CitiSense - Adaptive Services for Community-Driven Behavioral and Environmental Monitoring to Induce Change

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Recent revelations about the impacts of air pollution on our health are troubling, yet air pollution and the risks it poses to us are largely invisible. Today, the infrastructure of our regulatory institutions is inadequate for the cause: sensors are few, often far from where we live, and the results are slow to come to us. What about the air quality on *your* jogging route or commute? Can you be told when it matters most? Advances in computing technologies can allow us to answer these questions. By pervasively monitoring ourselves and our immediate environs, aggregating the data for analysis, and reflecting the results back to us quickly, we can avoid toxic locales, appreciate the consequences of our individual behaviors, and together seek a mandate for change.

The CitiSense project is leveraging the proliferation of personal mobile computing via mobile phones and the advent of cheap, small sensors is developing a new kind of "citizen infrastructure". Challenges abound in power management, data security, privacy, inference with "noisy" commodity sensors, and incisive yet considerate user notification. An overriding challenge lies in the integration of the parts into a seamless yet modular whole that can make the most of each component at every point in time through dynamic adaptation. Solving this problem will not only allow the superior integration of existing techniques, but allow developing new adaptive techniques not before possible. In CitiSense we are investigating the use of the Open Rich Services (ORS) publish-subscribe architecture to address these challeanges. As just one example, ORS will enable highly adaptive power management that not only adapts to current device conditions, but also the nature of the data, the data's application, and the presence and status of other sensors in the area.

We have completed our first prototype of the CitiSense system (See Figure). It comprises (a) a sensor board with Bluetooth networking that hosts nitrogen dioxide, carbon monoxide, and ozone sensors, (b) a back-end server that warehouses captured data, and (c) a phone application that connects to the board, relays sensor data to the back-end server, and displays information to the user. We conducted an initial field study with bike commuters, who found the information increased their awareness of their exposure to air pollution, which they found useful. To our surprise, the instantaneous levels of nitrogen dioxide reported on commutes often exceeded the EPA 1-hour standard. With an improved system, we are now running a larger, longer study with a wider range of commuters.

In the coming year we will be integrating the results of our research in power management research and statistical inference, the latter making the system available to those who do not carry a sensor board.