Editor: Anthony D. Joseph ■ UC Berkeley ■ adj@eecs.berkeley.edu

Environmental Monitoring and Task-Driven Computing

EDITOR'S INTRO

Two monitoring projects—one in Italy, the other in Ireland—relate to this issue's theme, "Hostile Environments." In addition, an ongoing project in Australia reports on a task-driven recommendation system for pervasive computing environments.

—*Anthony D. Joseph*

LANDSLIDE MONITORING IN THE EMILIA ROMAGNA APENNINES

Alberto Rosi, Matteo Berti, Nicola Bicocchi, Gabriella Castelli, Alessandro Corsini, Marco Mamei, and Franco Zambonelli
Università di Modena e Reggio Emilia
Matteo Berti
Università di Bologna

Italy's Emilia Romagna Apennines are characterized by widespread landslide phenomena that pose a potential danger to villages and infrastructures. Existing monitoring technologies are coarse-grained, discontinuous, and costly. To overcome these limitations, we've started an interdisciplinary collaboration to study wireless sensor networks in this context. We've developed and deployed the first prototype in a steep landslide area near the village of Calita.

The network's infrastructure was first deployed in late 2008, and it's been working ever since. It currently exploits 13 Crossbow Micaz motes with TinyOS software and covers a surface of approximately 500 square meters. The nodes embed accelerometer boards to capture slope movements and environmental boards to monitor ambient parameters such as temperature, pressure, humidity, and light depth. In-node processing and event-based data delivery minimize communications and save energy. A base station delivers data to a central server every 15 minutes to support near-real-time analysis (see Figure 1).

Analysis of the data collected so far proves the system's capability to detect slope movements with high accuracy. In fact, comparisons between the sensor-network data and the data collected from the preexisting instrument sensors, such as strain gauges and inclinometers, show a good match. The wireless networks could therefore potentially act as an effective comple-

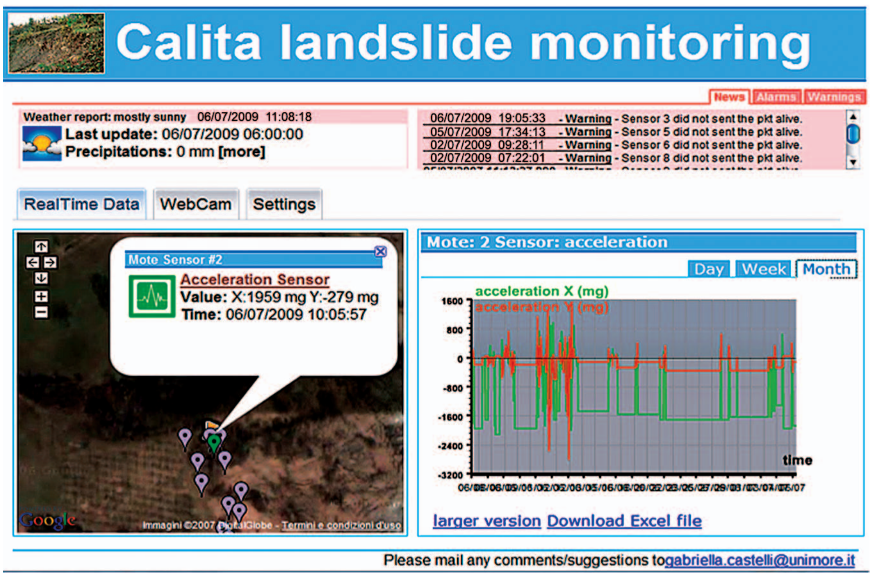

Figure 1. A screenshot from the Calita monitoring Web site. The top window displays log information. The left window shows node locations on a Google Maps layer, and the right window displays sensed data graphically.

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ment to existing landslide monitoring technologies.

Despite encouraging early results, the deployment has posed several challenges:

- *identifying suitable packaging to protect the sensors in a hostile environment while ensuring unbiased measurements,*
- *handling premature battery drains and unexpected sensor unavailability, and*
- *handling communications efficiency in highly variable environmental conditions.*

On the basis of lessons learned in the prototype deployment, we're currently working to deploy improved infrastructures in other critical landslide areas in the same region.

For more information, contact Alberto Rosi at alberto.rosi@unimore.it.

AIR QUALITY MONITORING FOR PERVASIVE HEALTH

Philip Angove and Brendan O'Flynn
Tyndall National Institute
Jer Hayes
IBM
Dermot Diamond
National Center for Sensor Research
Michael J. O'Grady and Gregory M.P. O'Hare
University College Dublin

Exposure to a range of gases over a long time can give rise to health problems. Identifying situations in which such exposure has been a contributing factor to ill-health is almost impossible. To address this issue, we've developed a novel sensor board (see Figure 1). We expect to integrate the board into sensor networks in both home and work environments.

Figure 1. The 25-mm Bluetooth air-quality monitor. Onboard sensors monitor critical carbon-monoxide and volatile-organic-compound levels as well as ambient parameters such as humidity, temperature, and vibration.

We mounted sensors for carbon monoxide (CO) and volatile organic compounds (VOCs) on the board. CO is one of the most common forms of poisoning death. Older adults are especially vulnerable to accidental poisoning, but CO can cause flu-like symptoms in otherwise healthy people. A variety of products frequently found in home and work environments emit VOCs. Such gases can linger long after the activity that generated them has stopped. Prolonged exposure can lead to a wide range of symptoms and may cause cancer.

The air-quality monitor consists of a stackable 25-mm Bluetooth sensing layer on the Tyndall 25-mm mote. Both the CO and VOC sensors are hosted on an IEEE 802.15.14 radio platform. We interfaced a standard Bluetooth 2.0/Enhanced Data Rate module to the mote microcontroller using a serial Universal Asynchronous Receiver/Transmitter interface. The system integrates with conventional wireless sensor networks through Bluetooth or Zigbee.

Ireland's National Access Program has supported this work under the auspices of the Tyndall National Institute and Science Foundation Ireland. For more information, contact Philip Angove at philip.angove@tyndall.ie.

TASK-DRIVEN FRAMEWORK FOR PERVASIVE COMPUTING

Chuong C. Vo, Torab Torabi, and Seng W. Loke
La Trobe University, Australia

We're engaged in an ongoing project to investigate the feasibility, effectiveness, and usefulness of applying a task-driven computing paradigm in pervasive computing environments (PCEs). Task-driven computing aims to abstract the technologies available in a given PCE so that users can focus on tasks they want to achieve rather than the technologies available for achieving them.

Consider a scenario in which a university is organizing an international conference that applies many pervasive technologies (services, devices, and so on) across the campus. Conference participants come from all over the world, and many are unfamiliar with the conference's implementation of the technologies. Features such as registering as a presenter, exchanging e-business cards, or setting up a slide show don't function in ways they expect.

WORKS IN PROGRESS

TaskOS is a task-driven system for PCEs that includes a context-aware task recommender. With TaskOS, users can quickly understand what tasks they can achieve across the environment, within a specific location (for example, a seminar room), or even with physical objects near them, such as large public displays. TaskOS also guides users through the selected task.

A task is the fundamental concept of the TaskOS framework. It represents a user's goal or objective. Developers create or modify a task in a *task model description*, an XML specification that describes how the task executes. Then they register the description with a task repository (local or global), where it becomes available as a recommendation to users according to their context. Contexts can include locations, nearby devices, or pointing gestures. TaskOS systems can also incorporate collaborative-filtering techniques into their recommendations.

Once a user selects a task, the system loads the corresponding task model description into a task execution engine. By incorporating context information, the task execution engine can automatically fill contextual parameter values required for executing the task, such as the time, location, and user's identity. Also, by considering the current environment's capabilities, the task execution engine can select appropriate services and devices during execution.

We're currently developing a task model description schema and task execution engine for supporting multidevice task specification and context-aware task execution. We're also investigating methods for discovering and recommending tasks and mechanisms for advertising and sharing task models.

For more information, contact Chuong Vo at c.vo@latrobe.edu.au.

IN THE MIDDLE OF A PERVASIVE COMPUTING PROJECT?

In addition to feature-length articles, *IEEE Pervasive Computing* invites work-in-progress submissions of 250 words or less on topics ranging from hardware technology and software infrastructure to environmental sensing and human-computer interaction.

Works in progress are not formally peer-reviewed, but submissions must be approved by the WiPs department editor, Anthony D. Joseph. If accepted, they are edited by the magazine's staff for grammar and style conventions.

Submit a WiPs report on your project to pvcwips@computer.org.