Special Issue on Wearable Computing

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Mention the phrase "wearable computing" and a flood of different images come to mind, from humans hung with electronics, to implantable devices and the deadly cyborgs of science fiction. The reality of current wearable computing research is quite different. In this special issue we have collected together some of the best papers presented at the *2000 International Symposium on Wearable Computers* (ISWC 2000) held in Atlanta, Georgia. ISWC is the premiere academic conference for wearable computing, and every year provides a snapshot of the state-of-the-art of research in the field.

The seven papers presented here can be divided into two categories; smart clothing and wearable applications. In the first category, we have collected together four papers that describe a variety of body-worn devices. The first of these, "Smart Clothing Prototype for the Arctic Environment" by Rantanen *et al.*, presents a fascinating case study of how to develop an intelligent survival suit for the arctic environment. It is difficult enough to develop wearable devices for a sunny afternoon, but these Finnish researchers have built a system robust enough to survive the harsh arctic climate. The paper provides a good introduction to the field of smart clothing in general as well as an example of a well thought out design process in which the wearable system is developed to match the environmental conditions.

In Rantanen's work, a one-handed Yo-yo interface is developed to interact with the wearable system. ISWC is well known for presentation of innovative wearable interfaces. The second paper, "User Interfaces for Applications on a Wrist Watch" by Raghunath and Narayanaswami, continues this trend. The problem they address is how to design an interface for a small form factor display. As computers vanish into everyday objects, the interface design becomes more and more of a challenge. In their case they have built a computer in a wristwatch form, and need to address the many interface challenges this brings. The solution is an elegant combination of a radial on-screen display with touch-screen and roller wheel input.

The last two smart clothing papers are focused on wearable sensors. In Randell and Muller's "The Well Mannered Wearable Computer", they describe a wearable accelerometer that can be used to determine the user's activity. This is used as part of the Cyberjacket system, another example of well-designed smart clothing. The Cyberjacket uses passive sensors coupled to the users body motion to provide context-sensitive information. In contrast, "Wearable Visual Robots" describes an active sensor that moves independently. Mayol *et al.* have developed a wearable visual robot that sits on a user's shoulder and gazes about under its own computer control. They use a combination of inertial and visual input into an active control system to decouple camera movement from the wearer's motions. This gives the wearable robot the ability to fixate on and track real-world objects, and enables a number of intriguing applications.

The second set of three papers is more application focused, all describing wearable systems for outdoor navigation and interaction. The first of these, "Development of a Wearable Computer Orientation System", by Ross and Blasch, describes a wearable system that addresses the important problem of providing navigational assistance to visually impaired people. Their paper provides an excellent example of how a wearable computer can be used to provide prosthetic assistance and help overcome disability. The user study that Ross describes is particularly valuable, because it provides one of the few careful evaluations of a wearable interface by the target user group.

Lehikoinen and Suomela have also developed a wearable navigational aid that they describe in "Accessing Context in Wearable Computers". Their application, the Context Compass, helps

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normally sighted users navigate through the real world using a cleverly designed visual aid. The key to the Context Compass is a small virtual linear array showing heading and contextual information along the top of a see-through head mounted display. Objects on the array can be selected and more information about them shown. Their interface neatly solves the problem of how to provide navigational information without cluttering the user's field of view, and should provide useful insights to others developing wearable interfaces for outdoor navigation.

The final paper in this special issue is also one of the most ambitious. In "First Person Indoor/Outdoor Augmented Reality Application: ARQuake", Thomas *et al.* describe a wearable outdoor augmented reality system for playing the classic game of Quake. To accomplish this, not only did they build a wearable system capable of displaying three-dimensional computer graphics, but also a hybrid tracking system for outdoor and indoor tracking, and a customized input hardware. This paper, like the first, gives a glimpse of some of the complexities involved in building a truly usable wearable system.

Each of these papers offers valuable lessons to the wearable computing community, and should provide motivation for even better work in years to come. It has been a pleasure for me to be involved in creating this edition of *Personal and Ubiquitous Computing*. I would like to thank those who submitted papers, and the reviewers who helped select and refine those that are published here without them there would be no special issue. I hope to see you all at future ISWC conferences!