Mobile Context-Awareness: Capabilities, Challenges and Applications

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ABSTRACT
Mobile context-awareness is a popular research trend in the field in ubiquitous computing. Advances in mobile device sensory hardware and the rise of 'virtual' sensors such as web APIs mean that the mobile user is exposed to a vast range of data that can be used for new advanced applications. This workshop allows industrial and academic researchers to present work focusing on novel methods of context acquisition in the mobile environment - particularly through the use of physical *and* virtual sensors - along with research into new applications utilising this context. In addition, the workshop will encourage insights, into the technical and usability challenges in mobile context-awareness, as well as observations on current and future trends in the field.

Author Keywords
Context, context-awareness, mobile computing, human-computer interaction

ACM Classification Keywords
H.5.3 Group and Organization Interfaces: Collaborative Computing, H.4.3 Communications Applications: Information Browsers, H.5.m Miscellaneous.

General Terms
Design, Experimentation, Human Factors

INTRODUCTION
Context-awareness has been a popular research area for a number of years, particularly in the mobile environment. Modern smartphone hardware is becoming increasingly sophisticated with accelerometers, digital compasses and ambient light sensors included as standard in devices such as the latest Apple iPhone or Google Nexus One. Faster CPUs allow more services and applications to run simultaneously, and better GPUs allow for richer and more intuitive user interfaces.

In addition, mobile users are becoming used to 'always on' network connectivity; taking advantage of faster connections to use services such as push email, synchronised calendars and online application programmable interfaces (APIs) into social services, e.g. Facebook. These 'virtual' sensors expose the mobile device to additional data sources such as social networks, user preferences, tagged photographs and music playlists. Fusion of these sources with traditional 'physical' sensors, e.g. GPS, can allow for better context inference and, subsequently, a wider range of mobile applications. Furthermore, software developers are turning to mobile devices for application development. The soaring popularity of the Apple App Store and Android Marketplace means the mobile application business is predicted to be worth $17.5 billion by 2012 [1].

Commercial context-aware mobile services, e.g. Google Latitude or Layar, focus primarily on location and the single user's interaction with the device. Although location is a useful area of context, it is not the *only* area [11]; and this is even more apparent with the aforementioned range and diversity of data available to the typical mobile device. Successful commercial mobile services such as Foursquare are emerging that use multiple forms of context.

There has been a lot of research on the underlying enabling technology for context-awareness, e.g. sensing, sensor fusion and inference, but not as much on the practical application of these enablers [7]. With dependent variables such as sensor availability, connection speed and processing power constraining performance, it is difficult to maintain context-awareness at such a level that services remain useable in the face of sensing or inference failure.

RELATED WORK
Mobile device based context aware systems and applications are active research areas [4], and early work by Schmidt et al [10] used physical and logical sensors on a mobile device to demonstrate situational awareness. In [8], Indulska and Sutton discuss the idea of physical, virtual and logical sensors when applied to location management in pervasive systems. Recent work by Anagnostopoulos et al [2] use *historical* mobile context with a supervised machine learning method in order to predict the location of the mobile user. This illustrates the capability of using contextual data to predict user actions estimate 'future' context parameters.

ContextPhone [9] is a mobile platform built to enable context-aware technology such as the ContextContacts application that lets users represent and exchange presence information with their mobile device contacts. The Connector application [6] uses a series of sensors and techniques for sophisticated context detection in order to intelligently connect people. More recently, the Friendlee application by HP Labs [3] uses call records and contextual data to infer the user's immediate social network, before reordering the device contacts accordingly.

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Further examples include Microsoft's Virtual Compass [5]; a peer-based indoor localisation system for mobile phones. To establish relative location, the application uses data on the relative spatial relationships between proximate peers through short range radio sensors. Privacy applications are also being developed; including the TreasurePhone application [12] that uses a context-sensitive security model for privacy protection on mobile devices.

PROPOSED RESULTS

The goal of the workshop is to share knowledge of ongoing research into mobile context-awareness, from hardware and middleware to higher level applications; particularly those that make use of multiple physical and virtual sensors. Thoughts, challenges and future developments in the field will be discussed, and the workshop will allow research to be presented to a target audience of academic and industrial peers.

The workshop is aimed at the UbiComp community, so submissions will be from both technical and HCI standpoints, with emphasis on studies and empirical results from work in the field. The proposed workshop results, therefore, are:

- Novel mobile applications that use context-awareness, particularly from multiple sources
- Novel methods of context data acquisition through physical, virtual or logical sensors
- Methods of context inference, particularly on-device implementations
- Mechanisms to deal with sensing and inference failure in context-aware applications and services
- Studies that successfully utilise historical context, i.e. through learning.
- Studies that utilise predictive methods of context acquisition, e.g. likelihood of availability or future presence.
- Privacy mechanisms and how they might affect usability in mobile context-aware systems.

We hope the results can contribute to the main conference by presenting an overview of the current state of the mobile context-awareness field, with overviews of ongoing research and future challenges for the community to address. It is hoped the workshop outputs can augment the contributions in the field presented at the main conference, with insights into alternative methods and ongoing projects that may not be in such a complete state as those presented at the main program.

We envisage the workshop focus on mobile context-awareness will reinforce work on presented work on general context-awareness, supporting the ethos of Ubicomp and pervasive computing.

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