Touch · Sensitive Apparel

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Abstract
Touch·Sensitive is a haptic apparel that allows massage therapy to be diffused, customized and controlled by people while on the move. It provides individuals with a sensory cocoon. Made of modular garments, *Touch·Sensitive* applies personalized stimuli. We present the design process and a series of low fidelity prototypes that lead us to the *Touch·Sensitive* Apparel.

Keywords
Apparel, Wearable, Haptic, Massage Therapy, Modular Design, Sensory Interface, Fashion Design

ACM Classification Keywords
H.5.2 [Information Interfaces and Presentation]: User Interfaces: Haptic I/O.

Introduction
In hypermobile societies, people carry objects, information and goods. They develop habits to dwell in generic hotel-like environments [1]. The notion of *habitus* coined by Bourdieu relates to everything that someone does, and in fact defines the individual [2]. The search for comfort, to feel at home (to inhabit space through habits, *habitus*) when on the move defines the populations of our hyper-societies. When always on the move, as an interview based study has shown, people use technological devices to "tune-out" or express their fear of technology by finding "a place

where [their] soul is" [1]. What if objects that people carry with them and even carry on them could offer this sensory comfort that they seem to seek?

Touch·Sensitive aims to provide individuals with a sensory cocoon, a comforting and alerting apparel with a feedback system. Our design for the *Touch·Sensitive* apparel comes from the observation mentioned earlier, that people need to sooth their body to protect themselves from everyday aggressions. *Touch·Sensitive* is a matrix made of clothing elements that allows diffusion of tactile information through heat sensors, mechanically-driven textural sensation and liquid diffusion.

Related work

Massage is a practice used for soothing the body. It is the application of pressure, tension, motion, or vibration onto the body skin. It can stimulate muscles, connective tissue, tendons, ligaments, joints and lymphatic vessels. It can be applied manually or mechanically and be relaxing and/or stimulating. The goal of a massage is to achieve a beneficial response. Massage for treating the patients' body, e.g. musculoskeletal pain, can also benefit people who are suffering from anxiety and depression [3].

Massage usually involves a patient and a practitioner. But today, consumers can find everyday objects like the mini massage rollers that enable themselves to provide massages anytime [4]. These objects are portable mechanical massage aids. The cellphone is another example of object that acts like a soothing device, though it is a very different soothing one. It is a portable fetish and is the means for electronic and emotional transactions. The *Cocoonmask*, a simple white head cocoon, intends to help people withdraw from the globalized network society [5]. Yet it is a device that only occults visually the world around. It has no pretense of healing. Artists and designers have revisited the notion of portable shelter in many ways. If they do protect physically against the rain for example, they can be portable asylums that recall home—they are therapeutic psychologically [6].

The body is an information space: it loads, carries and unloads information. *Body Mnemonics* uses the metaphor of the body as a loader of information and uses the body space of the user as an interface. It stores information that can later be accessed by moving a device to different locations around one's body [7].

Various wearable computing systems incorporate computer sensing and actuation. Previous work in haptic devices focused on designing systems that allowed affectionate touch to be shared [8]. Many devices have been proposed to mechanically replicate the sense of a hug. The Hug-Over-A-Distance jacket contains air compartments that inflate quickly all around the torso to simulate a real hug [9]. An object can receive and transmit touch to distant family members [10] and huggable sculptures can literally embrace the body [11].

In light of the precedents reviewed, *Touch·Sensitive* works as an alerting device to ground the user and as a comforting device to relax the user.

Design

Our design processes include the testing of heat sensors, mechanically-driven textural sensation, and

liquid diffusion. Many massage forms and healing traditions exist, e.g. aromatherapy, that inspired the extensive literary review of this project. Aromatherapy is the use of volatile plant oils for psychological and physical well-being. We researched on a mechanism for the diffusion of essential oils. *Touch·Sensitive* diffuses the oils either through natural body motions or by using thermoelectric sensors that warm them for instant diffusion. Our design of a haptic apparel for massage treatment needs to allow for customization to optimally satisfy the user's needs.

Low-fidelity Prototypes

Touch·Sensitive seeks to be a complement not a replacement to the aroma/massage therapy produced by professionals. The creation of the apparel requires the consulting with and feedback of professional massage therapists and specialists in aromatherapy. We present below a series of low-fidelity prototypes that test our ideas and help us define our design principles for the final apparel. The iterative design process considers the study of various kinds of materials, mechanical and computational technologies, and its effects on the body skin as for its pressure potential:

LOW-FIDELITY PROTOTYPE 1: Metallic wires are sawn into the fabric. It allows giving and maintaining a shape to the apparel. Wires also conduct heat and electric influx throughout. The apparel stretches mechanically, yet heats up through circuitry. The shrinking of the fabric happens onto specific points of tensions of the body and works as an alerting mechanism.

We tested thermally-responsive materials, in particular shape memory alloys actuators. The smart alloy can remember two different shapes at low and high temperature ideally by training. However the shape modification and the return to the original state are difficult to control. For the purpose of *Touch·Sensitive*, the user needs more tightening and pressure effect onto areas of the body and the change of shape of the wire is not enough. We will couple the smart alloy to a pressure mechanism, this to create areas of tensions. We are aware of the lack of control of the smart alloy and we plan on using its properties to unexpectedly change the fabric structure. The random effect of the textural and dynamic structural parts of the apparel is an element we consider in designing *Touch·Sensitive;* and would like to user test it. Designing a computational object means designing for people and it demands reflecting on the object's critical and aesthetic roles [12].

figure 1. This wired apparel alerts the user by mechanically shrinking the fabric onto specific points of tensions on the body.

LOW-FIDELITY PROTOTYPE 2: Textural silicone buttons act as pressure points for the person who receives the massage. The material of the silicon embedded in the clothing has a pleasurable tactility for the person who gives the massage. It invites an application of a stronger impulse that is then diffused onto a larger area of the body. It is comforting.

figure 2. The second low-fidelity prototype of *Touch·Sensitive* is made of buttons with silicone.

LOW-FIDELITY PROTOTYPE 3: Manually inflatable vinyl pockets can be used to receive a comforting pressure. We first experimented with commercial blood pressure cuff to quickly evaluate the effect of pressure onto areas of the body using air. However, we work on specific pressure points, so we necessarily needed a more accurate definition of the pressure location and diffusion. We created inflatable vinyl pockets. They are either filled in by an air pump or manually to produce pressure. The vinyl pockets are positioned at crucial back pressure points. It works as an alerting mechanism and can also provide comfort.

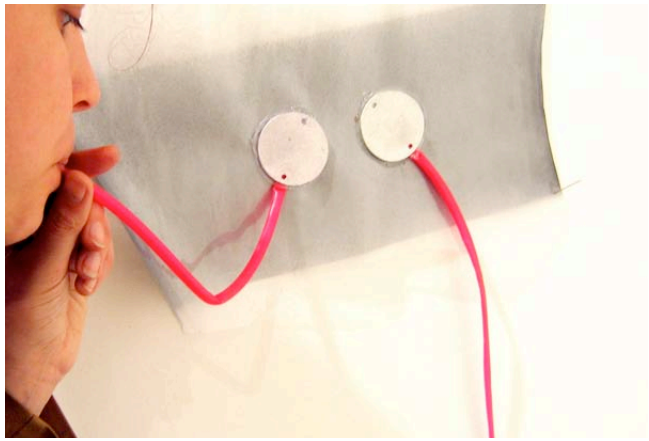

figure 3. Inflatable vinyl pockets.

LOW-FIDELITY PROTOTYPE 4: We explored how the essential oils can be included within the garment, through refillable containers. We created a mechanism to diffuse these oils. The thermoelectric sensors such as the Peltier junctions are activated mechanically using a switch button. They are mounted onto a heat sink for testing.

For *Touch·Sensitive*, we will detect the sensors temperature generated from the thermoelectric sensors to control diffusion. We will use the "cold" side of the Peltier junctions and transmit cold throughout the apparel. Optimally, the user could choose between "hot" and "cold" using the same thermoelectric sensors. The idea is to create a "reversible" apparel in the form of an electro conductive element, isolated in between layers.

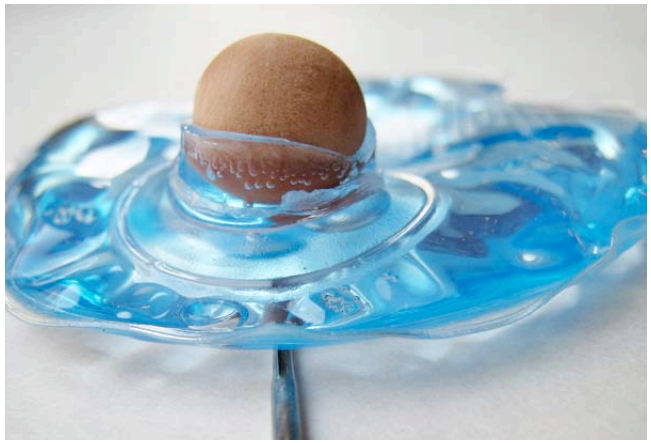

figure 4. Vinyl pockets are filled in with liquid, which diffuses around the massaging wooden ball through thermoelectric sensors.

Since the apparel has a contact with the skin we do consider the following points:

- Finding the right points of pressure. We hence need to consult regularly with professional massage therapists.
- Controlling warmth and define the optimal warming temperature through user testing.
- Selecting the best material, from rubber, foamy material to wood and stone.
- Feeding carefully the mechanism with oil essences, hence controlling the diffusion.
- Refilling the wearable, which affects the shape of the oil container and its interchangeability.
- Washing the garment.

The Touch·Sensitive apparel

Touch·Sensitive allows the diffusion of tactile information through computational and mechanical technologies. *Touch·Sensitive* is a computerized touch therapy apparel whose modular pieces can be integrated within the clothing. We have taken advantage of the growing miniaturization of computational components to integrate them seamlessly within the fabric. A feedback embedded microphone/headphone in the clothing also allows the user to control the system. It is manually actuated and takes advantage of the body morphology to trigger the desired actuation. The apparel exhibits four specific design principles:

STRUCTURE FLEX: The apparel takes advantage of impulsive motions of the body that corresponds to the user needs, e.g. rolling the shoulders to release stress. The motions can directly be transcribed onto the fabric and be detected as where the person wants the pressure to happen.

MECHANISM OF DIFFUSION: The apparel mechanically regulates the amount of oil using refillable vinyl pockets. Each pocket contains a certain amount of essential oil that is diffused with a rolling device and heats up electrically. The apparel is modular. Each module is function specific, for instance: Peltier junctions that heat up and cool down the surface through conducting fabric, a system actuated manually, or a combination of both.

LEARNING SYSTEM: We will integrate machine-learning algorithms to analyze the correlation between the motions of the user and the user's needs. This will allow

the system to provide the user with the right amount of pressure for the right place in addition to the individual customization of the type of actuation. We will add a feedback system using data coming from sensors that analyze skin temperature and use stress level. This helps in regulating the amount of oil, temperature and pressure. Embedded microphone/headphone in the clothing allows the user to control the system while s/he is on the move.

Conclusion and future work

Touch·Sensitive is a work-in-progress to develop a series of haptic modules that allow computational massage therapy to be diffused, customized and controlled by people on the move. Our current prototypes succeeded in defining a flexible structure, a mechanism of diffusion, and a feedback system for alerting and comforting the user through haptic means. In addition, we propose to integrate machine-learning algorithms to understand the massage needs of the users through the analysis over time of the correlation between the motions of the user, the location of the pressure points, the intensity and qualities of the stimulus. We plan to develop these next steps along with specialists in massage therapy.

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