Workshop on Smart Garments: Sensing, Actuation, Interaction, and Applications in Garments

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Abstract

Over the last years different wearable electronic devices, technically similar to smart phones, have become available in the form factor of watches and glasses. However, including wearable sensing, actuation, and communication technologies directly into garments is still a great challenge. Cloths offer the chance to unobtrusively integrate new functionalities. Nevertheless, it is essential to take into account that garments and cloths are fundamentally different from electronic devices. Manufacturing processes for fabrics and cloths, drivers for fashion, and user expectation with regard to comfort and durability are not comparable to classical electronic devices. In smart watches and glasses applications resemble common smart phone functionality (e.g., picture taking, (instant) messaging, voice communication, presentation of reminders) with new input and output channels. In contrast to this, new possibilities for sensing, actuation, and interaction are opening entirely new applications on garments. These new applications are needed to be identified and will then again drive the advances in smart garments. In this workshop, we focus on novel applications for garments. We discuss underlying abstraction layers that allow developers to create applications that are independent from a specific garment and that can be used with different garments. Furthermore, we invite research contributions and position

statements on sensing and actuation as the basic mechanisms for smart garments. Overall the workshop aims at improving our understanding of the fundamental challenges when wearable computing moves beyond accessories into garments.

Author Keywords
Workshop; Wearable Computing; Smart Garments; Interaction; Sensing; Activity Recognition

ACM Classification Keywords
H.5.m. [Information Interfaces and Presentation (e.g. HCI)]: Miscellaneous

Introduction
In the last years, several different wearable computing devices reached the mass market. They came in different form factors such as glasses (e.g., Google Glasses), watches (e.g., Samsung Galaxy Gear), or bracelets (e.g., FitBit). Glasses and watches provide nearly the same functionality (or a subset) as a mobile phone. Placing a phone call with a smart watch or taking a picture with interactive glasses seems to be obvious use cases. Bracelets and other tracking devices are able to gain information about the user‘s activity, speed, and modes of locomotion. Focusing on smart garments, however, we see fundamentally different possibilities and challenges. On the one hand, garments offer the possibility to integrate sensing and actuating technology that is not feasible in other devices. Garments can be used to unobtrusively measure physiological data (e.g., [5]), the user‘s posture (e.g., [2, 3]), or simply provide input and output modalities (e.g., [6]). These sensor and actuator data opens up entirely new application scenarios that cannot be realized with conventional wearable computing devices or smart phones, similarly as graphical user interfaces enabled new applications not possible with command line systems. There are many challenges that need to be tackled that are specific to the integration of computing and applications with garments. In research smart different approaches to smart garments are taken and we hope that this workshop brings together people interested in wearable computing that is integrated into cloths. Already 1996 research in smart clothing [4] provided an important step towards the vision of an invisible computer embedded into the user‘s clothes. Since then, the advancements in research led to a number of different prototypes that support users in a wide variety of ways. Most of these prototypes are specifically build. They highly rely on knowledge about the users context (e.g., only detects a specific set of postures) or the correct usage of the user (e.g., clothes must fit tight). These single purpose prototypes show the feasibility of the technology but seem not be ready for the mass market. This can be compared to early smart-phones, where all applications were pre-installed. A major progress was made, once a wide range of developers could create mobile applications. Smart phones rapidly gained importance in everyday life. By allowing independent developers to contribute to mobile phones by developing applications, it is utilized in ways the phone developer did not think about. We argue that smart garments are at the moment at a similar point and an infrastructure for smart garments needs to be identified [1]. In this workshop we invite contributions that address these challenges.

Defining Interfaces for Garment Apps
First, the interfaces for application developer need to be specified in a way that they are, on the one hand, easy to use for the developers and, on the other hand, allow the access to all recorded sensor data. This is a particular challenge since a number of different algorithms exist for

interpreting sensor data. Contributions in terms of new algorithms are welcomed.

Integrating Sensing
The data received from sensors embedded into the smart garments need to be exploited to gain a variety of different input. Since different applications require different data, sensors should be reused applying different algorithms to receive the needed input. Thereby, it needs to be differentiated between physiological sensing and explicit as well as implicit input. By the limited amount of space, it is necessary to reuse physical sensors, by reconfiguring them in terms of software and hardware.

Integrating Actuation in Fabric
Many types of output have been explored in prototypes, ranging from tactile output to integrated displays. We invite new ideas on actuation that is integrated in garments to be presented at the workshop.

Interacting with Smart Garments
Most developed smart garments are research prototypes and evaluated rather with regards to its feasibility or sensing capabilities. As soon as end-users are targeted as users in field studies or in studies through deployed systems, different factors in contrast to lab studies need to be taken into account. First, the prototype needs to allow the user to behave normal. Therefore, it should not hinder the user in his movement. Second, the sensor placement is not guaranteed and the system should deal with misplacement. Third, the prototype needs to be durable because it cannot be fixed during the study. We invite work tackling these problems.

Objectives

To tackle these challenges, this workshop addresses the following issues:

- How to decouple the application development for smart garments from the actual garment. What interfaces are necessary?
- Identify approaches for using smart garments in real world user studies.
- Compensating sensing limitations through models and algorithms.
- Abstraction from the actual sensor (e.g., increased heart rate) data to annotated information about the user (e.g., the user is afraid).
- Use-cases and applications for smart garments. This includes but is not limited to nutrition intake, physiological sensing, activity recognition, and interaction sensing.

The main objective of the workshop is to create a forum to exchange ideas and experiences in wearable computing that relates to different types of cloths and garments.

Detailed Plan for Conducting the Workshop

The workshop is planned as a one-day workshop. The focus of the first session will be on short presentations of the submission. In breakout sessions and plenary discussions we will assess research questions and work together on a road map.

The workshop will start with an introduction to the workshop topic, followed by very short introductory of each participant to build familiarity among the participants with the topics everyone is working on (9:00-9:20). Afterwards, the accepted submissions will be presented by the authors with short presentation slots (9:20-12:00). We will include discussion breaks. After the

lunch break (12:00-13:30), participants that bring along demonstration will have time to present their prototypes (13:30- 14:30). In the first break-out session (14:30-16:00) we will identify central research challenges. In the second afternoon session the results will be collected and we will compile the issues into a research road map in a plenary discussion.

Participants

Workshop candidates are requested to send a position paper about their research, research questions stating a central issue, a concept designs, experience reports, or a paper about a specific prototype that is closely related to the workshop theme (up to 6 pages in the SIGCHI Extended Abstracts style). They should link their work to the workshop theme either implicitly or explicitly. Participants will be selected on the basis of the relevance of their work and their interest in and familiarity with the topic.

Expected Participants and Selection Process

The workshop aims to bring together researchers, students, and practitioners who are interested smart garments and possible use-cases. In particular, we aim for submissions and participation from those with different backgrounds and perspectives, including hardware developers, application developers, and interaction designer. The number of participants will be limited to 20. Participants will be selected based on their submission through a review process. The organizers as well as selected experts will conduct the reviews.

Outcomes

The intended outcomes of this workshop are the following:

- Bringing together researchers and practitioners to discuss the aspects of applications for smart garments.
- Creating a common understanding and perspective of the challenges related to decoupling smart garments and applications.
- Proposing perspectives on how to address these challenges in future research and development of wearable computing.
- Understanding the challenge of defining layers to abstract from sensor data to user properties and input.

Organizers' Backgrounds

Stefan Schneegass is a PhD student at the Human-Computer Interaction group at University of Stuttgart. Since he joined Albrecht Schmidt's group in 2012, he worked on several projects founded by the European Union such as pd-net, meSch, and SimpleSkin. He is interested in ubiquitous computing (UbiComp) and human-computer interaction (HCI). His particular interests are in wearable computing and smart garments.

Jingyuan Cheng is a senior researcher at German Research Center for Artificial Intelligence (DFKI) since 2012. She received Ph.D. in Physical Engineering at University of Sci. and Tech. of China, 2007. Her current research mainly focuses on large-scale smart textile sensing, including also other high precision sensing modality, wearable and ubiquitous computing. She is now the coordinator of EU FET 7 project SimpleSkin, has worked on other projects including Chinese National 863 project Time-lapse Marine Seismic Data Acquisition and Recording System and EU project WearIT@work. She organized 1st Sino-German Symposium on Social

Interactive Computing (2014) and served as PC or reviewer for varies of conferences and journals.

Kristof Van Laerhoven obtained his Ph.D. at Lancaster University (UK) and his M.Sc. degree at the University of Brussels (Belgium). He heads the Embedded Sensing Systems lab at the TU Darmstadt (Germany), funded by the Emmy Noether Programme of the German research foundation DFG. His research combines sensing systems with pattern recognition and machine learning, to obtain adaptive and power-efficient systems. These are especially applied in the challenging scenarios of wearable systems and wirelessly connected networks. Kristof was the program chair of ISWC 2010 and general chair of ISWC 2013. He has published highly cited articles on wearable activity recognition.

Oliver Amft is a Full Professor (W3) leading the Chair of Sensor Technology and the ACTLab research group at University of Passau. He is also affiliated with the Wearable Computing Lab, ETH Zurich and the Signal Processing Systems section at TU Eindhoven. Oliver received the Dipl.-Ing. (M.Sc.) from Chemnitz Technical University in 1999 and the Dr. sc. ETH (Ph.D.) from ETH Zurich in 2008, both in Electrical Engineering and Information Technology. Until 2004, he was with ABB, Inc., leading product developments in embedded communication systems. Oliver is interested in sensors, multi-modal activity recognition and human behaviour inference algorithms. Oliver has co-authored more than 100 refereed archival research publications.

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