Sensors and Surveys: Collecting Qualitative and Quantitative Data on Human Attitudes, Behaviors, and Activities via Mobile Phones

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Context-aware mobile computing has enormous potential to impact healthcare. For example, research applications are being developed to predict an elder's likelihood for falling based on real-time gait measurements or automatically infer a user's level of fitness activity based on wearable sensors and machine inference. Such systems, however, are challenging to design, build and evaluate. Often, initial studies must be conducted to collect ground truth data to inform the machine learning and inference algorithms (*e.g.,* how does jogging, bicycling, and stair climbing manifest itself in a belt-worn accelerometer?). Once these algorithms have been constructed, the applications which use them must be evaluated in an ecologically valid way (*i.e.,* outside of the laboratory).

MyExperience is an open source tool for mobile phones, which combines sensing, machine inference, and self-report to collect both qualitative and quantitative data on human behaviors, attitudes and technology usage *in the field*. It supports both formative and evaluative studies within the context-aware computing design process. MyExperience has been used in a range of health-related studies including: (1) investigating the use of wearable activity-inference devices and mobile phone technology to promote physical activity; (2) using wearable heart rate variability monitors to trigger mobile therapy sessions related to stress and/or anger management; and (3) a preliminary obesity study looking at the correspondence between sensor measured physical activity and geospatial location. In addition, we are currently working with the rehabilitative medicine department at the University of Washington to study how activity levels affect pain and fatigue.

MyExperience provides access to over 140 sensor events including device usage (*e.g.,* open applications, buttons pressed), communication (*e.g.,* phone calls, SMS), user context (*e.g.,* calendar appointments), and the environment (*e.g.,* location). Other sensors can easily be added via our plug-in architecture—for example, study #2 above developed a sensor to interface with a Bluetooth-based heart rate sensor and Intel Research has developed a set of sensors to interface with their Bluetooth-enabled Mobile Sensing Platform (MSP). Sensor data is automatically time stamped and logged to a database local to the device. The sensor events themselves can be used to trigger custom actions such as wireless database synchronization, sensor throttling and *in situ* self-report surveys. MyExperience has been designed to run on a subject's personal phone thereby eliminating the need to carry a specialized data collection device.

MyExperience's *in situ* self-report surveys can be time based or sensor-triggered and are specified via an XML interface. The surveys may be used as a substitute for physical sensor data (*e.g.,* asking users for their location rather than requiring them to carry a GPS unit), to acquire ground truth via *in situ* labeling, or to gather data on imperceptible details such as the user's beliefs, feelings, or attitudes. To decrease user burden, self-report sampling strategies can be dynamically modified throughout the course of a study (*e.g.,* diminishing the number of self-report triggers in areas enough data has been gathered). Moreover, depending on the cell phone's data plan and hardware capabilities, real time updates on participation can be sent to researchers via text messaging, WiFi, or GPRS.

MyExperience has been open sourced under the BSD license (http://myexperience.sourceforge.net).