ENGENDERING TACTILITY THROUGH HAPTIC BODYSUITS

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Abstract

The paper presents how developments in the field of Smart Clothing and electronic textiles engenders new, corporal sensitivity and new artistic applications of touch. The senses of touch in the context of new media art and immersive environments pose many challenges. The paper centers around my work on haptic bodysuits that create somatic impressions of both touch and presence in immersive environments. Haptic technologies built into bodysuits enable new kinds of sense-manipulative art experiences. The somatosensory system is a little used, but important way to investigate how we perceive and understand the world. [2] Within immersive virtual environments and multisensory interfaces the artistic experience promises to become a sensual fusion of man and artwork, dependent upon the user's presence and bodily functions. A central component here is the design of bodysuits.

The purpose of this paper is to explore and present how tactile stimulation can be used in the arts. Tactility is a highly underexplored technology [1] and medium for art and is here presented as a valid artistic expression.

Haptic bodysuits

'Art can and should be a touching experience' - Mark Paterson [1]

A bodysuit is a wearable device in the shape of a suit that in some combination reads, feels and manipulates its users. Most bodysuit projects such as 'smart fashion' [3] are passive devices, using the body as an input device to influence external expressions –such as projections, sound, light, mechanical movements etc.- and not as a surface for internalized, somatic impressions and sensations.

My own work on haptic bodysuits started with the cyberSM project (1993). [4] In this experiment two users were enabled to communicate via touch, voice and visuals over the internet. In such multisensory communication systems, haptic bodysuits distinguishes themselves by using and activating a larger part of the somatosensory system compared to the often visual output of 'smart fashion'. Users can so better be included as active participants and even performers in the formation of somatic artworks.

The Erotogod Experiment

In the immersive, virtual reality installation Erotogod (2001 - 03) [5] [6], the bodysuit is designed as a two way instrument with both in- and output. The input is reading users auto-erotic self-touch and the output is impressing the users with complex vibrotactile patterns.

The bodysuit is one-size only and hardwired to the installation's suit interface. The custom built interface has 128 analogue outputs, 96 digital- and 16 analogue inputs. The in- and outputs were paired together into zones of approx. 4 by 4 centimeters and covered most of the frontal body. The more than 100 in- and output zones inside the suit represents a relatively high sensory resolution, turning the body into a sensory instrument. By touching one's own body the user triggered inputs that influenced the overall state and expression of the installation. Vibrotactile feedback was felt directly on his/her own body through i) the autoerotic self touch and ii) various haptic patterns triggered by the system.

The Erotogod bodysuit exemplifies several of the critical design factors such as solidity, anatomical fit and the user's sense of transparent, ease of use. Factors relevant for the aesthetic bodysuit design, wearability and the role of human form in wearable product designs are, according to Gemperle et al. [7], body ergonomics, perception, functionality, technology, materials, energy and possibly recyclability. Several of these issues were taken into account in the development of the Erotogod bodysuit. Two additional factors relevant for bodysuit design in artistic context are multi-sized suits and aesthetical looks and feel. One challenge encountered in the Erotogod installation was how to make the one, hardwired suit to fit all sizes of users and both sexes. Due to the large variety in shapes and sizes of human bodies it is often desirable to construct personal, individual suits. Personalized suits secure the right stimulus or sensor to be put in the right place. This is not always practical when doing shows in the artistic context. Here there is pressure to allow most visitors to try out the artworks. To solve this I have developed an average anatomical model that fit most users. This model evolved

through measuring various male and female body sizes. The final bodysuit design of Erotogod involved various strap-on modules that easily could be fitted to the various body shapes of the participants. Additionally all users were positioned in a kneeling position atop the installations platform. This allowed for designing a suit with a looser fitting compared to a moving users need for a more lightweight, anatomical transparent suit. Later versions of my other bodysuits have created solutions for such mobile scenarios. [8] [9] [10]

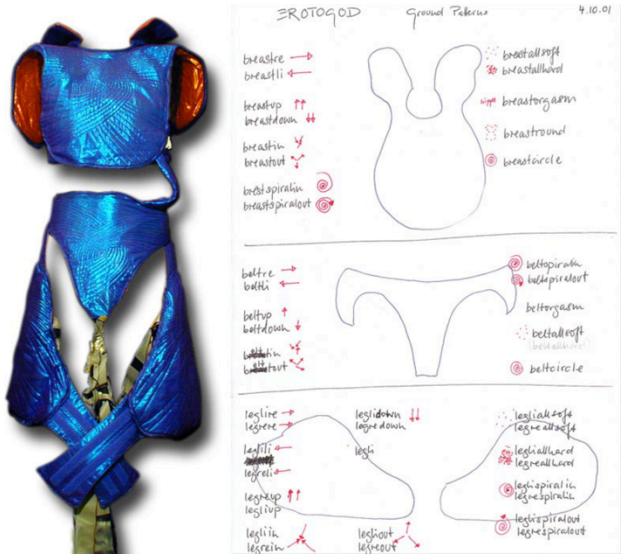

Fig 1. The Erotogod bodysuit (left), Haptic pattern sketch (right), 2003, Copyright Stenslie.

Usability issues

A range of problems has to be solved to make a bodysuit function like a second, transparent and functional skin of the user. Transparency is here used as an ergonomically measure of how the suit interferes with the user's sense of interaction. A high degree of transparency indicates ease of use while a low degree of transparency can significantly reduce for example the autoerotic sensation of touching oneself. Some of the major ergonomically challenges are involuntarily triggering by movement, squeezing, mechanical look-and-feel, discomfort and cable strain.
Aesthetically the haptic bodysuit of Erotogod was designed to make the users feel as if 'dressed in emotions'. Putting the suit on psychophysically prepared the users for something new and unexpected. Here the tactile qualities of the clothing material itself become significant.

Touch Technology

To produce concrete and physically measurable sensations of touch my first experiments [4] [11] used a wide range of electromechanical device that shake, move or vibrate the body. Based on ergonomical and functional issues such as power consumption, size, safety etc. the Erotogod suit only uses custom-made vibrotactile effectors (5V, max 200 mA). For input custom built, digital, soft touch switches were used.

Fig 2. *Erotogod user,* 2003, Stahl Stenslie, Copyright Stenslie.

Vibro-tactile illusions as design tool

Haptic expressions can be designed by combining zones of vibration in sequences, but they can also be built to exploit vibrotactile illusions. [12] These are perceptual phenomena that arise when two or more vibrotactile actuators are stimulated on the skin. [13] Examples are i) the PHI effect of apparent motion on the skin (Hayward) [12], and ii) the Phantom sensation. In the latter vibration-induced illusion [14] [1] [15], users sense a physical stimulation or object that is actually not there. One example of phantom sensation is the appearance of an object between the knees. This effect is triggered when each knee is vibrotactually stimulated at a certain frequency.

Haptic vocabulary

A haptic vocabulary can be defined as a 'toolbox' containing different ways and methods for touching users. Touch patterns were scripted as drawings before coded into the software. The resulting 'shapes of touch' patterns formed the suits tactile taxonomy. More than 120 tactile scripts makes up the haptic vocabulary made for Erotogod. The duration of each script lasts from a few seconds up to a minute. They can be triggered individually, in sequence or in combination with random patterns. The number of combinations resulting of this vocabulary is immense and the Erotogod project only scratched the surface of what is possible to express through such combinations.

Haptic language

An ongoing quest is to find out if haptic stimulation can somehow form an intersubjective language of touch. Here, Thecla Schiphorst has worked on developing a 'Semantics of Caress' [16] that investigates how the meaning of touch can be applied to tactile interaction. Her approach represents a somaesthetical turn where touch and movement is seen as something meaningful, contributing to quality sharing.

From a technological point of view, the relatively high two-way sensory resolution of the Erotogod bodysuit (90 sensors, 120 vibrators) opens up for the formation of a haptic language. The density of vibrators enabled the construction of complex sensory patterns to be imprinted on the body. The haptic perception induced by the patterns varied. The suits haptic vocabulary has over time developed into a toolbox able to create distinct sensations from being pulled, pushed, resistance, weight, (human) touch, tickling to objects and 'insects' crawling around on the user's body. The suit can also induce sensations of things going inside as well as through the body. Several users had the impression of the suit as being alive. It was reported felt as a living skin on the body. To maximize the physical effect of each vibrotactile effector it is important to place them as close and firmly onto the skin as possible. More effect is achieved if users are naked beneath a body suit, but due to the number of participants and for hygienic reasons it is normally sufficient to wear light clothing underneath.

Possibilities and applications

The practice based research into haptics has indicated several possibilities. Despite numerous projects [4] [5] [8] [10] that have dealt with how to engender tactility through bodysuits, there is still need for more data and research before any conclusive answers can be given. Also, as there are no standard technology or platform for haptics, there is no significant haptics community that work together, especially not in the area of artistic use of touch as materiality. Some of the findings in my projects are: [6] [17]

1. Immersive closure of space: when bodysuits are applied in a mobile context (Stenslie 2012), [xx] users reported being mindful of public exposure beforehand, but inside the suit they quickly immersed into the experience and focused mostly on own sensations. This indicates a closure of space, strengthening users' sense of an intimate, personal and 'inner' experience.
2. Multimodal strengthening of senses: cross-modal combination of sound and touch results in strengthening of experienced stimulus. Touch makes users stay longer, intensifying the overall sensation of body and space.
3. Increase of spatial awareness: In mobile context, users tended to be more self aware of how they were moving in space.

Applications

There are several possible applications of this paper. It touches upon -and is related to the various areas such as the design of:

4. Immersive environments, to the extent that it offers a practical approach to the construction of haptic technologies that has a proven effect on users' sensation of immersion.
5. Interface design, as far as it describes the various psychophysical approaches
6. Haptics in that the research is specifically targeting development of vibrotactile stimuli.
7. Ergonomics, by how the research presents bodysuits as a highly functional way of designing and applying haptic expressions and communication.

Outlook

Haptic bodysuits represent an extension within the area of smart fashion. Their engendering of tactility enables new approaches to the telling and experience of corporeal narratives. Users of the Erotogod experiment reported a heightened corporal sensitivity and that haptic stimulus function as aesthetic experiences also without visual and acoustic input. Being inside a touching bodysuit is therefore an indication of how somatic sensations possibly can form artistic content, also on their own.

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