Guest Editors' Introduction: Hostile Environments

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Hostile Environments

Hostile environments are a particularly relevant application of pervasive computing. The technology can save lives by both eliminating the need for humans to work in these environments and supporting them when they do. Examples of application areas include firefighting, search and rescue, the military, and environmental monitoring. Potentially hostile environments for humans include outer space, caves, the arctic, deserts, jungles, underwater, and certain industrial or research settings, such as nuclear power stations, accelerator beamlines, biohazard zones, and chemical plants. Significant challenges for pervasive systems are often also found in sports (for example, swimming or skiing), which can at times involve user risk.

In general, environments that are hazardous to humans are hard on technology as well. Of course, nonhazardous situations can also strain the technology—for example, monitoring machinery that creates intensive, high-frequency vibrations can be hard on the electronics without being dangerous to humans.

Applications in Hostile Environments

We can distinguish three broad categories of applications in hostile environments, which are exemplified by the articles in this special issue.

Environmental monitoring is the traditional domain of sensor networks and has a large pool of research and applications. Devices record and forward simple parameters, often over large areas and extended time periods. Such applications facilitate the study of...
environments that are hostile or not easily accessible without endangering humans. In this issue, Marcus Chang and Philippe Bonnet’s article on arctic monitoring represents this category.

Going beyond monitoring of simple parameters, pervasive computing also offers situational awareness and tactical support, assisting teams engaged in activities in hazardous environments with complex, integrated information and extended communication and collaboration capabilities.1 The article on wildfire monitoring by Cristina Barrado and her colleagues exemplifies this domain.

Pervasive systems can also focus on the individual, enhancing his or her ability to deal with a hazardous situation. Functionality can range from guidance support and advanced communication capabilities to hazard warnings.9 In most cases, appropriate user interfaces are a key issue, and wearable computing solutions play an important role. In this issue, the LifeBelt article by Alois Ferscha and Kashif Zia is an example of such an application type.

Technology challenges come mainly from four sources:

- the harshness of the environment, in which factors such as temperature, vibration, or radiation have significant impact on hardware reliability and stability and require special precautions;
- the environment’s impact on the system’s ability to function correctly, in particular with respect to sensor-data collection and communication;
- the need for safety-critical systems with high data reliability and accuracy; and
- the need for interaction concepts that provide full access to the required functionality without distracting the user from the physical world.

Although such interaction requirements in this last challenge are common of many pervasive systems, they’re particularly critical and difficult in hostile environments, where undue distractions can be life threatening.

In This Issue

This issue contains three articles and a Spotlight column, all of which illustrate many of the issues discussed here.

Chang and Bonnet’s article, “Monitoring in a High Arctic Environment: Some Lessons from MANA,” is an experience report illustrating the challenges involved in water-quality monitoring in a remote arctic region. The system consists of sensing buoys deployed on a lake and a base station that receives, processes, and forwards the data. Discussion includes handling temperatures as low as −40º C combined with humidity and winds; power supply considerations; communications system design; and deployment problems.

The Spotlight column, “The IceCube Detector: A Large Sensor Network at the South Pole,” by Martin Merck, takes place at the opposite end of the Earth, and describes challenges involved in deploying the IceCube neutrino observatory—essentially a large sensor network comprised of many phototubes deployed deep in the Antarctic ice to detect neutrinos for cosmic ray physics research. Sensor networks are a core technology of ubiquitous computing, and this article indeed describes an extreme implementation of one.

“Wildfire Monitoring Using a Mixed Air-Ground Mobile Network” by Barrado and her colleagues describes a mobile ad hoc network solution for forest-fire-hot-spot localization that consists of unmanned aerial devices equipped with infrared sensors, a set of relay balloons that improve communication quality, and ground vehicles. The article focuses on communication design and quality.

Ferscha and Zia’s “LifeBelt: Crowd
Evacuation Based on Vibro-Tactile Guidance” describes a vibro-tactile belt designed to help people find their way out of a building in an emergency. The article briefly sketches the devices, then models their influence on large-scale evacuations. This article exemplifies an emerging trend in pervasive computing research—examining the impact of technology on collective behavior.

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