Usability Studies on Sensor Smart Clothing

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Abstract. This paper presents approach to usability evaluation on sensor smart clothing that the methodologies can be divided into two categories. 1) usability evaluation that gather data from actual users on sensor smart clothing. 2) investigation weight values which is calculated for evaluation item. The result of usability evaluation shows that SC(sensor controller) influence on overall usability of sensor smart clothing. Effective item and module is social acceptance of SC, wearability of GC(general connector) & PA(platform appearance), usefulness of GC & PA and maintenance(400) of PA & SC. To estimate the sensor smart clothing, task process was applied and the components on the response of user were investigated. This study was performed to determine how effects the properties of sensor smart clothing. Our study suggests that usability evaluation may be important within design process of sensor smart clothing.

Keywords: Smart Clothing, Usability, Evaluation, Sensor, Wearable Computing, Wearablility.

1   Introduction

Wearable computing has arisen in the area of human computer interaction design which is involved human cognition, context of use, platform of access, task analysis and user experience [8]. "Wearable" has been defined as implying the use of the human body as a support for some product [2]. Besides, "Smart clothing" may be an intelligent garment, which is augmented with electrical or non-electrical component, including safety and entertainment [6]. User-centered smart clothing design must be related with user task [9] since smart clothing is constantly with the user's better responds to their needs [7].

This paper is focused on developing product of sensor smart clothing in terms of user experience. Usability is needed design frames through that people can use technology that are meaningful.

Daily activities can be classified into two categories. Some are characterized by the way the human body is being used as sitting, standing, walking and so on. These activities are best recognized directly where they occur, using body-worn sensors. Recent work used this approach [4], [5]. Other activities are defined by the usage of certain objects or a sequence of objects. Sensors in the environment could track the conditions [4], [5].

There are a lot of sensing technologies that could be envisioned for context recognition for instance audio, video, photography, acceleration, light, air, body temperature, heat, humidity, pressure, and heart rate. Many physiology sensors require skin contact or special outfits. There is clearly a tradeoff between informative and unobtrusive sensing. In addition, other points are battery life and price. In order to reach user acceptance wearable device must be small and unobtrusive. If possible even fashionable, there are several accessories that are widely accepted, such as belts, watches, necklaces, cell phones or pagers on a belt-clip. Miniaturization of hardware has made it possible to integrate sensors into such devices while nobody would want to wear sensors strapped around all legs and arms. This work focuses on a minimal set of sensors. Several studies using physiology sensors were conducted.

The aim of usability study in sensor smart clothing is to be determined whether evaluation item of wearable computer would be useful. This study is to investigate partially for weight which is used to calculate for evaluation item.

2   Method

2.1   Participants

12 participants took part in this research. All the participants are undergraduate student. All participants were male because prototype sensor clothing was man type.

2.2   Procedure

Participants could put on and handle sensor smart clothing directly. This study surveyed as paper-based questionnaire, with all questionnaire on a 7-point scale from 1 to 7 [1], [3]. Evaluation contents are as following. There are social acceptance(100), wearability(200), usefulness(300), maintenance(400), and safety(500) in item evaluation and there are pa(platform appearance), pm(platform material), sc(sensor controller) sd(sensor detector), gc(general connector) and e(satisfaction). It was total 153 questions (pa 36, pm 8, sc 23, sd 7, gc 14 and, e 65 questions). All usability evaluation had the same procedure. First, participants did the simple task to be accustomed on smart clothing. And then they fill in a questionnaire and interviewed with experimenter about the evaluation. All procedure was recorded on video-tapes. The entire experiment lasted approximately 60minutes. There is description of rating about item evaluation in Table 1.

Participants sat in a UT(Usability Testing). Moderator explained sensor smart clothing. Moderator took unstructured interview and made participants talk freely for sensor clothing. After interview was completed, participants were asked to fill out questionnaire. The participants were debriefed after the survey.

Table 1. Item Evaluation Description

| Item	Code	Description
Social acceptance	100	I am worried about how I look when I wear smart clothing. I am worried about how I look when I wear the device. I would like to look better in front of others
Feeling of wearing	200	This smart clothing is causing me comfortable when I wear smart clothing. I can feel comfortable device when I can feel the device on my body.
Utility	300	Smart clothing makes me feel physically difficult. Device makes me feel physically inconvenient.
Easiness of maintenance	400	It is difficult manage smart clothing.
Safety	500	I do not feel secure about the smart clothing I do not feel secure about the device

3   Results

3.1   Survey

Sensor controller's social acceptance was estimated by low point than other items. In addition, sensor controller of maintenance was estimated by low because of controller's size or point.

Graph that compares each mean and whole satisfaction item sees two graphs keep similar inclination and is showing possibility that can estimate satisfaction which is whole through the question that estimates each part item(Figure 1).

In Figure 2, it is showed pa(platform appearance), pm(platform material), sc(sensor controller), sd(sensor detector), and gc(general connector). These influence on social acceptance, wearability, usefulness, maintenance and safety. Latent outcomes showed
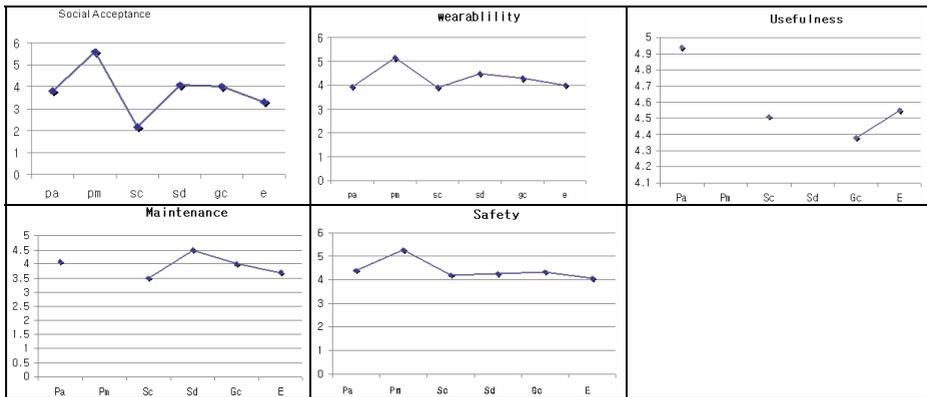
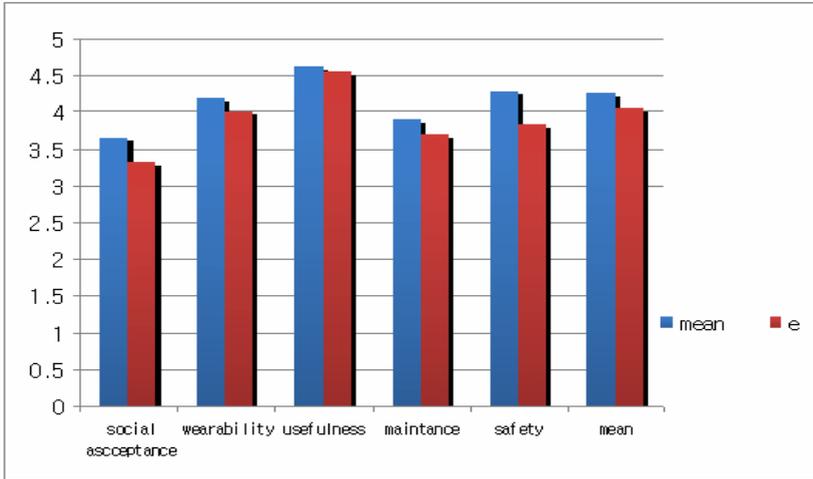**Fig. 1a.** Module and Item Evaluation

**Fig. 1b.** Evaluation item on sensor smart clothing

that social acceptance was influenced on sensor detector, wearability was influenced on appearance and connector, usefulness was influenced on appearance and connector, and maintenance was influenced on appearance and sensor controller (Table 2). Figure 2 indicated that main factor influencing on usability regardless of individual item was Sensor controller.

Table 2. Evaluation Code and Qusetion Screening Results

C-code	pa	pm	sc	sd	gc	SIG.
Social Acceptance	2,30	0,07	-0,69	0,53	1,16	-0,32	N.S.
Wearability	0,64	0,37	0,02	0,10	-0,08	0,41	N.S.
Usefulness	-0,45	0,48	x	-0,05	x	0,64	p=,005
maintenance	-0,31	0,96	x	0,74	-0,27	-0,32	N.S.
Safety	6,91	-0,11	x	-0,43	-0,06	-0,08	N.S.
Total	9,56	-4,68	-2,28	4,50	1,59	0,31	N.S.

3.2 Interview

We asked a question briefly of participants except quantitative measurement through question. We could not speak that suggestion which is said here is meaning statistically, but items that are worth as subjective measured value.
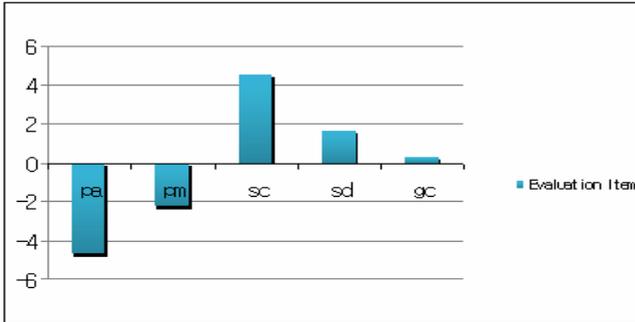
Fig. 2. Sensor controller Influencing on usability

Weight imbalance. As shown in question before, because controller was heavy, point that symmetry of clothing throws was brought to problem.

Information display. If user wants to see acidity sensor and display, a user is possible though drop head deep. It means others must inform than feeling that do oneself check.

Function concentration. Smart Clothing is positive at point that offer convenient function, but user will need to think point that can inform person who does exercise. For example, present activity is achieved properly and if inform how momentum becomes, there was opinion that is good for a person who does exercise.

4   Discussion

The present underlying conclusions about evaluation of module and item suggest that sc(sensor controller) influence on overall usability of sensor smart clothing nevertheless evaluation item(figure 2). And effective module of social acceptability(100) is sc(sensor controller) and sd(sensor detector), wearability(200) is gc(general connector) and pa(platform appearance), usefulness(300) is gc(general connector) and pa(platform appearance) and maintenance(400) is pa(platform appearance) and sc(sensor controller).

   This study has had two main purposes. First, usability evaluation of sensor smart clothing had mean value above average about evaluation item except social acceptance and maintenance. Social acceptance and maintenance is influenced on the reason of experiment of being not perfect prototype. Of course, second, when item validation procedure have seen only tendency, it is not easy to conclude. But in un-experienced product centered technology, though one of factors is a problem such as sensor controller on sensor smart clothing, such a factor would effect on other items. Appearance and material of smart clothing would influence on factor except function in technology because of character clothing itself.

   On sensor smart clothing prototype is essential measurement based on the physiological measurement. The purpose of sensor smart clothing is to help the user

to reach optimal condition. Usability evaluation for this smart clothing is connected to technology. To estimate the sensor smart clothing, mechanical stimulation was applied and the components of the response user of smart clothing were investigated. A simple procedure of user study was performed to determine how effects the properties of sensor smart clothing. To evaluate behavior of user, It is necessary that daily measurement and over a period of a month.

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