

2.7 Participatory Sensing (PART)

The vision of Participatory Sensing is of distributed data collection and analysis spanning the personal, urban, and global scale, often using “everyday” technologies like cell phones, in which participants make key decisions about what, where and when to sense. Previously called Urban Sensing, the area was renamed to emphasize both its wide applicability outside of cities and its strong conceptual grounding in user participation (Figure 5).

The area targets technologies and applications that transform our capacity to help individuals, families, and communities monitor and improve their own health behaviors, adopt sustainable practices in resource consumption, and participate in civic processes. Each of these three touchstone topics—**health, sustainability** and **civic engagement**—is being explored in real-world deployments, such as *AndWellness* (now Google and NIH-funded); the *Personal Environmental Impact Report* and *What’s Invasive*; and *Remapping LA*, respectively. In addition to these application-driven pilot deployments, the area has conducted technology-focused research around topics necessary for complete, robust participatory sensing systems, including: participant recruitment, task planning, and sensing campaign management; human activity classification based on mobile phone sensors; integration with environmental monitoring assets; and data visualization. Privacy challenges are being addressed within a holistic ethics framework that emphasizes principles of participant primacy, data legibility, longitudinal engagement, and parsimony. From this work, the concept of a *personal data vault* (PDV) has emerged as a key technical component of a safe future participatory sensing ecosystem. The PDV would provide both technical and legal mechanisms to protect individuals’ participatory sensing data while supporting its use third-party applications of benefit to the user.

Since the introduction of the term by CENS in 2006, the area of *participatory sensing* (along with urban sensing) has generated a body of multidisciplinary work spanning many universities, including UCLA, Dartmouth, Columbia, MIT, CMU. It has also inspired work outside computer science in design, urban planning, and the arts. The more technical aspects of our PS innovations are included in the section covering Programming and Platforms.

Application Drivers & Pilot Deployments

Collaborations targeting the three focus areas continue with the Semel Institute’s Global Center for Children and Families at the UCLA School of Medicine, the National Park Service, UCLA REMAP, and others. The group has also developed new collaborations to increase the scale of public use of these technologies. For example, a partnership with the Los Angeles Unified School District and Google will incorporate participatory sensing on Android phones into computer science and mathematics classrooms starting in Spring 2010, with expansion across the district pending further funding from NSF. A new collaboration has begun with the Boyle Heights Neighborhood Collaborative in Downtown Los Angeles to map, record, and accumulate data on community member circulation and related conditions—a unique, active and participatory approach to supporting the Boyle Heights Planning for Place project in developing its plan for a healthy community. CENS also received a highly competitive ARRA-funded NIH Challenge Grant to develop an innovative real-time assessment of behavioral exposures for cardiovascular disease (CVD) in young overweight mothers. Other health science projects include exploratory work around supporting cancer survivorship research, HIV behavior

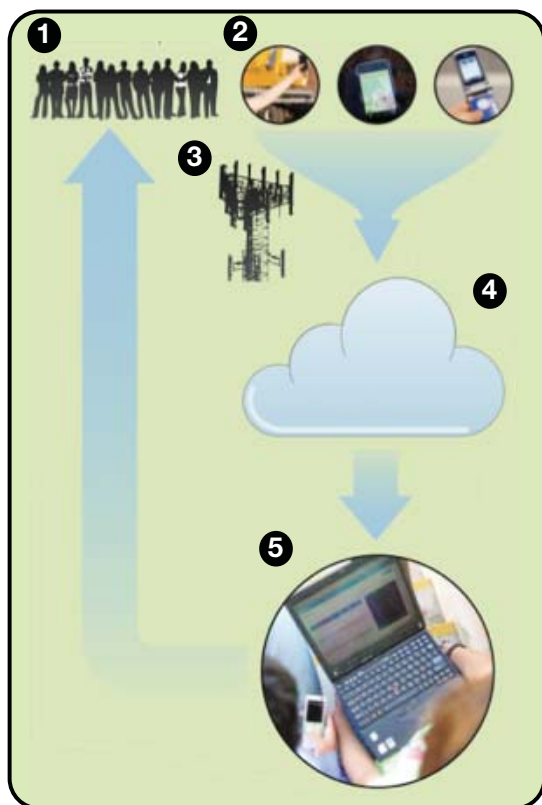


Figure 5. Participatory Sensing in Action. **1. Participate.** People can initiate a Participatory Sensing exercise for a variety of reasons. The first step is to organize the participants—whether individuals acting alone or a large group acting in concert—to determine the goals and data collection plan. **2. Mobile personal data devices.** Using mobile phones, participants collect data automatically (e.g., location logging) or manually (e.g., taking pictures). **3. Ubiquitous wireless transfer.** Data are moved from anywhere in the world via wireless infrastructure. **4. Data processing in “the Cloud.”** Data from a variety of sources and locations are collected and processed to reveal patterns that were previously invisible. **5. Learn and act.** Participatory Sensing systems digest the results of analyses into simple visualizations that can be shared and used to make change.

survey with the Center for HIV Identification, Prevention, and Treatment Services, and a collaboration with UCSF on “mHealth” architecture.

Applications have thus taken on larger populations, with the largest this Spring on the order of 300 users, with increasing number and scale planned for 2010-2011. This scaling will generate substantial feedback on system robustness requirements and optimization targets; participant pool coordination, planning and management needs; and the importance of careful user experience and interface design for successful deployment. Longer-running applications, like PEIR, have provided the opportunity to create second generation architecture and begin model validation.

Privacy, Ethics, Law and Policy

A major focus of research and implementation is the Personal Data Vault (PDV): a logically isolated secure repository for participatory sensing data that is controlled by the handset owner. The PDV receives participatory sensing data as it is collected and selectively distributes it to third party applications according to a set of sharing rules created by the user. Not only does this aim to reduce the number of parties holding potentially sensitive data, but also to create a place for users to visualize and manage what data are being collected about them and what they have elected to share. We envision an ecosystem of PDVs as a fundamental part of future participatory sensing systems, and are collaborating with Prof. Jerry Kang of the UCLA School of Law to develop a legal approach that could provide additional protection for the data contained in the PDV. An initial implementation is being built and will be integrated into CENS applications in 2010-2011.

The PDV is one of several examples of CENS participatory sensing research that is influenced through interaction with ethics education and research that aims to promote the participatory principles and user empowerment fundamental to this area. This work is in its second year of funding from the NSF Ethics Education in Science and Engineering, and is centered a participant-observer study of CENS research that aims to develop educational materials promoting ethics considerations in the development of participatory sensing systems, as well as original work in Information Studies on participatory practices in data collection. In addition to academic publications, reports, and popular articles in this area, a new interdisciplinary undergraduate course is being offered this spring that will explore the topics in depth.

Future Work

New work in the next year will continue to focus on expanded real-world deployments with a larger number of users, higher stakes uses in real communities, and more robust, shared systems (such as the PDV) to support data collection campaigns. These deployments will provide the systems scaffolding and practical opportunities to incorporate technology research in campaign deployment, management, recruitment, incentive, data processing and the other areas listed above. They will also provide opportunity for formal user studies and more concrete understanding of how to achieve maximum impact in the real world. Following an assessment of progress of the area planned for early Summer 2010, we will reorganize the technology and application research around a set of central challenges for the remaining two years of CENS core funding.