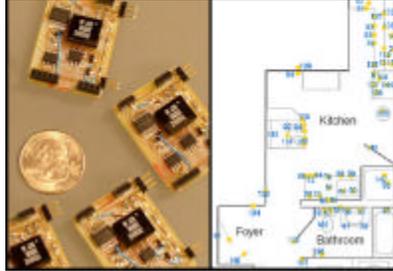


# Portable Place-Based Research Tools



## A House<sub>n</sub> Initiative

House<sub>n</sub> researchers have developed a collection of small, portable, and inexpensive wireless sensors, wearable devices, and associated algorithms and methodologies enabling MIT researchers and sponsors to conduct research in everyday places of living, work environments, and public spaces.

### Overview

Behavior in the real-world home or workplace setting is enormously difficult to simulate in a laboratory. The interaction of people with other people and objects in their spaces leads to unexpected behavior that is difficult to anticipate with focus groups, surveys, and other standard product development and marketing inquiry methods. As a result, a high percentage of new products fail because their design was based on erroneous assumptions.

The PlaceLab has been designed to bring the capabilities of a highly instrumented research lab to a home in a residential building located in a residential neighborhood. The PlaceLab, however, is a single facility that must be shared between multiple projects, and it requires people to move into an environment that is not their own. To complement the PlaceLab, House<sub>n</sub> researchers have developed a low-cost, portable kit of technologies and corresponding design methods for studying people in their own spaces. Many anticipated studies will take advantage of both the PlaceLab and the portable place-based research tools. For example, researchers will be able to determine a subject's baseline activity patterns in their own home, test the effect of prototyped innovation while the subject is living in the PlaceLab, and observe if the effect is sustained over time when a subject returns to his/her home.

### Portable Place-Based Research Tool Features

- o **Affordable.** On limited budgets, an extensive network of observational sensors can be installed in multiple homes or workplaces
- o **Easy to install and remove.** The sensors and algorithms are designed to permit rapid installation and removal without damaging the environment by non-expert installers. Installation consists simply of taping on the sensors or, for mobile sensors, wearing an elastic wristband
- o **Unobtrusive.** The sensors are small and wireless so they can be installed in an environment in an inconspicuous way and left to monitor the environment for months. Wearable sensors are small and comfortable and can be worn continuously if desired, even when sleeping
- o **Informative.** The place-based research tools consist of both sensors and algorithms. The sensors acquire data that is processed by algorithms that can detect what people are doing and when. MIT research results on algorithms that automatically detect activities are being incorporated into the research tools. Currently, sensors can detect events such as cooking, walking, running, toileting, cleaning, bicycling, etc.. Proactive querying tools can be used to acquire information from a person about mood, state of mind, or other cognitive states difficult to infer automatically from sensor data.
- o **Robust.** Portable place-based research tools are designed for deployment in real environments, not academic laboratories. They have been tested in homes in the Boston area in MIT studies. Based on this work, they are being continuously improved so that other researchers and sponsors can deploy them on a larger scale in homes and workplaces for long-term studies.

### Portable Place-Based Research Tool Components

- o **Context-aware experience sampling.** Software has been developed for standard PocketPC to acquire data and context-specific feedback from people. Sensors may be used to trigger questions and data capture. For instance, the computer can monitor heart rate and ask questions based upon variation in heart rate .
- o **Tape-on sensor kit.** These small, wireless, and low-cost sensors can be distributed by the hundreds throughout an environment. They can detect on-off, open-closed, and object movement events. MIT algorithms can then be used to study the data and automatically detect certain activities in real-time. The tape-on sensors can be used with computing devices such as computers, phones, or PDAs to develop and test technology that automatically presents information based upon a person's activities. (Time-stamped data version is currently available - real-time version is under development)
- o **Image-based experience sampling.** Computer vision algorithms can be used with portable cameras to collect video and audio data from an environment using MIT software, laptop computers and the tape-on sensor kit.
- o **Location beacons.** Low-cost radio frequency devices permit approximate position detection of people within their environments and the tracking of movement over time. People do not need to wear visible tags and can turn the location tracking off by simply removing a small sensor from their pockets. (In development)

- o **Wearable motion sensors.** These small, comfortable, and low-cost accelerometer devices can be easily worn for days or weeks and used to collect data on what people are doing. MIT algorithms have been developed to automatically detect specific activities, such as walking, cleaning activities, moderate physical activity, and body posture. In combination with a mobile computing device (e.g. PDA or phone), the sensors can be used to detect specific activities of a person in real-time and provide or collect context-specific information. The devices are being validated by the medical community for use in monitoring activities of daily living. (Time-stamped data version is currently available - real-time version is under development)

### Right to Use

The place-based research tools are available to Changing Places / House\_n Consortium sponsors for studies conducted in homes of their customers or their own workplaces. MIT researchers will provide guidance on the use of the tools and, through additional sponsored research grants or consulting, will work with MIT researchers to develop and execute studies of special interest to individual companies.

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Document Revision: November 11, 2003