

We constituted a strong technical program committee, keeping a balance between academic and industry researchers. The PUCAA 2013 TPC is composed of 18 members that are worldwide top and active researchers in the ubiquitous computing and mobile crowdsensing areas. Consequently we could have each paper reviewed by at least 3 members of the technical program committee, so that the authors could receive valuable feedback about their work from the committee. Following is the list of program committee members:

- Aman Kansal, Microsoft Research, USA
- Anupam Joshi, UMBC, USA

- Arkady Zaslavsky, CSIRO, Australia
- Christos Efstratiou, Cambridge, UK
- Daniel Gatica Perez, Idiap Research Institute & EPFL, Switzerland
- Daniel Roggen, ETH, Switzerland
- Daqing Zhang, Institut Mines-Télécom/Télécom SudPais, France
- Demetris Zeinalipour, University of Cyprus, Cyprus
- Hans Scholten, Univeristy of Twente, Netherlands
- Janne Lindqvist, Rutgers University, USA
- Justin Manweiler, IBM Research, USA
- Mikkel Kjaergaard, Aarhus University, Danmark
- Pradipta De, SUNY, Korea
- Salil Kanhere, University of New South Wales, Australia
- Santosh Kumar, University of Memphis, USA
- Yoshito Tobe, Aoyama Gakuin University, Japan
- Youngki Lee, Singapore Management University, Singapore
- Zhiwen Yu, Northwestern Polytechnical University, China

In addition, we thank two external reviewers: Chenren Xu from Rutgers University, and Tao Feng from University of Houston.

TECHNICAL PROGRAM

Paper Submission and Review

We got 12 full papers submission from 9 countries, including Germany, France, Switzerland, Denmark, Netherlands, Hungary, Singapore, India, and United States. We followed single-blinded review process. Each paper was assigned to 4 TPC members for a peer review. Based on the review results, we selected 6 full papers (12 pages each) for presentation in the workshop and recommended major revisions for the rest of the papers based on the reviewers comments for them to be considered as short papers (8 pages each). After receiving the revisions they were accepted as short papers for presentation in the workshop.

The papers cover almost all topics related to next-generation of urban crowd sensing, including the strategies of designing distributed, energy-efficient sensing infrastructure, the models of sensing data interpolations, as well as many application aspects and scenarios.

- *Architectures (distributed)*: The design of distributed crowdsensing infrastructures, e.g., using DHT based peer-to-peer platform, applying the publish/subscribe middleware system.
- *Architectures (energy-efficient)*: The systems are dedicated to building sustainable sensing platform, and building more cost-effective and energy-efficient crowdsensing architectures.
- *Models and Metrics* - Multiple papers have presented methods to evaluate the crowdsensing systems, in term of designing metrics to quantify the heterogeneous data quality.

- *Applications* - Interesting application papers cover various scenarios, e.g., environmental monitoring through air quality sensing, security in enterprise settings, locating emergencies, conference sensing and proximity based Bluetooth sensing.

Technical Program

We have planned the technical program for the one day workshop as follows:

- Full Paper presentations: Each full paper presentation will be for 20 minutes with another 10 minutes for Q & A discussion.
- Short paper presentations: Each short paper presentation will be for 15 minutes with another 5 minutes for Q & A discussions.
- Keynote and invited presentations: We plan to have one keynote talk as well as one invited presentation to be delivered in the workshop.
- Discussion sessions: If time permutes, we would like to have one session dedicated to an open discussion among a panel of experts, whom we invite from the list of attendees in the workshop and UbiComp.

Workshop Awards

We are happy to announce two awards for PUCAA 2013. A *Best Paper Award* is sponsored by IBM Research and a *Best Presentation Award* is sponsored by Samsung Research. The awards will be announced at the workshop.

Proceedings

The accepted papers will be included in the UbiComp '13 Adjunct proceedings as well as in the ACM Digital Library.

Post workshop follow-up

We believe that our topic has a multi-year relevance, at least over the next 2-3 years. We do not plan to have a journal version of best papers this year. However, depending on the feedback we receive this year, we may have this in our plan for next year. We plan to host one meeting amongst the workshop co-chairs after the workshop at UbiComp, possibly bringing in some more experts present, to form a steering committee in order to plan for next year.

CONCLUSION

The PUCAA workshop at UbiComp 2013 offers a forum to bring researchers and practitioners working in the areas to discuss the potentials, technical challenges, the possible solutions for the emerging urban crowdsensing paradigm. The primary focus is on the efficient design of user-friendly sensing architectures and interesting and useful crowdsensing applications.

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