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Haptic Technology – Space and Touch

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Abstract

Haptics is the science of applying touch (tactile) sensation and control to interact with computer applications. Haptic device gives people a sense of touch with computer generated environments, so that when virtual objects are touched, they seem real and tangible. Haptic technology refers to technology that interfaces the user with a virtual environment via the sense of touch by applying forces, vibrations, and/or motions to the user. However, most of these technologies are vision-based, consequently lacking the physicality of bodily expression itself. Moreover, such technologies tend to isolate the expressive body from its surroundings, thus interfering in the relationship between the body's expressions and the environment that engenders it. This position paper presents an attempt to explore bodily expressions in a tactile manner through the tangible properties of physical space itself.
Keywords: Vision-Based, Tangible Properties, Virtual Objects, Senses of Vision

I. INTRODUCTION

"Haptic", is the term derived from the Greek word, "haptesthai", which means 'sense of touch'. Haptic is defined as the "science of applying tactile sensation to human interaction with computers". Haptic permits users to sense ("feel") and manipulate three-dimensional virtual objects with respect to such features as shape, weight, surface textures, and temperature. By using Haptic devices, the user can not only feed information to the computer but can receive information from the computer in the form of a felt sensation on some part of the body. This is referred to as a Haptic interface .As a result, the variable array of bodily senses has been greatly disregarded in an attempt to emphasise on a distant, idealized visuality. However, spatial experience is always embodied and multisensory, equally dependent on vision, hearing, smell and touch.

Designed as a dense conductive grid, this textile spatial element can accurately translate bodily gestures into arrays of coordinates which are in turn fed into MAX/MSP to be translated into sound. Therefore, user engagement with the interface not only depends on their bodily gestures but also requires a close interrelation of their senses of vision, touch and hearing. The following section will start with a short introduction to basic concepts of haptic space and its relation with embodied experience and emotional response. From there, I will continue with an overview of my work and how it is placed within the fore mentioned theoretical platform. The last section will be concerned with the technical details of the textile haptic interface I have designed and the gesture tracking method it employs. For the purposes of the AISB 2009 Symposium on Mental States, Emotions and their Embodiment, I am proposing a live demonstration of gesture tracking, using a sample of the fabric prototype.

II. HAPTIC SPACE: A CONTINUUM OF BODILY AND EMOTIONAL RESPONSE

Spatial experience is a synthesis of all of our senses; within this synthesis all senses are interrelated and co-dependent and that constitutes their distinctness or separation purposeless when it comes to spatial perception In their famous A Thousand Plateaus, Deleuze and Guattari argue that haptic space 'may be as much visual or auditory as tactile', acknowledging that haptic embraces the sensory interrelation of the eye, the ear and the limbs.

From this point of view, haptic is extended to address the essence of our embodied spatial perception; a perception that is simultaneously orchestrated by our vision, hearing and touch, and that therefore reflects our bodily experience of space's textural qualities: weight, mass, density, pressure, humidity, temperature, presences, and resonances. However, haptic can also be extended to involve emotional connotations and to reflect affective response. Translating the words haptic, sense and emotion in Greek, my mother language, the interconnection of the three concepts becomes obvious at once. Haptic originates in the Greek word απτό, which means something that can be touched or grasp-ed. Sense, translated as aesthesiin Greek involves notions of feeling, grasping and understanding.

Consequently, the concept of 'grasp', in other words perceive, is core in both sense and haptic. Emotion on the other hand, translated in Greek as aesthema, shares the shame root with aesthesi, as both derive from the word aesthanome, whose ambiguous meaning can be equally translated as 'I sense' or 'I feel'. Among these three words -haptic, sense, and emotion- there is an underlying relation that, if examined closely, reveals the very nature of haptic as a sense that is ultimately bounded with emotional grasping. The idea of 'haptic' embodying notions of emotional experience attachment has been repeatedly used by theoreticians like Merleau-Ponty, Kant and Paterson.Berenson notes that our bodily response to the 'tactile properties' of our surroundings –and space- highly depends on our understanding of their ability to affect and 'touch' us, while Fisher addresses haptic as the merging of the bodily senses and the affective aspect of what creates them. Drawing on the above, my study on the relation of bodily and emotional response with the space that encompasses those starts with the design of a responsive haptic environment that addresses all sensory data as an inseparable narrative pathway upon which our spatial experience is unfolded. That is an environment whose qualities can trigger our senses, affect our bodily expressions and can be affected by them. Such an environment should be able to not only evoke bodily expressions but also to capture them and 'feed' them back to its 'organism'. Of course, similar approaches have repeatedly taken place since the advance of computational systems that can provide interactive modes of communication between a space and its users.

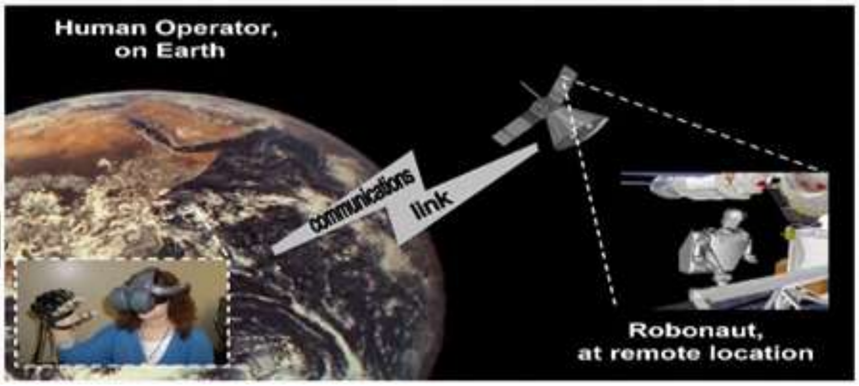

Fig. 1: Haptic Space Interface

In most of the cases though, communication is established through distant modes of interaction such as sensors and vision-based tracking systems. It is my intention to engender a bi-directional relation of affect between the body and its surrounding environment that is entirely based on the two agents of the interaction: the space and the body, without having to embed 'external' systems into their channel of communication. This mode of interaction springs, like Palasmaa puts it, from the tactile sensibility of 'enhanced materiality, nearness and intimacy'. To model such a form of intimate, tangible interaction, my focus has been on the design of a spatial interface that is capable of 'perceiving' bodily expressions itself, and which also presents a range of textural qualities that challenge bodily responses. My approach is greatly influenced by the work of Finnish architect JuhaniPallasmaa who notes that space should be re-sensualized 'through a strengthened sense of materiality, hapticity, [and] texture'; also by the work of Bloomer and Moore which propose textural change as a generator of sensations that link the haptic materiality of a space with the bodies that inhabit it.

III. AN AUDIO-HAPTIC INTERFACE

To meet these goals, I have designed a custom-made fabric to be used as an enveloping interface for an installation space. This fabric prototype is knitted with non-conductive thread (PA, diameter of 0.20mm), and has conductive wire (tin copper, diameter of 0.10 mm) embedded on both its outer sides, horizontally on the one and vertically on the other, thus forming a conductive grid.

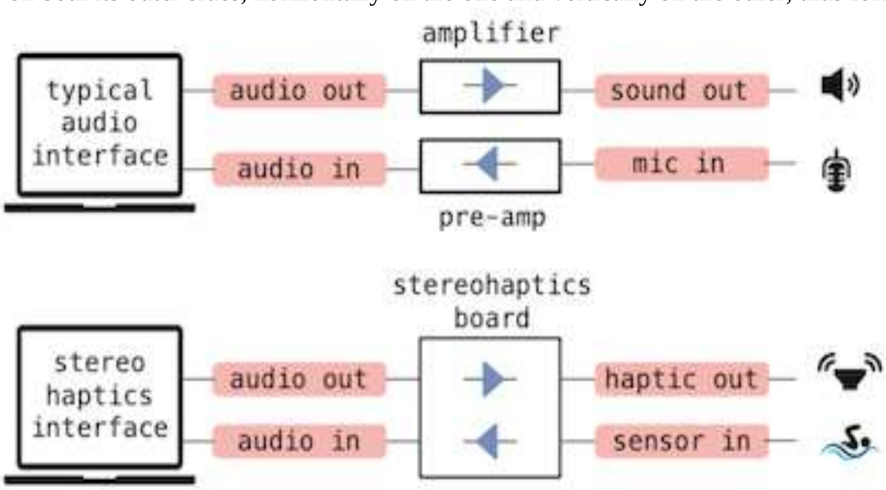

Fig. 2: Haptic Audio Interface

Fig. 3: Example of Vertically Embedded Conductive Bands

The conductive bands are wired to a complex of keypad encoders, which is in turn connected to an Arduino microcontroller. That allows for the physical textile nodes to be perceived within the Arduino programming environment as elements of a matrix whose rows and columns are accordingly equivalent to the parallel and vertical conductive bands of the fabric. Eventually, that enables the prototype to simulate a tactile, numerical interface whose resolution depends on the density of the conductive grid. The conductive elements do not make contact within the same plane unless they are compressed by touch. When the fabric is being touched, the encoders detect which conductive elements make a connection.

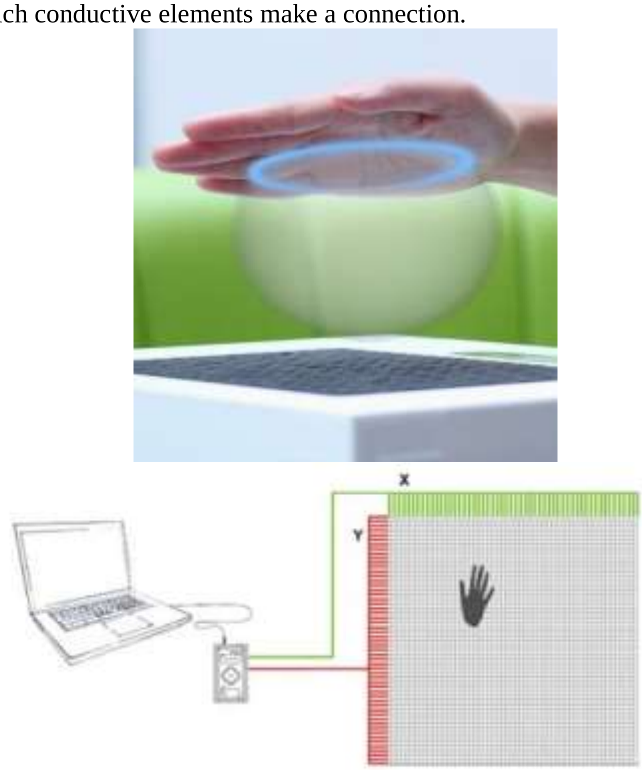

Fig. 4: Interaction Design System

This way, the gestures of the users upon the interface are captured as arrays of compressed grid nodes, and are 'transduced' into arrays of integers that respond to the matrix elements. These integers are then passed to MAX/MSP to generate sound accordingly to the users bodily gestures. Before, explaining in more detail how sound is produced from the gestural movements of the users upon the fabric prototype, it is important to refer to the physical qualities of the interface when exhibited in space as well as to the reasons for which I have decided to relate the interface with sound generation. Both sides of the prototype are layered with a translucent tulle surface upon which I am embroidering a variety of different stitches using yarns that vary in colour and weight. Apart from embroidery, I am also using a number of different techniques to process the tulle such as printmaking and collage. These processes result into a highly textured surface that acts as the skin of the prototype interface.

Fig. 5: Details of the Embroidered Surface

With the conductive grid acting as the 'nerves' of the interface and the processed tulle acting as its skin, a quite abstract representation of the textile spatial element as a living organism evolves; a representation that sets the ground for a bi-directional relation of affect between the interface-enveloped space and the bodies it encloses. The textured surface of the envelope attempts to intrigue the users senses of vision and touch, aiming to evoke bodily engagement.

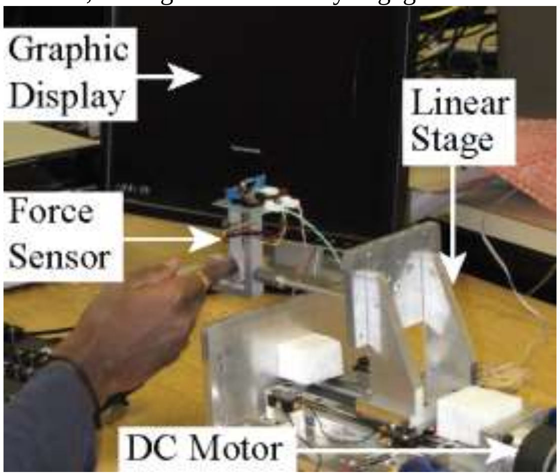

Fig. 6: Interface Requirement

As soon as the users engage with the interface through the medium of touch, their gestures are translated into sound. That enables a straightforward relation between the visual / haptic qualities of the interface and the generated sound, allowing for gestural patterns to be 'choreographed' and perceived both by the haptic qualities that engender them and by the audio output they generate. A number of different audio samples map the different textural /chromatic qualities of the processed prototype skin, with 'warmer' sounds mapping the interface areas that are dominated by warm colours and/or smooth materials and vice versa. Within each textural area, a central grid node is assigned a given sound, and acts as the 'command centre' for its peripheral nodes. That means that within a certain radius –defined by the size of each distinct textural area- the sound of all neighbouring nodes is interpolating with respect to their distance from the central node.

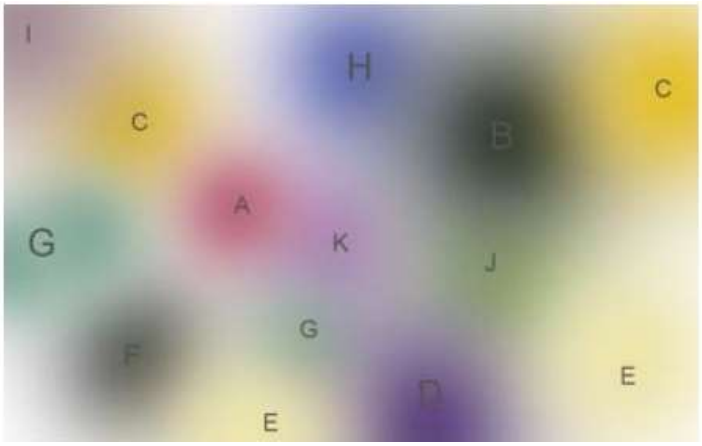

Fig. 7: Example of Audio Interpolation Mapping

When more than one person is engaging with the interface the sound is being produced as the merged outcome of their embodied engagement with the interface and with each other. The envelope can be approached from both its inner and outer side; as its weaving allows a certain level of translucency, the users' figures become part of the interface patterns. Thus, apart from an auditoryoriented collaboration of the users' gestures, a visual level of interaction among them holds also an important role in the orchestration of their bodily expressions.

IV. Conclusion

In this paper I have presented my attempt to design a responsive haptic environment that explores bi-directional relations of affect between space and its users by addressing the close collaboration of the senses of vision, hearing and touch as a medium for a fully embodied spatial experience. Within this relation both space and body are considered as living organisms that can equally affect and be affected by each other. The mode of affection between the two agents is immanent in their interaction without the need for 'external' systems, such as sensors or camera tracking methods, into their channel of communication. Such an environment consists of a space that is being enveloped by a highly-textured conductive fabric prototype, which can 'perceive' the users gestures as arrays of matrix elements. These elements are then being translated into sound, thus merging vision and touch (input) with hearing (output / and input) into a sensuous loop that 'orchestrates' the users bodily expressions and changes the space's audio qualities. The work presented in this paper is still in a very early stage of development. The description I have provided so far is strictly based on small scale sample testing I have practiced myself. I am expecting improvements considering the accuracy of gestural tracking and sound generation as soon as I have user testings in larger scale pieces of the prototype. I therefore consider the AISB 2009 Symposium on Mental States, Emotions and their Embodiment to be an exceptional opportunity to present and perform the application live to a wider audience, and I am looking forward to their feedback.

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