Supporting Weight Loss Through Digitally-Augmented Social Expression

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Abstract. In this paper, we present the design, prototyping and implementation of i-Ribbon—a wearable device designed to support weight loss through digitally-augmented social expression. Starting with an Obesity Awareness Ribbon, we introduced the exploration process and formation of the i-Ribbon concept. Prototypes of different fidelity were built during the design process, including a working system that could extract the user's personal health-related data through a mobile application and sent it to a wearable expression device. Evaluation through interview has been conducted. Base on the reflection on design, prototyping and evaluation process, we summarize the insights and discuss the options for future work.

Keywords: Wearable · Weight loss · Quantified-self · Healthcare · Social interaction · Interaction

1 Introduction

With the development of sensing technology and the popularity of wearable devices, more and more types of health-related data can be monitored. In most existing wearable applications, quantified-self data is visualized and fed back to the end users. Supporting users in their self-management have become an important role in wearable applications. However, the starting point of this research—the Obesity Awareness Ribbon (Fig. 1) [1] inspired us about the social attributes of the wearable device. Instead of staring at the increasing sensing capabilities of wearable devices, we try to discover its potential in social expression.

The original role of wearable devices is to monitor the wearer's health-related information. However, just like the role of conventional apparel is no longer just to shield the wearer's body, wearable devices should also not be restricted to their most primitive roles. If we consider wearable devices as apparel augmented by the integration of digital technology, they could have properties similar to conventional

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apparel, reflecting wearer's identity, taste, attitude, and values. Additionally, with the help of sensing and display technology, quantified-self data can also become a type of social cue, enrich the social expression through wearable devices.

Different from the existing tracking devices, the wearable devices we present in this paper—i-Ribbon, is designed as a channel for social expression rather than a self-tracking terminal. By introducing the design and research process of i-Ribbon, we discussed the opportunities of wearable devices in promoting social expression in the context of weight loss.

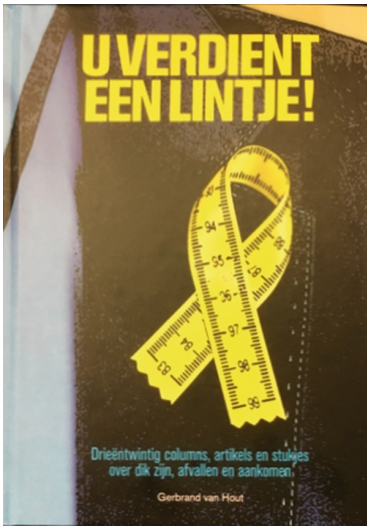

Fig. 1. The book of Gerbrand van Hout, entitled "U Verdient een Lintje!" (in Dutch) which means "You deserve a ribbon!" The cover of the book shows the physical version of the Obesity Awareness Ribbon.

2 Related Work

2.1 Wearables in Social Interaction

A number of prior researches explored the social aspect of wearable device. Fajardo et al. [2] proposed a contextual wearable display model to describe the typical relationships between display devices, wearers, onlookers and the context, the model was subsequently used to evaluate a pilot study that compared the abstract and overt visualization of skin conductivity on a wearable display device. Some other research also considered the relationship between the wearer of a wearable device and people in proximity [3, 4]. Moere and Hoinkis [5] proposed a wearable folding display that is able to convey wears' behavioural typology. The concept was defined as "an electronically enhanced form of self-expression for increased social awareness in physical reality".

2.2 Social Applications of Quantified-Self Data

Some previous efforts integrated quantified-self data into social applications to motivate physical exercise. The most used data type in these applications is heart rate [6–10]. Mueller presented "Jogging over a Distance" to support runners in different cities to jog at the same time, runners' heartbeat audio are shared between each other to facilitate a social experience [11]. In some other research, the user's activity level has also been publicly displayed to motivate physical activity [12, 13].

3 Starting Point and Initial Exploration

The starting point of this research is the Obesity Awareness Ribbon presented by Dr. van Hout (Fig. 1) [1, 14]. Similar to the pink ribbon design for breast cancer awareness [15], this ribbon is designed for everyone "who wants to show awareness for obesity and wants to hearten obese people" [14]. The physical version of the ribbon was given to the patients and staffs in the Obesity Centre of Catharina Hospital in Eindhoven.

Fig. 2. The upper four pictures showing the explorations on ribbon wearing behaviour and the lower pictures showing the potential interaction related to a digitalized Obesity Awareness Ribbon.

Starting with the concept of the original Obesity Awareness Ribbon, an initial exploration has been conducted. We tried to enhance the expressive feature of the ribbon by integrating digital technology. In order to explore the potential values related to this digitalized Obesity Awareness Ribbon, several low fidelity prototypes were built (Figs. 2, 3, 4). Figure 2 shows the explorations on ribbon wearing behaviours and potential interaction related to a digital ribbon. Figures 3 and 4 show the different possibilities for digitalizing the ribbon.

With the help of these prototypes, evaluation through interview was carried out, two persons with weight loss experience participated and provided some inspirational feedback. The most significant finding from the initial exploration was the value of "weight-loss efforts". In the process of weight loss, efforts are usually invisible before the significant changes appear. Therefore, the users would like to show their weight-loss efforts through the digitalized ribbon in more expressive ways.

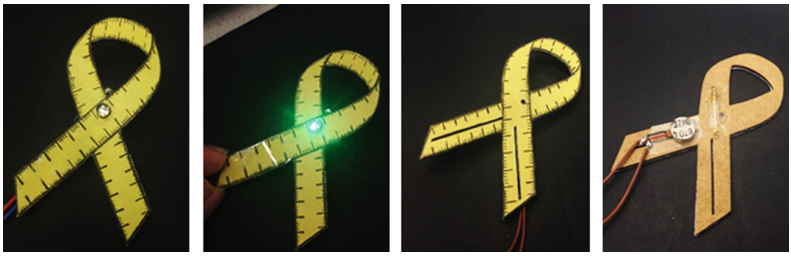

Fig. 3. Two versions of the digitalized Obesity Awareness Ribbon, the first two pictures showing a concept based on visual output, the last two pictures showing the tactile output (vibration).

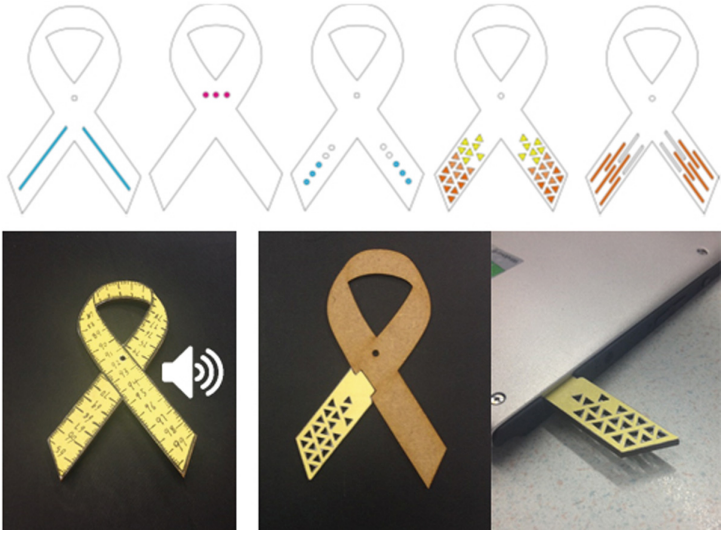

Fig. 4. Additional possibilities for the digitalized Obesity Awareness Ribbon.

4 First Iteration: Visualize Efforts

4.1 Concept of I-Ribbon

Based on the result of initial exploration, we presented the concept of i-Ribbon, a wrist-worn wearable device that expresses the wearer's weight-loss efforts. A dynamic pattern which represents the wearer's physical activity was integrated with the conventional ribbon to enhance its social expressiveness. The pattern on i-Ribbon change according to the wearer's amount of physical activity (reflected by steps, distance and floors), see Figs. 5 and 6. The wearer can also personalize the expression of i-Ribbon through a mobile application (Fig. 5). Therefore, the concept of i-Ribbon consists of two parts:

- A wrist-worn device, which is visible to onlookers and carries symbolic meanings. At the same time, it has a built-in accelerometer to detect movements, similar to other commercial activity trackers.
- A mobile application, providing an additional interface, which would not fit on the limited size of the wrist-worn device.

There are many ways to wear conventional awareness ribbon. The decision to make i-Ribbon a wrist-worn device was motivated by the following factors: first of all, the wrist is a body location that can be seen by both the wearer and onlooker. Therefore, a wrist-worn device offers the opportunity for the wearer to express more actively [2]. Additionally, the wearers can conceal the device worn on their wrist, so they will have more freedom to decide where and when to show i-Ribbon to others. Moreover, as a product designed to support weight loss, a wrist-worn device will not cause inconvenience in most physical activities.

4.2 Prototype and Evaluation

In order to completely present the original concept of i-Ribbon, the first prototype we built is a non-functional simulation of i-Ribbon under the ideal condition. This prototype consisted of two complementary parts, including a set of mock-up of i-Ribbon (Fig. 5), and a screen-based simulation of the dynamic pattern (Fig. 6).

Fig. 5. The prototype of the wrist-worn device and the mobile application of i-Ribbon (non-functional simulation).

Evaluation with early prototypes (Figs. 5, 6) has been conducted through semi-structured interviews, the process and results have been presented in a published paper [16]. Participants showed a positive attitude towards the idea of "showing weight-loss efforts", they described i-Ribbon as a trigger that can start conversations and expect a more obvious way to show their weight-loss efforts. We also found that the symbolic meaning of the original Obesity Awareness Ribbon is obscure for some participants.

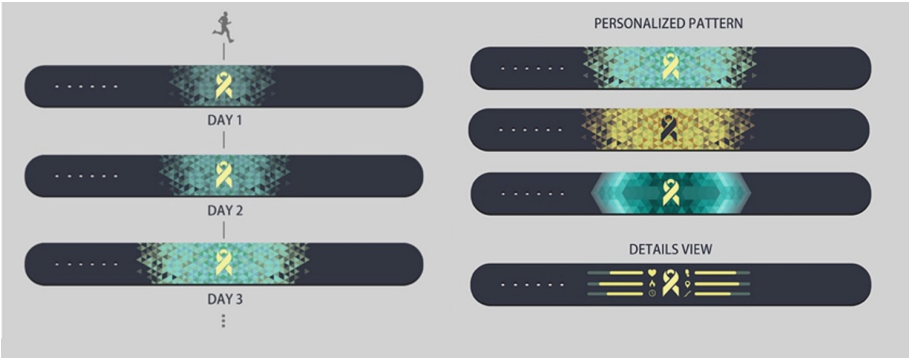

Fig. 6. The prototype of the wrist-worn device of i-Ribbon (screen-based simulation of the surface).

5 Second Iteration: Embody Values

5.1 Symbol, Design and Values

The original Obesity Awareness Ribbon was essentially a symbol [1]. From the initial exploration and first iteration, we realized that due to the short history of the symbol, it has not been widely spread and recognized. Compared to the famous Pink Ribbon [15], the values conveyed by the Obesity Awareness Ribbon is relatively obscure for some of its wearers. Showing "weight-loss efforts" is a potential value that we identified. We need further understanding about the relationship among the original Obesity Awareness Ribbon, i-Ribbon and the values it conveyed.

A further literature review about human values and values elicitation has been conducted. Existing research shows that values could be integrated into technology through design [17] and could be elicited through a variety of ways [18–21]. With a deeper understanding of value theory [22] and its relationship with system and product [23], we present a framework (Fig. 7) to clarify the relationship between the symbol (the original Obesity Awareness Ribbon), design (i-Ribbon), values (weight-loss efforts) and user.

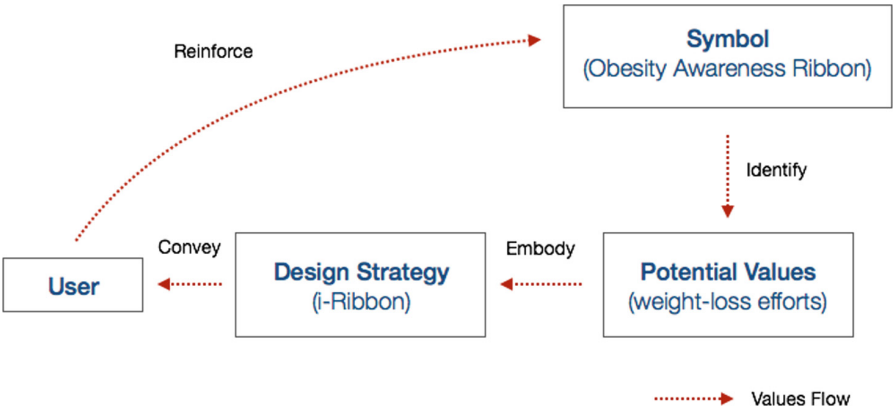

Fig. 7. The relationship between the symbol (the original Obesity Awareness Ribbon), design (i-Ribbon), values (weight-loss efforts) and user.

As shown in Fig. 7, potential values could be identified from the symbol of the Obesity Awareness Ribbon. Design strategy can be used to embody the identified values in a specific product. Through interacting with the product, the user may have a better understanding of the values that symbolized by the Obesity Awareness Ribbon. We have identified the value of "supporting weight-loss efforts" in the previous study, with other values identified in further research, corresponding design strategies can be used to embody these values and convey them to users.

5.2 Working Prototype

The prototype we built at second iteration is not only a technical upgrade of the previous version (Figs. 5, 6), but also a flexible system that has the potential of embodying different values. The working prototype of i-Ribbon includes a wrist-worn device as a medium of social expression (Figs. 8, 9), and a mobile application connected to the Google Fit platform to access user's physical activity data (Fig. 12).

The core function of the wrist-worn device was implemented through LightBlue Bean with an RGB LED matrix. With the built-in Bluetooth LE module on LightBlue Bean, the device can receive wearer's health-related data from the mobile application and represent through the RGB LED matrix (Figs. 8, 9). In addition, a button with the abstract version of the Obesity Awareness Ribbon (Fig. 10) was assembled into the device as a button. The wearer could turn on/off the display by pressing this button. The display will automatically turn off after ten seconds if there is no other operation. Wearer's interaction with the button could strengthen the connection between the symbol of Obesity Awareness Ribbon and the values we expect to elicit through i-Ribbon. Other electronic components such as lithium battery, charging module and main switch were also included in the wrist-worn part of the prototype.

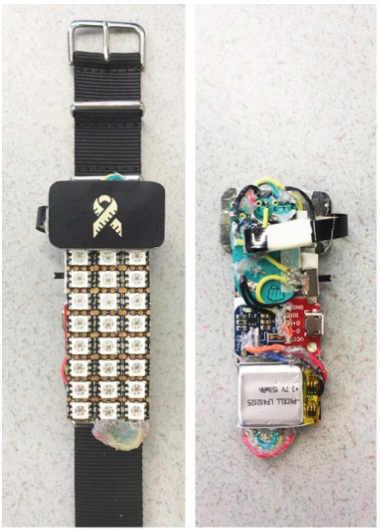

Fig. 8. Two sides of the working prototype of i-Ribbon's wrist-worn part.

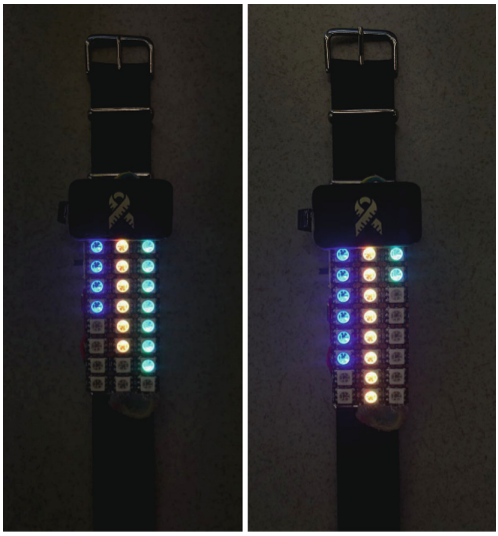

Fig. 9. Two examples of the representation of wearer's health-related data through the RGB LED matrix on an i-Ribbon.

Fig. 10. The abstract version of the Obesity Awareness Ribbon.

In addition to the hardware of the wearable device, we developed an Android mobile application to access the user's physical activity data and provide an extended user interface. With the Google Fit API, the application can extract data from any device connected to the same Google Fit account and send it to the wrist-worn device through the smartphone's built-in Bluetooth LE module. This feature technically separated the expression and sensing function of the prototype and brought the possibility of getting data beyond the wrist-worn sensing device (Fig. 11).

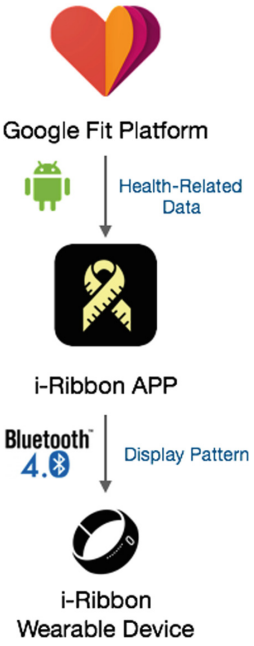

Fig. 11. System built for the working prototype of i-Ribbon.

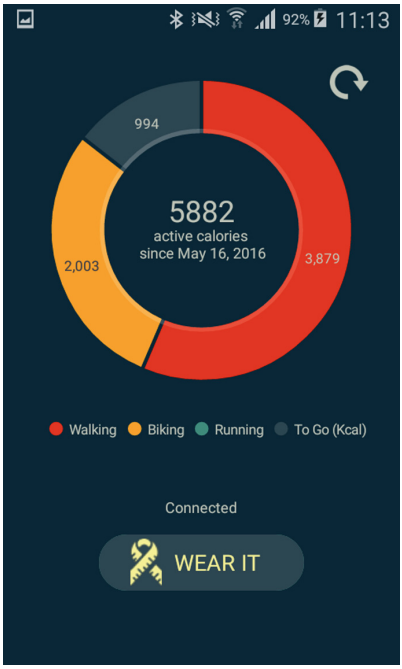

Fig. 12. Screenshot of the Android mobile application for i-Ribbon's working prototype.

Although we only used the smartphone's built-in accelerometer and Xiaomi Mi Band as a data source at this stage. Data from any other device that compatible with Google Fit platform could be used in further research. The main interface of the mobile application consists of two parts: (1) a pie chart showing user's calorie consumption of walking, running and biking, and (2) a "WEAR IT" button enabling user to convert the data into the visual pattern and display on the wrist-worn device (Fig. 12) [24].

Evaluation with the working prototype should be conducted in further research, with the flexible system we built for the working prototype, we are also able to embody other values by using different data sources and design strategies.

6 Discussion

6.1 Visualization of Weight-Loss Efforts

"Effort" is a concept that is difficult to quantify, but with the help of existing sensing technologies, many indicators can be used to represent efforts in the context of weight loss. In this study, we used some common data type that can be monitored by most exiting wearable devices, such as step, distance and calorie consumption. However, due

to the diversity of the user's physical condition, the same value under the same indicator may not mean the same level of effort for different users. Therefore, choosing appropriate indicator is very important for objectively presenting "weight-loss efforts". The historical data of the same user can be compared, and the degree or speed of change is more appropriate than the absolute value to reflect efforts. Data types like calorie consumption are directly related to the user's age, gender, and weight. These types of data are more suitable for representing efforts than steps, distances or floors.

In addition to the choice of data types, the strategy of visualization is also very important. Due to the limited space on wearable devices, visualization for social expression on wearables differs from statistically oriented visualization. Our purpose is not to show specific data details, but to represent "weight-loss efforts" intuitively and clearly. Therefore, one direction of further research is to identify the appropriate data types and visualization strategies for "weight-loss efforts".

6.2 Wearables and Digitally-Augmented Social Expression

Based on the design and research process of i-Ribbon, we summarize two perspectives of enhancing social expression through wearable devices. Firstly, the wearable devices themselves can incorporate digital technology to enable dynamic information display. In this perspective, wearable device can be seen as apparel that augmented by digital technology, it can be a garment, watch or jewellery and does not necessarily have the sensing ability. Secondly, quantified-self data detected by wearable devices can become a new type of social cue. Some users are already sharing their fitness tracking record on social networks. With appropriate visualization, quantified-self data not only can be displayed in the mobile application but also can be combined with user's cloth, jewellery, vehicles or other daily accessories to enrich user's social expression channels.

These two perspectives also provide two directions for future research: (1) Explore the social potential of a particular type of wearable device. (2) Investigate the social properties of Quantified-self data in specific scenarios.

6.3 The Influence of Context on Social Expression

An important difference between wearable devices and awareness ribbons is that they are worn in the different context. Most people only wear awareness ribbons on specific occasions, such as charity gatherings or events. And in these occasions, there are usually many people wearing the same ribbon for similar reasons. However, wearable devices are usually worn all day by users, like other clothing and accessories, they may be seen by others on a wide variety of occasions. When we add some social expression feature to wearable devices, some autonomy should be given to users, because the user may not want to present this information on all occasions. Autonomy can be given to the user in two ways: (1) Set a switch that lets the user decide whether to present or hide the information in different situations. (2) Present the information in an abstract way, leaving the user with the space to explain to others.

6.4 Symbol and Values

It's difficult for people to realize the values represented by a symbol by simply watching or wearing it. The values behind a symbol could be embodied into a specific application and conveyed to its user. In this research, we identified the value of "supporting weight-loss efforts" in the initial exploration and embodied it into a wearable application to, by using i-Ribbon, the user will have a deeper understanding of the values represented by the symbol. A framework was presented to explain the relationship between symbol, design, and user (Fig. 7). From the perspective of symbol and values, there are two directions for future research, (1) Identify other values related to the Obesity Awareness Ribbon. (2) Embody the value of "supporting weight-loss efforts" into other applications by different design strategies.

7 Conclusion

In this study, we presented the design and research process of i-Ribbon —— a wearable device designed to support weight loss through digitally-augmented social expression. Starting with the Obesity Awareness Ribbon. The value of "weight-loss efforts" was identified through an initial exploration. We designed a wearable device to visualize the user's "weight-loss efforts" in the first iteration. In the second iteration, a working prototype was built and the relationship between symbol, values, design and user was clarified. Serval insights and options for future works were identified.

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