Atelier of Smart Garments and Accessories

Maurizio Caon
University of Applied Sciences and Arts Western Switzerland & University of Bedfordshire
Fribourg, Switzerland
maurizio.caon@hefr.ch

Yong Yue
University of Bedfordshire
Luton, United Kingdom
yong.yue@beds.ac.uk

Giuseppe Andreoni
Politecnico di Milano
Milan, Italy
giuseppe.andreoni@polimi.it

Elena Mugellini
University of Applied Sciences and Arts Western Switzerland
Fribourg, Switzerland
elena.mugellini@hefr.ch

UbiComp'13 Adjunct, September 8–12, 2013, Zurich, Switzerland.

http://dx.doi.org/10.1145/2494091.2495968

Abstract
Wearable computing represented an important paradigm shift in engineering and computer science. At the present time, wearable computing is undergoing a new paradigm shift: the wearable systems that used to be transportable devices are actually weaving itself into 'the fabric of everyday life' (as predicted by Weiser). Indeed, the current trend of wearable computing is integrating the technology directly in the garments without introducing new body-worn systems. Clothes, shoes, eye-glasses, bracelets and watches are becoming smarter, seamlessly embedding more and more powerful computational resources and communication possibilities. The change has already begun and this workshop aims to bring together researchers from the academia and the industry in order to establish a multidisciplinary community interested in discovering and exploring the challenges and opportunities coming from this natural evolution of wearable computing.

Author Keywords
Smart garments, electronic textiles, intelligent clothing, wearable computing.

ACM Classification Keywords
H.m. [Information Systems]: MISCELLANEOUS; K.m. [Computing Milieux]: MISCELLANEOUS.

General Terms

Design, Human Factors.

Introduction

The introduction of the wearable computing paradigm revolutionized the engineering and computer science domains making an important step towards Weiser's vision of the invisible computing [1]. In 1996, Steve Mann gave a first definition of smart clothing as "the combination of mobile multimedia, wireless communication, and wearable computing" [2]. The technological progress made during the following years brought to the introduction of two different categories of wearable computing systems: body-mounted or garment integrated [3]. These two different types of wearable systems had a different speed of evolution and they represent only a part of the major topics in the wearable computing paradigm. In fact, Thomas analyzed the challenges of wearable computing looking back to its historical course and found eight major topics: the wearable computer system form factor, the garment integration, the displays, the user interaction, the case studies and applications, the augmented reality, the networking and the context awareness [4]. In this analysis, he deduced that "the wearable computing research community has produced a vast array of contributions over the years" even if the ultimate wearable computer has not been achieved. The wearable computing involves several different domains and the aforementioned topics do not take into account its multidisciplinary nature. This workshop aims at bringing together experts from many different academic and professional domains (e.g., electronics, computer science, design, materials, fashion, psychology and energy systems) in order to create a research community that could boost the progress towards the achievement of the ultimate wearable computer.

State of the Art

The previous section reports the eight major topics present in wearable computing. Each of them progressed in the past decades and the research is still continuing in all eight topics. Moore's law specially benefited the wearable computers; in particular, current models of smart-phones brought to the users a pervasive computation and graphics power of gargantuan scale. Research in wearable computing is providing also new types of body-mounted systems that are supposed to be launched in the market soon. A well-known example is the Google Glass project[1], which is a pair of eyeglasses with an embedded computer and a head mounted display. Another project that is quite mature and almost ready for the market is the Pebble watch[2]; this wrist-worn watch allows the communication with the smart-phone and displays useful information to the user. A smart bracelet is already available in the shops: the Nike+ Fuelband[3] is a wristband that uses an accelerometer to measure the movement during sports activity in order to monitor the personal progress and to share it on the social networks. Although many body-mounted systems are ready to enter the market, the research is still continuing also in this topic; for example, eyeglasses with embedded cameras for eye-tracking [5] or integrated electronics for electrooculography [6] or touch-enabled watchbands implementing resistive

[1] http://www.google.com/glass/start/

[2] http://getpebble.com/

[3] http://www.nike.com/us/en_us/c/nikeplus-fuelband

sensing technology [7]. As shown, the body-mounted computers are becoming pieces of smart jewelry and the technology is so advanced that they are already conquering the market. A different trend is observable for the garment integration. Technology made big leaps in this topic, especially in the electronic textile (e-textile) development. The first e-textiles were introduced in 1997 [8] and from then many types of different e-textiles have been presented. For example, some e-textiles can sense muscles contractions [9], the electrical muscular activity [10], the movement of the joints [11] and other parameters [12]. The e-textiles technology is not limited to sense data but can also display information [13]. To this end, displays constitute another important topic in wearable computing that gained the researchers' interest, especially if related to the augmented reality topic, as shown in [14]. The literature shows how the technology is rapidly achieving and exceeding the scientific community's expectations. Unfortunately, many of these astonishing technologies remain as separated pieces of a puzzle. In fact, it is particularly curious to observe how the interaction with garments didn't receive the same amount of attention in comparison with the research about the underlying technology. The few examples present in the literature show how interesting the user interaction topic is; for instance, gestures are the most explored way of interaction: touch gestures are presented in [7] and [15], while a different kind of fingers gesture is explained [16]. Also Lukowicz et al. presented the gestures as main mean of interaction with wearable computers but they introduced also the concept of implicit interaction [17]. This innovative concept is strictly linked to the topic of context awareness. At the beginning this topic used to focus on initial low level research questions (e.g., simple activity recognition, location based information presentation et cetera); at the current time, the evolution of more complex machine learning techniques led to real context awareness [4]. Networking is another major topic, which focuses on the communication between the different entities on three different scales: PANs, wireless local area network and global communication systems. Currently, all the three are available on commercial component (e.g., for the smart-phones there are the Bluetooth for PAN, 802.11 Wi-Fi for local area and 3G for global [4]). The research in this topic is continuing the progress too (e.g., the recent Bluetooth 4 for higher speed and lower energy consumption[4]). The last topic emphasized by Thomas concerns the case studies and applications. The biggest part of the developed applications refers to the eHealth (from the birth [18] to the old age [19]) and the human wellbeing in general. However, the tireless work of the research community is continuing the development of new applications exploring a wider range of case studies in order to better understand the utility of wearable computer systems.

The aforementioned eight topics belong to the computer science and engineering domains. The development of the ultimate wearable system has to take into account other domains such as design, psychology, ethnography and fashion design. Design in concerned since the ergonomics plays a key-role in the comfort and the consecutive acceptance by the users. Ethnographic investigations are a valuable mean to adapt the systems to the peculiar preferences belonging to a specific culture; sometimes the interaction with wearable computers is radically

[4] http://www.bluetooth.org

different even among people of the same ethnical group [20]. Psychology is obviously important; in fact some studies demonstrated that even aesthetics plays a crucial role in the usability [21]. That leads directly to the fashion design domain, which can make easier the acceptance from the users; moreover, fashion design can take advantage of the technology in order to create new astonishing creations, as demonstrated in this collaboration between the Swiss Federal Institute of Technology in Zurich and the Swiss Textile College [21].

The importance of all these topics (with relative challenges) in the design and development of smart garments has already emerged in the literature [23] but a strong multidisciplinary community for a joint effort towards the ultimate smart garments is still missing.

Workshop Topics

The workshop topics are strictly related to the major topics analyzed in the Section 2, and they comprehend and are not limited to:

- Technologies for smart garments and accessories
    - Electronic textiles
    - Wearable computers form factors for the integration in smart accessories
    - Displays
    - Augmented reality
    - Networks
    - Advanced machine learning for context awareness
- Interaction design for smart garments and accessories
- Case studies and applications of smart garments and accessories
- Psychological and ethnographic investigations
- Design
    - Ergonomics
    - Fashion

Expected Workshop Results

The aim of this workshop is to build a network of researchers dealing with the issues related to the design and development of smart garments and accessories in order to prepare joint projects, funding applications and work towards a series of workshops. The workshop will discuss the development of a coherent but multi-disciplinary research agenda for smart garments and agree detailed proposals for future work in the area. Moreover, the accepted workshop papers will be published in the ACM digital library and supplemental proceedings of the conference.

Schedule

The initial planned schedule is the following:

- April 19, 2013: Publication and distribution of the call of papers with relative website.
- May 15th, 2013: Submission deadline for the submission of workshop papers.
- June 1st, 2013: Notification of acceptance for the submitted workshop papers.
- June 23, 2013: Submission of the camera-ready version of workshop and all workshop papers.

- Sept. 8-9, 2013: Workshop: during the first day, each participant will present his workshop paper, followed by a short discussion; in the second day, a discussion session will be held aiming at sorting out identified challenges and opportunities; therefore, the attendees will work in order to set up the multi-disciplinary research agenda for further collaboration.

Bio of Organizers

Maurizio Caon is currently a PhD student in cooperation between the University of Applied Sciences of Western Switzerland (CH), and the University of Bedfordshire (UK). He holds a BSc in Computer Science and Electronics Engineering and an MSc in Computer Science and Telecommunications Engineering from the University of Perugia, Italy. His research domains are in the area of computer science: Activity Recognition, Gesture Recognition, Context-Aware Ambient Intelligence and Human-Computer Interaction.

Yong Yue is Professor at the University of Bedfordhisre. He obtained a BSc in Mechanical Engineering from the Northeastern University, China and a PhD in CAD/CAM from Heriot-Watt University, Edinburgh. He is also a Chartered Engineer. Professor Yue was a design and development engineer in industry for eight years. He also worked as a postdoctoral researcher at the University of Nottingham and project manager at Cardiff University before joining the University of Bedfordshire. Apart from running the Department, Professor Yue has led and participated in a number of research and professional projects with collaborative links in over 10 countries.

Giuseppe Andreoni received the Laurea Degree in Electronic Engineering in 1993 and the PhD in Biomedical Engineering in 1998 at the Politecnico di Milano, where he is assistant professor at the Industrial Design Faculty and Department. Currently, he is director on the Campus Point, and at the same time he is the coordinator of the Sensibilab (Biomedical Sensors and Systems Lab.) and of the LyPhE (Laboratory of Physical Ergonomics) at the INDACO (Industrial Design, Art, Communication and fashion) Dept. of the Politecnico di Milano.

Elena Mugellini is Professor at the Information and Communication Department of the University of Applied Sciences of Western Switzerland. She is the leader of MISG research group. She is also member of the Telematics Technology Laboratory at the University of Florence. She holds a PhD in Telematics and Information Society received from the University of Florence in 2006, and a Master in Telecommunication Engineering from the same university received in 2002. Her current research interests are on the areas of Ambient Intelligence, Multimodal Interaction, Tangible User Interface, Personal Information Management, Document Engineering.

References

[1] Weiser, M. The computer for the 21st century. Scientific American 265, 3 (1991), 94-104.

[2] Mann, S. Smart clothing: the shift to wearable computing. Communications of the ACM, vol. 39, no. 8, pp. 23–24, Aug. 1996.

[3] Toney, A., Thomas, B., and Marais, W. Managing Smart Garments. In *Proc. of ISWC'06*, pp. 91–94, Oct. 2006.

[4] Thomas, B. Have We Achieved the Ultimate Wearable Computer?. In *Proc. of ISWC'12*, pp. 104–107, Jun. 2012.

[5] Pires, B. R., Devyver, M., Tsukada, A., and Kanade, T. Unwrapping the eye for visible-spectrum gaze tracking on wearable devices. In *Proc. 2013 IEEE Workshop on Applications of Computer Vision (WACV)*, 2013, pp. 369–376.

[6] Bulling, A., Roggen, D., and Tröster, G. Wearable EOG goggles: Seamless sensing and context-awareness in everyday environments. Journal of Ambient Intelligence and Smart Environments, vol. 1, no. 2, pp. 157–171, 2009.

[7] Perrault, S. T., Lecolinet, E., Eagan, J., Guiard, Y. WatchIt: Simple Gestures and Eyes-free Interaction for Wristwatches and Bracelets. To appear at CHI 2013.

[8] Post, E. R., and Orth, M. Smart fabric, or 'wearable clothing'. In Proc. of *ISWC'97*, pp. 167–168, 1997.

[9] Amft, O., Troster, G., Lukowicz, P., and Schuster, C. Sensing Muscle Activities with Body-Worn Sensors. In *International Workshop on Wearable and Implantable Body Sensor Networks*, 2006, pp. 138–141.

[10] Taelman, J., Adriaensen, T., van der Horst, C., Linz, T., and Spaepen, A. Textile integrated contactless EMG sensing for stress analysis. In *Proc. of IEEE EMBS*, vol. 2007, pp. 3966–9, Jan. 2007.

[11] Cheng, J., Bahle, G., and Lukowicz, P. A simple wristband based on capacitive sensors for recognition of complex hand motions. In IEEE Sensors, 2012, pp. 1–4.

[12] Kinkeldei, T., Zysset, C., Cherenack, K. H., and Troster, G. A textile integrated sensor system for monitoring humidity and temperature. In *Proc. of the 16th International Solid-State Sensors, Actuators and Microsystems Conference*, 2011, pp. 1156–1159.

[13] Wijesiriwardana, R., Mitcham, K., and Dias, T. Fibre-Meshed Transducers Based Real Time Wearable Physiological Information Monitoring System. In *Proc. of ISWC'04*, pp. 40–47.

[14] Kiyokawa, K. Trends and Vision of Head Mounted Display in Augmented Reality. In *Proc. of the International Symposium on Ubiquitous Virtual Reality*, pp. 14–17, Aug. 2012.

[15] Holleis, P., Schmidt, A., Paasovaara, S., Puikkonen, A., and Häkkilä, J. Evaluating capacitive touch input on clothes,. In *Proc. of MobileHCI'08*, p. 81, 2008.

[16] Karrer, T., Wittenhagen, Lichtschlag, M., L., Heller, F., and Borchers, J. Pinstripe. In *Proc. of CHI'11*, 2011, p. 1313.

[17] Lukowicz, P., Amft, O., Roggen, D., and Cheng, J. On-Body Sensing: From Gesture-Based Input to Activity-Driven Interaction. Computer, vol. 43, no. 10, pp. 92–96, Oct. 2010.

[18] Fanelli, A., Signorini, M. G., Ferrario, M., Perego, P., Piccini, L., Andreoni, G., and Magenes, G. Telefetalcare: a first prototype of a wearable fetal electrocardiograph. In *Proc.of IEEE EMBS Conference*, vol. 2011, pp. 6899–902, Jan. 2011.

[19] Burns, W. P., Nugent, C. D., McCullagh, P. J., Finlay, D. D., Cleland, I., Scotney, B. W., McClean, S. I., McCann, J., and Gueldenring, D. Evaluation of a technology enabled garment for older walkers. In *Proc.of IEEE EMBS Conference*, vol. 2012, pp. 2100–3, Jan. 2012.

[20] Sheridan, J. G., Lafond-Favieres, V., and Newstetter, W. C. Spectators at a geek show: an ethnographic inquiry into wearable computing. In *Proc. of ISWC'05*, pp. 195–196, 2000.

[21] Sonderegger, A., and Sauer, J. The influence of design aesthetics in usability testing: effects on user performance and perceived usability. Applied ergonomics, vol. 41, no. 3, pp. 403–10, May 2010.

[22] Rossi, M., Cinaz, B., and Tröster, G. Ready-to-live. In *Proc. of UbiComp'11*, 2011, p. 609.

[23] McCann, J., Hurford, R., and Martin, A. A Design Process for the Development of Innovative Smart Clothing that Addresses End-User Needs from Technical, Functional, Aesthetic and Cultural View Points. In *Proc. of ISWC'05*, pp. 70–77, 2005.