Sensors in a Shoebox: Engaging Detroiters in Analyzing and Meeting Community Needs

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Introduction

The Sensors in a Shoebox project focuses on empowering urban citizens with the tools and methods necessary to observe and analyze the physical, social, and natural systems that affect their communities for improved community-based decision making. The project creates a novel, ultra-low power wireless sensor architecture called *Urbano* to serve as a versatile foundation for an affordable and ruggedized sensor kit. This kit consists of solar-powered wireless sensors with cellular Internet connectivity that can be distributed to communities to sense environmental parameters, vibrations, and motion, among other parameters. Data is transmitted from community-deployed sensor kits to the cloud where sensor data is stored and managed. The community directly accesses their data from a web portal offering a suite of user-friendly analytical tools that citizens could use to extract community-relevant information from raw sensor data.

Research Objectives

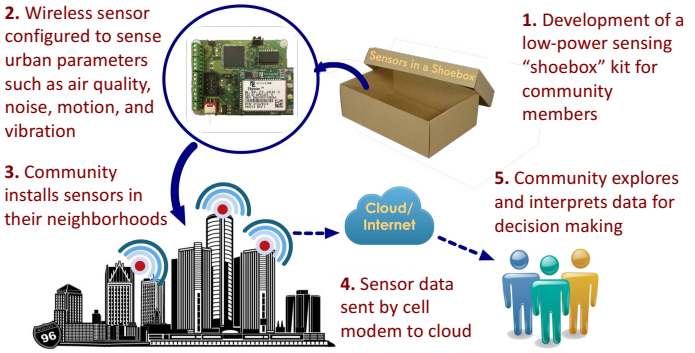

Figure 1: Objectives for the development and implementation of the *Urbano* platform

Methods

Microcontroller
Ultra-low power µC manages sleep states and controls DAQ, storage, processing and data transfer

Power Harvesting
Solar power harvesting to ensure self-sustaining nodes

Cellular Modem
4G/LTE modem transfers data using AWS (to the cloud) and via SMS

Freedom from Wired Power Source
Enables deployments in cities using solar energy

Rapid Deployment
Self-sustaining nodes make managing dense deployments feasible

Mobile Connectivity
Sensors can be deployed (stationary or mobile) anywhere with connection to internet

Urbano Wireless Sensing Architecture

Urbano consists of an ultra-low power microcontroller, flexible sensing interface that is compatible with analog and digital sensing transducers, has external SRAM for storage and on-chip data processing, and uses a wireless 4G cellular modem. The platform is designed to allow *all* urban stakeholders easy access to data collection capabilities but does emphasize use by community members. First, the cellular modem ensures stakeholders using the platform do not require access to tethered communication media (*e.g.*, fiber network). Second, its low power design allows it to be operated from solar panels without a need to access a wired power source (*e.g.*, power provided by street furniture). By eradicating the need for wired connections, the device allows stakeholders to deploy more freely and minimizes their dependencies on other parties (*e.g.*, gaining permission to access power and communications at a lamppost). Data collected by *Urbano* is pushed to a cloud database where data is stored, curated and analyzed. Visualization tools are used to view the data.

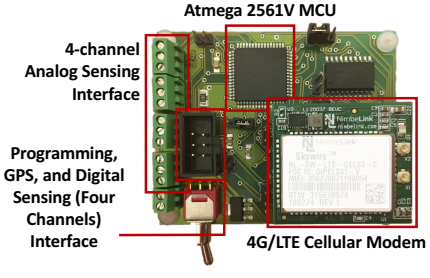

Figure 2: *Urbano* node with key components highlighted

The *Urbano* node is coupled with a variety of sensing transducers into a water-tight enclosure called a *Sensors in a Shoebox* kit and deployed by community members in Detroit. The Shoebox kit includes air quality sensors (measuring O_3, SO_2, NO_2, and PM), passive IR sensors (measuring pedestrians) and GPS receivers (to measure kit location). Figure 3 shows air quality and pedestrian counting Shoebox kits fully assembled. These kits have been deployed by youth in Southwest Detroit where poor air quality is known to be a leading cause of high rates of asthma among young community members.

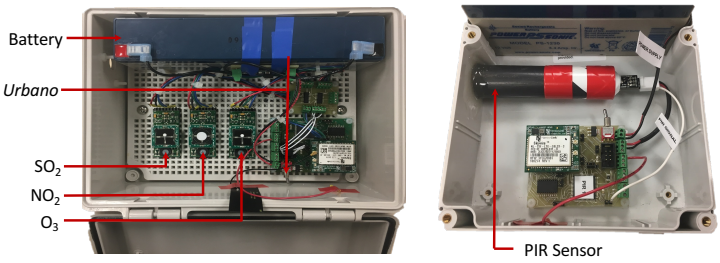

Figure 3: Ruggedized sensing "shoebox" kit for (a) air quality and (b) pedestrian counting sensing

Impact

To achieve the goal of conceiving of Detroit as a "smart and connected" city, the researchers understand the need to support citizens, specifically youth, in developing the skills necessary to engage with the *Shoebox kit* meaningfully. In its pilot phase, the educational team worked with community youth around urban sensing research. Through afterschool programming, youth defined and delimited their own research problems that could be studied by sensors technology within the City of Detroit. Several problem ideas were generated by youth including *water quality*, *air quality*, *space usage*, *walkability*, and *noise levels* of their city, informing sensor selection. The team supported youth in 1) building qualitative instruments to compliment and expand sensor data collection; 2) collecting sensor and social science data; and 3) analyzing said data to support claim-making. Through this work, youth are positioned as agents of change for their city. The educational team are continuing to explore the impact of this in the context of teaching and learning.

Figure 4: Deploying a *Shoebox* kit on the Detroit waterfront to count pedestrians

Acknowledgements

The authors gratefully acknowledge support for this research, through NSF Grant Number 1637232 and the Knights Foundation.