

**INTERFACE DESIGN USING CLOTHING FASTENERS FOR
FUNCTIONAL SEPARATION, COMBINATION, AND
MANIPULATION OF WEARABLE SYSTEMS**

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Abstract. As wearable systems gradually change from a technology-oriented paradigm to a wearer and garment-oriented paradigm, it is even more necessary to support the diverse desires and psychological satisfaction of wearers. A wearable system should enable the user to reorganize the interface to suit their convenience, style and use. With this aim, this study is conducted to develop a human friendly wearable system interface design from a user-oriented design perspective by producing the exterior shape from existing garments or changing the function of a garment through the attachment or detachment of the garment, and using a familiar garment fastening system used for straightening wearer's garment. The study obtains technical factors applicable to a wearable system for developing a wearable system interface design, as well as garment fastener and garment compositional factors, and then it deduces behavioral vocabularies that separate/combine/manipulate a garment fastener based on those factors, as well as wearable system interface design factors that support the separation, combination, and manipulation of the functions by using a garment fastener through research into the observing of user behavior. Then, this study prepares a concept design by utilizing the deduced interface design factors and addresses the usability of the garment fastener as a wearable system interface design factor based upon the design Prototypes.

1. Background

Wearable Computers demand a close association between various fields of learning such as computer technology, clothing, design, psychology, Human Sensibility Ergonomics, etc. Considering the fact that users actually ‘wear’ the technology, such factors as stability, ease, fashion, and design should be recognized as influential factors in accepting the technology in addition to the performance and technical matters of the system. Fashion Designer Ferretti (1999) states this:

“Consumers, who came to know how to choose clothes in accordance with their desires, become more and more independent, playing the role of ‘Prosumer,’ or active in creating fashion according to their own style.”

This indicates that clothing is used as a means of expression of an individual character’s strong desires, personal values and goals. In other words, people express their own emotional, functional goals through the Mix & Match of various clothes and items. Besides, as in the case of mobile phones and iPods, technological artefacts are getting smaller, embedded, and wireless, and due to the convergence of the key functions in various aspects, technological methods have developed into specialization and divergence of key functions. Such changes in technical environment also affect the wearable system fields as well.

As seen in these environmental changes, wearers require the wearable system interface design environment in which they can freely choose and reorganize various functions and interface methods that the wearers feel are natural, familiar, and well matched to their own characteristics like a clothing mix and matches.

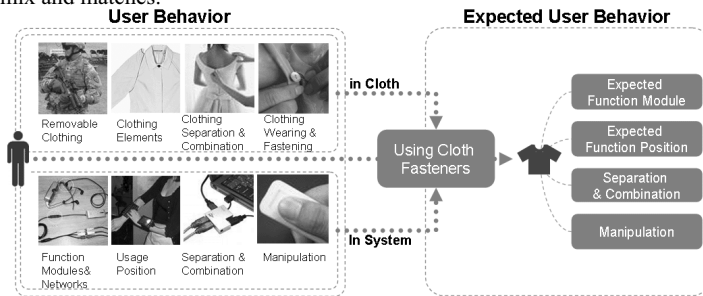


Figure 1. Concept Diagram of Extracting Expected user behaviors to design the Cloth fastener wearable Interface using the comparison with User Behavior of cloth and system.

2. Clothes Fastening System

Fastening System means the fastener that connects materials and the effect of the elements. Fasteners connect things, and play the major role in adjusting, opening, and closing so as to make it convenient to wear the clothes. Cloth Fastening System, based on the functions of zipper, snap, hook, Velcro, roof, and pin, adds and applies some more modernized functions.



Figure 2. Reprehensive cloth fastening systems.

Roles of Cloth Fastening System can be divided mainly into two parts: functional, intentional role to attach to and detach from clothes and to change the original functions; visual role to change the decorative elements and materials of clothes or the appearance of the clothes.

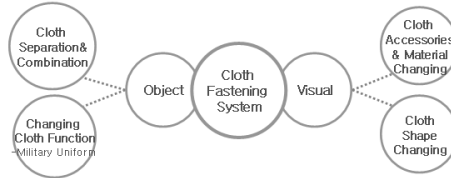


Figure 3. Roles of cloth fastening system.

Each fastener has not only different forms and structures respectively, but also different ways of attaching and adjusting, utility at clothes, and ways to use. The major features are as follows: Firstly, a *Fastening System* tightens a certain part of clothes, and enables *opening*, *closing*, *attaching* and *detaching*, which causes changes in the form of clothes, partly or totally. Secondly, a Fastening System is not a mere part but the theme of clothes, functioning as the clothes as it is. Thus, it is possible to expand the border of expression of clothing by forming new textures and structures. Thirdly, it is possible to change the general silhouette or partial form flexibly, which produces formative functions that change the design. Furthermore, fasteners enable the development of modular clothing or removable clothing through separation, combination and manipulation of the clothing elements.

4. Interface Design for Wearable System

4.1. THE RELATION OF CLOTHES FASTENERS AND BODY POSITION

Clothes fasteners are usually used in outerwear, this study limited the object clothes to outerwear to grasp the region of fastener utilization in clothes. We observed the cloth fasteners of different style outerwear to know the usages of cloth fasteners. As a result of observation, we could find some resemblances of the usages of clothing fasteners in the clothing element parts. But Cloth fasteners are also used for the purposes of design and visual element in the cloth, so it is not easy to form the direct relation of fastener types and clothing element parts.

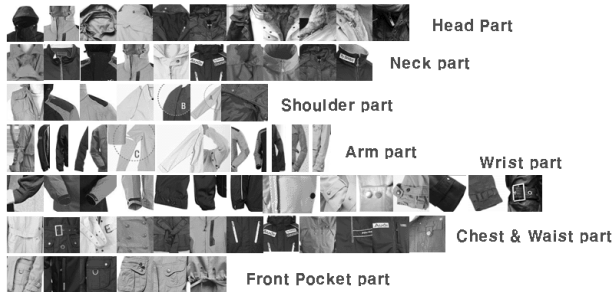


Figure 4. The types of clothing fasteners in different part of outerwear clothing elements.

4.2. FUNCTIONAL ELEMENTS SAMPLING

4.2.1. Functional Elements Sampling

For sampling of general functional modules, we examined digital products in the product list at a shopping website and the functions of each product. (ex. – mobile phone: voice/video communication, SMS, etc) The sampled functions of each product were re-grouped according to the functional modules of each product. (ex. - voice communication function: input-microphone; output –speaker; phone case, etc.)

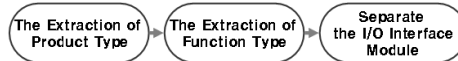


Figure 5. Methods for functional elements sampling.

4.2.2. *Functional Elements of switches sampling*

We investigated variable switches (Tactile switch, push switch, micro switch, slide switch, rocker switch, toggle switch, magnetic switch, dip switch, and rotary switch) to know switch characteristics and System manipulations. As a result of investigation, all switches is made of the structure of electrical connection and disconnections, so we divided switch type as On/Off type (Key click switches– click tactile feeling, non click – soft touch or none tactile feeling, 1 channel switch) and linear type (2ch over) according to the Channel count and the way of switching method.



Figure 6. Some samples of variable switches.

4.3. SURVEY OF USER BEHAVIOR

A survey was conducted in which 10 university students (male:5, female:5), men and women respectively, were given the clothes fasteners attached to actual clothing, and asked to relate their views and imagined vocabularies on separation, combination, and manipulation to each fastener and the personally preferred location of the functional modules.

The first findings show that as for the separation, combination, and manipulation of Clothes Fasteners, the respondents had various opinions not only on shaking, change of the snap cap and other common use, but also on the change of some structure of fasteners.

TABLE 1. Example of Relation between Vocabularies of separation, combination, and manipulation

Fastener Sort	Meaningful Vocabularies for Interaction	Relates Switch types
Snap	Rotate Cap, Shake the cap, Button/ unbutton, Press the cap, change the cap	On/off type and Linear type
Zipper	Zip Up/ Down, Unzip , Change the handler, Grab the handler, shake the handler, Press the handler,	On/off type and Linear type
Button	Button Up/ unbutton, Rotate button, grip , twist the button	On/off type
Draw string stopper	Secure/Insecure, Shake stopper, Chang stopper, Bend string,	On/off type and Linear type
Velcro	Spread, Press the Velcro, attach together	On/off type

And next, as for the preferred locations of input/output and other functional modules, they preferred such areas as wrist, back of the hand, arm, etc at

which they could operate input/ output functions and see the results easily. As for the modules for listening and speaking, they preferred the head area.

As for other functional models (power, process, network, data storage module, etc except the input/output functions), they preferred various locations such as waist, shoulder, belly, arm, etc, and especially waist and shoulder where they feel comfortable and can bear without much effort. Interesting thing is, though, they did not want the modules to be near the heart or chest. We examined the relation between components of outerwear and functional modules at each body part. Based on the Wearable System cases, the formation was classified mainly to head-wearing type, hand/arm wearing type, and cloth-embedded type. So we arranged the result data base on to these 3 classified types.

TABLE 2. Example of Relation between Body Parts, Outwear Elements and Functional Modules.

Types	Body Part	Clothing Elements	User Behavior- Functional elements (I-Input, O-Output, E- except the input/output functions)
head-wearing	Head, Eyes, Ears, Mouth, Nose	Hood, mask	I- Mic, Sensor, O-Speaker, Display, Smell
hand/arm wearing	Hand, Fingers	Gloves	I-Touch pad , Joystick, keypad, Sensor, O-Tangible Device
	The back of the hand. / wrist	Cuffs, Sleeves	I-Keypad, Touch pad, Joystick, O -Display, Tangible Device
	Arm	Sleeves, Pocket, Design Line	O-Display, Tangible Device, E-Device Box
cloth-embedded	Neck	Collars, Neck Line	I-Mic., sensor O-Speaker, Tangible Device, E-Device Box
	Shoulder	Shoulder Pad, strap, Design Line ,Design Line	I-Sensor, O-Speaker, Tangible Device E-Device Box
	Chest	Design Line, Outer Pocket, Inner Pocket, Front	I-Sensor, O-Display,
	Back	Design Line, Back	O- Display, Speaker, E-Device Box
	abdomen / waist	Front Pocket, Belt, Waist Line, Front, Back	E-Device Box

5. Prototypes & Concept Design

Base on research results, we made the electronic fasteners that could be used in separation, combination, modulation of clothes components and functions by means of *clothes fastener*. By using snap buttons, and referenced the user behavior of control of snap button (ex. - rotation and button up and unbutton),

we could be made not only on/off 1 channel switches but also linear switches of 2 channels or more.

Using these electronic snap buttons, we could make the concept design clothing to explain the functional separation, combination, and manipulation using cloth elements in the wearable system.



Figure 7. Example of 1ch Snap Switch button and Separation of the Stereo speaker Hood (3 channel switch of Snap Button).



Figure 8. Exhibition of DAT (Digital Art and Technology) 2007 in Singapore.

6. Conclusion and Future Study

Fastening systems are already a familiar clothing interface to many users. Owing to the form and structural advantages, it enables the formation of electric signal processing On/Off (1channel) or linear (2channels or more) systems. The original systematic features enable separation, combination, and manipulation of various clothing elements.

The clothing fastening system can modulate the original formation, adjust the functions of the garment, and even decorate the appearance of clothing. As well as such various external, visual functions, this system brings together the connection and combination of a variety of functions. Users are free to express their unique characteristics and create their own wearable computer interface design with the separation, combination, and manipulation of functions.

In the future, there should be a scenario development for its application to actual clothes and a study on the connection between various clothing components and functional elements. In addition, there should be a study on separation, combination, and manipulation of various Cloth Fastening Systems so that ultimately, the wearable computer interface can help wearers express various characteristics and intentions in a natural way.

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