Smart Handbag for Remembering Keys

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ABSTRACT
In this paper, we present a design and prototype of a smart handbag, which detects the presence of the user's keys in the bag and shows it with an ambient display, consisting of LEDs embedded to the design. The handbag prototype is an example of a smart accessory, which has been designed for both aesthetics and usefulness. The handbag was evaluated in an in-the-wild user study, where five participants used it for a period of one day each. The salient findings from the user study emphasize the perceived usefulness of the concept, successful adaptation of the prototype in everyday life, and aesthetic design. The sensing mechanics and implementation need careful design to achieve a reliable detection accuracy. In addition, the in-the-wild study provoked concerns related to the potential mismatch between the user's personal style or outfit and the handbag's appearance.

Author Keywords
Aesthetics; wearable computing; wearables; smart accessories; hand-bag; in-the-wild studies; user experience.

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

INTRODUCTION
Advances in technology have enabled the development of various different types of smart environments, and the trend to make everyday objects enhanced with technology is taking off. Mobile computing does not anymore mean just smartphones and tablets, but also smart accessories, which in the form of smart watches and bracelets are already commonplace. Wearable computing is emerging as consumer products with different form factors. According to the framework by Liu et al. [8], wearable technologies can be categorized into clothing and accessory type form factors. While earlier research on wearables has focused much on the enabling technologies, the technology maturization is now allowing more opportunities for exploring the design and aesthetics of the concepts.

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Figure 1. The functional prototype of the smart handbag indicating if the keys are outside (left) or inside (right) of the bag.

While new concepts and prototypes have been introduced, in-the-wild user studies conducted with aesthetic wearable computing prototypes are very rarely reported. This aligns with ubiquitous computing in general, as it has been pointed out that user experience research in the field is still scarce [14]. To gain insight to the challenges and validate the design choices made, the prototype solutions should preferably be evaluated outside of usability tests and laboratory conditions.

In this paper, we present an interactive handbag, Figure 1, with aesthetics as a key design driver. The handbag integrates a visual indicator, LED lights, to show if the user has remembered to put her keys into the bag. The prototype was then tested in-the-wild by five people, who each used the handbag for one day. Our paper contributes to the body of research in the cross-section on aesthetics, design, and wearable computing by presenting a functional prototype and reporting user's experiences from a field trial.

AESTHETIC WEARABLES
While early research on wearables involved bulky and technical looking prototypes, the miniaturization of the components and availability of toolkits has made it easier to shift to focus more towards the design of the smart artifacts. Examples of concepts, where aesthetic design has been a key driver, have been presented in prior art. Earlier research has

introduced jewellery type designs, such as the Nenya ring input device [1] and the WaterJewel bracelet [4] for illustrating the user's water drinking behavior. As interactive, aesthetic clothing solutions, the Solar Shirt has been demonstrated to detect and display noise pollution in the surroundings [12], and a dynamically changeable tartan pattern shirt, created with fiber optics, has been introduced [2]. Juhlin et al. consider fashionable wearables from an outfit centred design viewpoint, and demonstrate a smartwatch, which adapts to match to the colors of the wearer's outfit [7]. Do-It-Yourself communities have also adopted the toolkits for making wearables, and prototypes presented at online forums such as Instructables [6] showcase designs created e.g. with LEDs and optical fibers.

THE CONCEPT AND THE PROTOTYPE

In this section, the design and functional prototype of the smart handbag are introduced. The concept builds on the findings reported by Colley et al. [3], who created and user tested a smart handbag prototype with a display integrated on its side. When different concept designs were evaluated with users, the feedback suggested that a see-through feature which showed the contents on the bag was valued for its utilitarian aspects, but the visual indicators should be ambient enough to preserve the privacy of the user. Thus, our concept is narrowed down to focus around the use case of remembering the keys, and presenting the user an indicator if the keys have been placed in to the bag. Our design seeks to find a balance between the utilitarian and hedonic aspects of user experience design [5].

Remembering keys was selected as the core use case for the smart handbag for the utilitarian reasons. Keys are one of the most important items that people carry with them daily, and having them with is an essential factor for the day to run smoothly. When leaving a place or on the go, it is not unusual to check multiple times whether the keys are with you or not. Typically, among women, the keys are placed in a handbag. To guide the user to take her keys with her, and to a provide confidence for having them, a handbag with a visual cue was designed. The designed smart handbag indicates with LED lights when the keys are in it, enabling the user to see it in one glance. The design of the indicator display was to be ambient [9], avoiding explicit information presentation which has been demonstrated in wellness wearables research [10, 13]. Using indicator lights integrated with the design has earlier been suggested e.g. with smart bracelets [4, 11].

The design process for a smart handbag began with a review of different designs for inspiration, and concepting and drafting a handbag design targeting for a sedate and stylish product for women for daily use. The shape and color of the bag was inspired by the autumn leaves. Felt was selected as the prototype material as it is soft but stiff, and keeps its shape. Also, a needle felting technique allows very complex and detailed patterns to be made, and felt is an insulating material, which suits well for embedding the technical components. The final design is presented in Figure 1. The yellow felt forming the body of the bag was made of polyester, and the needle felted small balls attached on the front of were of wool. The look and feel of the materials was aimed to be warm, as a contrast to the technical items embedded into the product. The placing of the indicator lights was explored by trying out different design solution, and embedding them with the felt balls was found as a functional and aesthetic solution. The lights blended into the textile, and the change was easy to see. In addition, the lights could function as a safety feature in the dark, providing visibility of the user e.g. to passing cars.

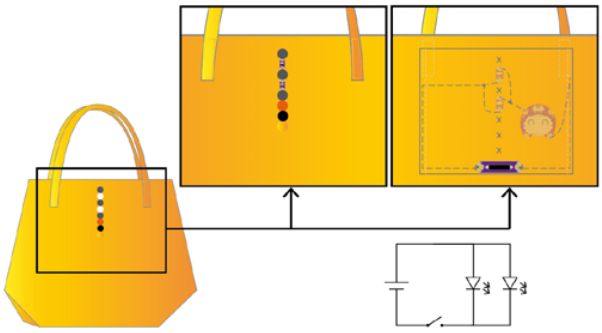

Figure 2. The technical implementation.

The technical implementation of the smart handbag is presented in Figure 2. The functionality was implemented with a magnetic sensor. A small ring magnet was attached to the user's keys, and when the keys were placed to the pocket inside the bag (Figure 3, right), the two LEDs located behind the white felt balls switched on. The components including a battery holder were connected with a conductive yarn.

FIELD STUDY

Setting of the Study

To collect feedback of the concept and the prototype, we organized an in-the-wild user study, where participants used the handbag as part of the everyday life routines. Five female participants, mean age 32 years and active users of handbags, were recruited for the study. For the study, a magnet ring was attached to the keys of the user. Each participant was instructed to use the smart handbag as the primary handbag for the period of one day (24 hours), and to take it with them as they would normally do. The participants were also asked to take photos of the use situations, when easily applicable. The study consisted of the starting session, where the user was instructed with the equipment, and the end session. Here, feedback was collected through a written questionnaire with six questions about the contexts and experiences of the smart handbag usage, and verbal comments, including also describing the photos taken.

Figure 3. Examples of the field study use situations. On the right: keys placed in the pocket inside the bag.

Results

The contexts where the handbag was used by participants consisted of their everyday activities: being at work, doing grocery and other shopping, going out, visiting, and hanging out with friends. Examples of the usage of the bag during the study are presented in Figure 3. The collected feedback could be divided into three main categories: 1) how the users perceived the concept, 2) comments on the design, and 3) technology and implementation.

The concept design was recognized to be useful by all participants. They recognized the challenge of remembering the keys from their own experiences, and liked the concept of the smart handbag. The ambient design of the visual indicator was perceived as a good feature, as the meaning of the lights remained hidden from others. This was described as a secret code between the user and the handbag. *"It was also nice to have the light in the bag so that the others around me didn't know why those small lights were on or off. Instead it was like a "code" between me and the bag"* (#2). It was even commented that the concept was so useful, that there should be an option to detect the presence of several different items in the bag with corresponding notification lights (#2, 3, 4). *"Could there be two pockets with lights, or one with two [pocket] sections and different lights, which would show if the keys and the mobile phone or both are in the bag"* (#4). An additional feature of providing help in finding the missing keys was also suggested by one participant (#3).

The design and the appearance of the handbag were also positively perceived, but several suggestions for different types of improvements were made (#1, 4). These addressed factors that would make the handbag to match better for their personal preferences in size, color, or details. When seeing the bag for the first time, some of the participants (#1, 3, 4) were worried about how it would match with their outfit. In the end session, it was reported that the yellow colour of the handbag was the reason that some of them (#1, 3, 4) chose their clothes to wear in order to match better with it. None of the participants reported of any undesirable attention because of the bag. Instead, one user (#4) commented of receiving a lot of positive feedback from her friends: *"The bag got lots of praise [from my friends] in the city"*. Another design related issue considered the way the smart handbag was constructed. The design of the handbag required the users to place the keys to a pocket inside the bag, see Figure 3. This may have affected to the routines of the user, and two of the six participants wished for a possibility to just drop the keys into the bag.

The technical implementation was commented both from the detection mechanism and the output point of view. The magnet attached to the keys was very small, and the users could carry a large set of keys with them. This sometimes made it harder for the magnet to get placed near enough to the sensor. However, once the input was read, the technical system functioned well. One occurrence with a false negative was reported: the lights went off, the user noticed it, and thought of having the keys stolen or lost. However, this was caused by the key magnet moving too far from the sensor. The brightness of the LEDs was sufficient indoors and outdoors in a cloudy weather, but the difference was hard to see in the bright daylight. As the study was run during summer, the participants (#1, 2, 3) pondered if the handbag would work better in autumn and winter, with dimmer ambient light conditions.

DISCUSSION

In this paper, we have presented our design and prototype of a smart handbag, which detects the presence of the user's keys in the bag with a magnetic sensor, and displays the status with design-integrated lights. The contribution of our work is in the functional design prototype and in the in-the-wild evaluation, where the handbag was used by five women as a primary handbag for 24 hours each. Despite of the limited sample and duration of the study, we believe this provides interesting insights in the research landscape with aesthetic wearable technologies, especially as the in-the-wild evaluations are scarce. To be able to run a valid study in such settings, the prototype needs to be developed to a mature enough level to function reliably in everyday use, and the appearance of the artefact polished enough not to cause embarrassment or awkward feeling for the user. With the design prototype, we aimed to support as natural everyday interactions as possible.

The importance and concern of matching the handbag with the personal style was an interesting user study finding, as it can affect the adaptation and acceptability of wearable technology. Matching with the outfit has been considered also by earlier research. Adapting the handbag appearance dynamically according to the garment design has been proposed by Colley et al. [3], and Juhlin et al. built the whole concept of an adaptive smart watch facet around outfit centered design [7]. Our findings support the notion that the design and fashion related questions are important when the use of everyday wearables are developed. For instance, utilizing soft materials could make new technical devices more desirable and easier to approach for the users.

Integrating LEDs as part of the design and making the indicator ambient rather than explicit was found to be a good design choice. In future work, alternative technology solutions should be explored to gain a more reliable functionality. Altogether, the positive feedback on the concept and the design prototype suggest that the concept was well received both from the utilitarian and hedonic user experience aspect point of view.

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