
Enhanced through Clothing

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Abstract

Since the dawn of the history of humankind, clothes have been an integral part of our culture. In the course of time, clothes have become more advanced both in used materials and function. In this positioning paper, we present examples and discuss clothes as a platform for augmenting humans and human perception. Due the design opportunities related to them, clothes can offer aesthetic, socially acceptable and usable ways to augmented the wearer both in sensing the surrounding world as well as in expression.

Author Keywords

Wearable computing; aesthetics; user experience design; augmented human.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction

Wearable computing has become one of the rapidly growing areas in ubiquitous computing research as well as in industry. While mobile phones are still the *de facto* technology for communicating and accessing information while on the go, more and more products which use alternative mobile form factors are appearing. Activity bracelets and smartwatches are devices that already are commonly adopted by large

audiences, and today, sensors embedded to clothing and fabric integrated computing components are receiving growing attention both in academia and product development. For instance, Google's project Jacquard [4] has gained a high level of media attention. Similar type attempts to improve the manufacturing techniques with textile integrated computing are ongoing in several industry sectors related to clothing or computing.

Wearable computing itself is a wide field, considered to cover not only clothing but also accessories and skin interfaces [3], and the research in the area has so far been driven rather by engineering than design. However, as the technical enablers become more mature and easier to prototype with, there are more possibilities to develop designs that take an advantage of the opportunities that the technology offers. Using clothing for different purposes, including augmenting human perception, offers possibilities that will exponentially grow in the future.

Opportunities with Clothing Design

Clothing design has long traditions as well as an active and dynamic design industry around it. In this positioning paper, we argue that clothing design offers an under-explored and massive potential design direction for augmenting human perception and self-expression beyond the current levels.

Clothing design is tightly entwined with fashion design, and fashion and trends have a significant effect on what people wear, in which context, and what is socially acceptable or admirable. Adopting the current fashion and clothing trends can thus function as the key for technology adoption [10]. Technology design has

however inherently some differences with fashion thinking. First, technology driven design does not place aesthetics or user experience as the key design driver. Secondly, fashion and trends do not take garments or other design items as isolated objects. Juhlin et al. have proposed outlook centered design, and present an example, where a smart watch facet adapts to the color scheme of the outfit, thus creating a matching piece [2]. Thirdly, fashion and trends are very temporal in nature, and their lifecycle is quite short. Although the lifecycle of technology gadgets is relatively short, typically on the scale of two years, fashion trends vary annually and seasonally. In order to achieve success through clothing trends, wearable computing needs to adjust its product design approach to match the requirements of the fashion industry.

Clothes have always been part of culture. With clothes, one can indicate social status, values, and opinions, and they are a display for expressing one's identity. This way, clothes enhance and augment our self-expression. As the next step in this direction, clothes can function as an expressive user interface and public display, where the user's self-expression is emphasized with the help of technology. For instance, the fashion design garment the Twitter Dress displays social media messages [6], thus providing an extra window to express the user's social network. This information is usually targeted towards other people, but can also have a function towards the user him/herself, for instance when providing heartbeat information [9]. The digitally presented information can increase the user's awareness, provide assurance, or support self-confidence.

Clothes can also be used for augmenting human perception by integrating sensors that provide the wearer better capabilities than the bodily naturally senses. For their design and form factor, different sensors can be easily hidden within clothing and be used for providing e.g. enhanced vision or hearing to the user. With proximity or environmental sensors, the garments can be used to react to its surroundings without the objects touching the user, as in Spider Dress [5].

Examples

In this section, we present examples of our works on augmented clothing.

Solar Shirt

The Solar shirt [8] is an environmental awareness concept, where the wearable computing garment integrates sustainability as part of its functional and visual design. The Solar shirt integrates sound sensors to detect the level of noise pollution, thus enhancing the hearing and providing better environmental awareness to the user. This way, the garment is used to inform the user and other people of excessively noisy surroundings which may have health and wellbeing effects.

The environment's noise level is displayed on a clothes-integrated public display, see figure 1, where a smooth visualization is used to create an aesthetic and ambient communication style. In the design, special attention was paid to create an aesthetically pleasing outlook for the garment, in order to take a step towards a trend conscious design of wearable computing.



Figure 1: Noise detection and public display as part of the garment design.

Augmented Self-Expression Shirt

Our second concept and prototype, illustrated in Figure 2, is an augmented reality (AR) shirt, demonstrated in [7]. Here, the removable AR markers can be placed around the shirt according to the user's wishes, and the garment's outlook thus personalized. When designing the available places to attach the markers, we used the results of our earlier user study reporting preferred areas, e.g. chest and arm, for the purpose [1].

Whereas the garment does not augment the senses of the user as the previous example, it provides a new channel for the user to express him/herself, and augments his/her appearance in the eyes of others. Augmented reality provides a new design dimension for the garment design by providing an enhanced view of the physical reality. To the casual viewer, the augmented reality content is hidden, and the markers are seen as ordinary decorative patterns.



Figure 2: Augmented reality shirt.

Illuminated Jacket

Currently, we are working on a garment, specifically a jacket, which has several sensors embedded into it. The garment adapts its outlook based on environmental factors, thus providing the user with more fine-tuned senses e.g. for temperature. Sketches for the design are presented in figure 3. The design concept includes color changing thermochromic materials. Electronic heating elements and sensors will be used to create visual effects on the garment through the color-changing ink.



Figure 3: Context sensitive jacket under design.

Discussion

Wearable computing is a rapidly emerging field, and offers a platform for augmenting the user both in outlook as well as functionality. Clothes are objects which have been used to self-expression since the dawn of humankind, and they may offer a platform that is more socially acceptable than (potentially) strange looking new gadgets or human-integrated technology. Thus, clothes can offer an easier and more acceptable way towards human augmentation on a large scale. In this position paper, we have discussed clothing design as an opportunity for augmented humans, and presented examples of our current work.

For integrating and hiding sensors that amplify human senses, clothes offer a suitable and easy-to-access platform. The cut of the cloth as well as material selections can be used to hide the technology, and to enable placement of components in an optimal way. Currently, in our work we have been focusing on visual design, which inherently links to traditional clothing design. However, technology offers possibilities also for multimodal output, and for instance heat and shape-changing could be utilized. Our aim is to address these aspects in the future work.

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