Designing Wearable Device-Based Product and Service Ecosystem

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Abstract. In the design of wearable device, the focus is normally put on the device itself and functions serving individual users. However, as a product widely spread out over a large population, the consolidated data collected from the devices could be used to bring to users functions or services far beyond personal scope and increase the value of services for individual users as well. When the focus of design is switched from individual product to the overall landscape involving large amount of devices, a central data platform, and services supported by the data platform, a systematic planning of the working mechanism and services at both individual and social level become possible as the result of the scope expansion. We introduce in this paper our in-depth analysis of key issues involved in the design in this new type of ecosystem. Specifically, we use E-Wearable, a wearable device-based platform for environment protection and environmental information service to exemplify the concepts and methods we propose.

Keywords: Wearable device · Social innovation · Environmental information service · Environment protection

1 Introduction

With rapid development of sensing and mobile technologies, wearable devices have emerged in various forms and brought to people new functions and services in sports, health, and many other fields. In the design of most of the wearable devices, designers tend to focus on the product itself and functions serving individual users. Even though some of the functions do involve with the utilization of user data, its value is mostly constraint to personal use. However, rich data collected from large quantities of wearable devices could provide services at the social scope and increase the value of personal services at the same time. There are already explorations along this direction such as the MTA Relay by Frog Design [4], yet there lacks in-depth study of design from this expanded scope. When the focus of design is switched from individual products to the overall landscape including both the platform and the devices,

P.L.P. Rau (Ed.): CCD 2015, Part I, LNCS 9180, pp. 108–115, 2015.
DOI: 10.1007/978-3-319-20907-4_10

one needs to find out the running mechanism, define the system structure, and design the products and services in a systematic way.

In order to better exemplify the focus switch concept and the related design methods we propose, we implement them in E-Wearable, a wearable device-based social innovation platform for environment protection and environmental information service. We choose to experiment with the environment topic for the following two reasons: (1) Environment protection requires participation at the social scope, (2) Ubiquitous and crowd-sourced data collection is typical for environmental information gathering [2, 6–9]. In the following sections, we will explain in detail (1) How to construct a full-fledged ecosystem by defining the key components, (2) How to establish a running system through the construction of a contribution-benefit mechanism, (3) How to come up with specific product and service design by refining and combining the ecosystem components, (4) How to use modules at the platform level to both lower down the development cost of service applications and provide users with consistent experience.

2 Construction of the Ecosystem

As illustrated in the left part of Fig. 1, the platform that could consolidate large amount of user data is often out of designers' focus. Data collected by a device is normally treated as a property of the device itself and is mostly used by individual users. However, if the scope of design is expanded to what is illustrated in the right part of Fig. 1, designers will then be able to start from the central data platform, make connections with different products of a user or with products of large quantities of users.

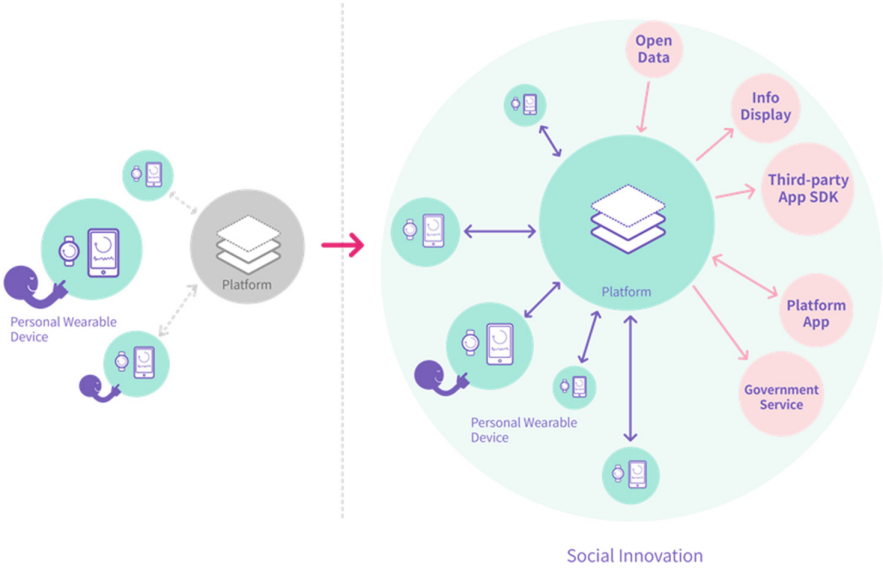

Fig. 1. The concept of focus switch

They can also link the platform with related data sources besides those collected from wearable devices. On top of this rich data set, services could be lineated out in various ways. The ecosystems thus formed are mainly of two types: association-oriented and crowdsourcing-based.

For association-oriented platform, it is important to pull in different kinds of data from as many types of products and data sources as possible and then make associations over them. Taking Apple's HealthKit [5] as an example, in the construction of the ecosystem, it is necessary to find out various types of health-related data along with their data source (e.g. EHR data) or collecting applications and devices (Jawbone, Up Move, Withings, Misfit Shine, etc.) and then make the platform connect to or be compatible with them. Services could then be derived out both directly in the form of personal applications and indirectly (through ReserachKit) as health data-based research serving hospitals, insurance companies, etc.

In crowdsourcing-based platform, the amount of devices or users involved is crucial. In the design of the ecosystem, one should think about how to incorporate large quantities of data through various types of devices and derive both public and personal services on top of the consolidated data. In designing E-Wearable, we first outline possible directions for further development of potential products, e.g. by data concerned, by wearing methods, by sensing capabilities, and by using scenarios. In order to complement data collected by wearable devices, we also include in the ecosystem devices put on vehicles, facilities installed in public environment, and open environmental data provided by the government. When deriving the services, we start by looking into services for both professional (e.g. government and IT companies) and individual users. For individual users, we further look for services provided to them by different parties: platform, third party, and government. These services could again include different modules, e.g. environmental information display, travel path recommendation, etc. Specifically, we come up with a system structure as shown in Fig. 2. There is a data collection layer including both private and public data collection devices

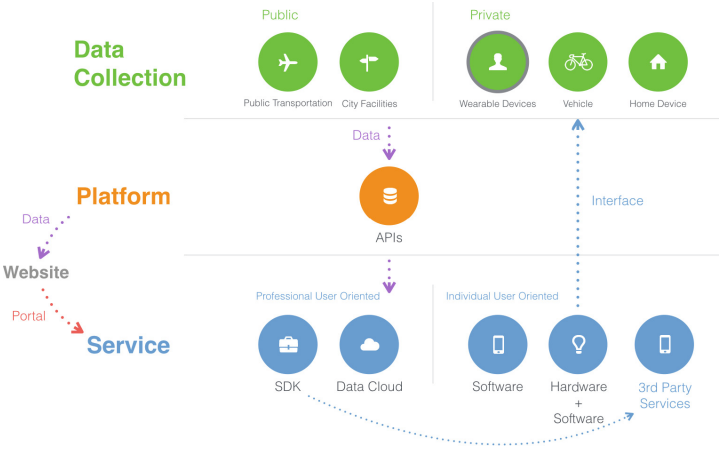

Fig. 2. System structure of E-Wearable platform

or facilitates, a platform layer for data processing and consolidation, and a service layer with services for professional and individual users.

3 Establishment of the Contribution-Benefit Mechanism

In order to keep the ecosystem running, it is essential to establish a contribution-benefit mechanism to attract more users and encourage them to make contributions. Specifically, designers should derive from users' contribution as many benefits as possible. There are mainly three types of contribution-benefit relationships to refer to while constructing this system:

1. Benefit made possible by the accumulation of certain type of data contributed or activities performed by the users
2. Benefit come into being through the association of multiple types of information contributed by the users
3. Benefit provided by another party other than the platform based on users' contribution.

In E-Wearable, there are different types of user contributions that can lead to accumulation-based benefit. Various types of environmental data collected by users at different locations across time can form together the environmental information map for users to check directly or for more services to build on top of, e.g. environmental status of people the user cares about or recommendation of traveling path with better air quality. Large quantities of user comments about the afforestation rate and other general appearance of the environment can complement with the data collected from sensing devices and enrich the environmental information map. Environment protection activities by users can also help to improve the environmental quality accumulatively. However, the resulted benefit could not be sensed immediately. The platform needs to provide an organizing and rewarding mechanism to encourage such activities. In E-Wearable, we designed an environment protection game for this purpose, in which users join different groups to accomplish environment protection or improvement tasks of certain areas in the city. Both virtual (game points or credits) and real (coupons or wearable devices) awards are given to the participants as encouragement.

For association-based benefit, one example in E-Wearable is that users can get environmental condition alerts or protection wear suggestions based on their health status and the surrounding environmental information. One example for benefits provided by other parties is that the government could take environment improvement actions, such as increasing afforestation coverage or installing environment protection facilitates, based on environmental information contributed by the users and their reports of environmental problems.

4 Design of the Products and Services

We explain is this section how we derive product and service design in E-Wearable through refinement and combination of the ecosystem components. Refinement refers to the process of specifying product and service attributes along the main categories of the key components, and combination refers to the process of deriving product and service concept through associating the refined attributes from both the data collection and the service side.

For data collection, based on the type of data concerned, the products can be refined into those for pregnant women, for people with breathing diseases, for people allergic to dust, etc. By wearing methods, they can be refined into devices in the form of glasses, necklace, wristband, ring, mask, shoes etc. By sensing capabilities, they can be refined into products sensing air quality, humidity, noise intensity, radiation intensity, vehicle exhaust pollution level, etc. And by using scenarios, they can be refined into products for people to wear or use while taking a walk, biking, or driving.

From the service side, for different types of users, there are data cloud service for the government, development SDK for third-party developers, and a variety of services for individual users which can be further refined by service provider, service module, and characteristic of the users. Services provided by the platform may include environmental information map, path recommendation, warnings towards the change of the environmental status, comments on environmental problems etc. Those provided by the government may include public environmental information display, construction of environment protection facilities, pollution treatment etc. And services provided by third-party can be refined into applications supporting specific hardware, protection wear suggestion, radiation alert, etc.

Shown in Fig. 3 are a set of products derived through the process introduced above. Considering of different data emphasis and wearing methods, we designed phone case, wristband, and ring that can collect data of the surrounding environment. Considering of the different using scenarios, we designed devices placed on bicycles and cars. Services associated with these devices are mostly provided through mobile applications. Some of the devices themselves are also able to give lighting cues or alerts regarding environmental quality. In order to complement the sensing capability and using scenario of wearable devices, we also designed sensing facilities installed in parks, on the street, and on building facades. Main services they provide are real-time environmental information displays in public.

5 Application Design at the Platform Scope

As part of the ecosystem, there would be many applications affiliated with the data platform. Besides the platform official application, there are also third party applications and applications for different devices. Not only sharing the same set of data from the platform, these applications may also have in common many service modules closely binded with the platform. For example, in E-Wearable, environmental data visualization, path recommendation based on real-time environmental information,

Fig. 3. Example products and services in E-Wearable system

comments about environmental status etc. may be modules many applications would like to include.

In order to avoid reinventing the wheel in the development of different applications, in E-Wearable, we utilize a module-based design for all the affiliated services. Core modules like those introduced above will be developed by the platform. Device or third party service providers also develop their applications as modules, such as environment protection game module and modules supporting the use of various wearable devices. The platform provides visual and development guidelines for third parties to follow during the development of their own modules. As shown in Fig. 4, the basic application and applications for users with different devices may include different modules [1, 3]. For people like pregnant woman, it is also possible to include in their applications specialized modules such as radiation intensity alert.

Such an application design at the platform level helps to bring to users consistent experience while using different services. It saves them from installing multiple applications with overlapping functions in different design. When there are more and more modules in the repository, the platform can recommend to users modules they may be interested in based on their profile information, such as health status, living habits, environmental information concerned, etc. Over the process of use,

Fig. 4. Module based application design

the application can also help users dynamically adjust their application based on their browsing preference and using habit of different modules.

6 Conclusion

We introduce in this paper the concept of focus switch in the design of wearable devices and propose to design the products and services from the perspective of a data platform-centered ecosystem. Through E-Wearable, a wearable device-based social innovation platform for environment protection and environmental information service, we exemplify in detail design concepts and methods from this expanded scope. More research along this line worth to be carried out to increase the quality of design in different application fields. Also, there are security, privacy, and other issues need to be well dealt with during the process of utilizing data collected by wearable devices. Hope the concepts and methods proposed in this paper could serve as a starting point for further research on the mechanism and design principles of wearable device-based product and service ecosystem.

Acknowledgments. This work was supported in part by the Fundamental Research Funds for the Central Universities in China (0600219044) and the Grant from the International Cooperation Project of Ministry of Science and Technology (2012DFG10280).

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