Ubiquitous Mobile Instrumentation

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Abstract
Mobile phones allow us to reach people anywhere, at anytime. In addition to the benefits for end users, researchers and developers can also benefit from the powerful devices that participants carry on a daily basis. Collectively, mobile phones form a ubiquitous computer. Ubiquitous Mobile Instrumentation (UbiMI) workshop focuses on using mobile devices as instruments to collect data and conduct mobile user studies, to understand human-behavior, routines and gathering users' context.

Author Keywords
Mobile; Ubiquitous; Computing; Instrumentation; Frameworks; Middleware; Experiments; Context-aware; User studies

ACM Classification Keywords
H.m. Information systems: Miscellaneous.

General Terms
Design, Experimentation, Theory, Verification

Introduction
Mobile phones are inherently personal and the potential to sense the user's environment, or in other words the user's context, is appealing to researchers. The convenience and availability of mobile phones and application stores makes it easier for a researcher to reach thousands of study participants. More

importantly, mobile phones have several built-in sensors (*e.g.*, accelerometer, proximity sensor, gyroscope). These mobile sensors are primarily used by the mobile operating system to enhance the user experience, such as application functionality or mobile phone user interaction (*e.g.*, vibration feedback, screen orientation detection), but they are increasingly being leveraged for research purposes.

Mobile phones are currently the most widespread sensing device. Can we instrument mobile devices to become the ubiquitous computer for the user? Widespread, mobile instrumentation offers opportunities for research and in facilitating a better understanding of human behavior. Challenges such as *heterogeneity*, *transparency*, *security, privacy*, *scalability*, *stability*, *reliability,* and *redundancy* to name a few, require a collaborative effort to manage user's context. If collectively instrumented, mobile devices can become the ubiquitous computer.

Contributions in UbiMI

In this section, we summarize two years of contributions to this workshop. Papers [4, 7, 9, 10, 11, 12, 14, 15] are from UbiMI'12. Papers [1, 2, 3, 5, 6, 8, 13] are this year's contributions. The papers' topics and challenges highlight the inherent diversity in expertise required in Ubiquitous Computing.

Focusing on understanding human mobility, Gustarini and Wac [7] proposed a people-centric mobility sensor that is both privacy- and energy-aware. Their solution can be applied to systems that aim to efficiently sense mobility context to study large-scale phenomena or perform location management. Rodrigues *et al.* [9] shared experiences on engaging participants for collaborative and longitudinal studies on sensing human mobility.

Tamilin *et al.* [12] propose a context-aware mobile crowdsourcing infrastructure to request civic participation into public decision making for public administration purposes. Similarly, Bustos-Jiminéz *et al*. [2] present the challenges of a crowdsourcing campaign on quality of service of mobile Internet providers in Chile. Besaleva and Weaver [1] CrowdHelp application provides emergency response teams real time patient assessment, by crowdsourcing in-situ information of an incident.

To advance the methods and tools for ubiquitous mobile computing, Desruelle *et al*.'s [4] web-based ubiquitous application platform, WebinOS, provides support for cross-device access to mobile sensors using HTML5. They share their design process, challenges on portability, scalability and privacy. Rodriguéz *et al*. [10] demo'ed InCense Toolkit, a GUI and interactive ontology builder to enable users to define the configuration of a sensing application, *i.e.*, what to sense and the flow of sensing. Lastly, Weiss and Lockhart [14] tackled the challenge of distribution and processing architectures for capturing and analyzing mobile sensor data and a data server. They concluded with a demo of WISDM (Wireless Sensor Data Mining) evaluation architecture.

Gamecho *et al*. [5] provide a sensor-fusion platform, as a context server. The server combines multiple sensors together, thus abstracting data mining and machine learning algorithms as an API for mobile devices. Böhmer *et al.*'s [3] AppSensor tool allows researchers to study mobile application usage.

In the domain of caregiving, Sano *et al.'s* [11] work focused on individuals with Autism Spectrum Disorders (ASD). More specifically, they look at challenging behaviors (CB's), such as self-injury or emotional outbursts, and leverage mobile sensors to capture context preceding such events. In collaboration with behavioral scientists and therapists, the paper reports on design requirements and an open-sourced prototype a mobile application to study ASD.

For indoor measurements, Zhang and Sawchuk [15] leveraged magnetometer sensors present in modern smartphones to detect the usage of household appliances by listening to unique magnetic signatures.

Moreover, for physical activity and activity recognition, Üstev *et al*. [13] discuss the challenges of human activity recognition on mobile phones, covering sensor diversity, accuracy and recognition limitations. Marshall [8] provides a sports coaching mobile application for sports researchers and practitioners. More concretely, Marshall's swimming coaching application provides amateur swimmers with instructions on how to improve their stroke with waterproofed sensors and mobile phone. Lastly, Gustarini *et al*. [6] discuss the challenges of human subject studies "in-the-wild" when using personal smartphones.

UbiMI Goals

UbiMI provides a better understanding of the current state-of-art in mobile devices instrumentation and how it affects future ubiquitous systems. In two years, we collected experiences, challenges and recommendations on:

- *Devices and techniques*: design, architecture, usage and evaluation of mobile devices and techniques that create valuable new capabilities for ubiquitous computing;
- *Systems and infrastructures*: design, architecture, usage and evaluation of mobile systems and infrastructures that support ubiquitous computing;
- *Applications*: design and/or study of how mobile applications can leverage other ubiquitous devices, systems and applications;
- *Methodologies and tools*: new methods and tools that are applied on studies or building novel mobile ubiquitous systems and applications;
- *Theories and models*: critical analysis or organizing theory with relevance to the design or study of mobile ubiquitous systems;
- *Experiences*: empirical investigations of the use of new or existing mobile technologies that can potentially motivate future mobile ubiquitous systems.

In this workshop, we bring together researchers who take advantage of the proliferation of mobile devices and use them as instruments for research on ubiquitous computing. We are especially interested in the mobile devices, systems, applications, methods and tools that were built to explore rich mobile context datasets. More so, we want researchers to share their experiences, successes and frustrations on conducting research in such power and processing constrained devices.

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