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A Critique of Haptic Interaction Design in a Historical Context - What's the Matter with Touch Now?

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Abstract

Examining some of the historical and philosophical frameworks, this paper seeks to contextualize increased research activity around haptic interaction. Embracing the idea that mind and body may not be separated, a general urge for embodiment and added sensuality in Human Computer Interaction research is emerging. This points to a culturally constructed history of the senses, which in turn influences research and design aims.

Through an analysis of haptic designs, some of these research aims and design parameters are grouped and then mapped onto three different philosophical models of touch: the physical-sensory model, the psychological-humanistic model, and the field model (Weber, 1990). Including various modes and senses in the interaction process gives the impression that this will become more "natural" and "intuitive". We will explore what the haptic senses can specifically add to digital interaction and communication, depending on the philosophical standpoint of the designer/researcher.

Keywords

haptics, philosophy, embodiment, perception, senses, interaction design

Crítica del diseño de la interacción háptica en un contexto histórico - ¿Qué sucede hoy con el tacto?

Resumen

El objetivo de este trabajo es contextualizar la creciente actividad investigadora en torno a la interacción háptica examinando algunos marcos históricos y filosóficos. A partir de la idea de que mente y cuerpo son inseparables, la investigación sobre la interacción entre personas y ordenadores experimenta en general un deseo de corporización y sensualidad añadida. Dicho deseo apunta hacia una historia de los sentidos construida culturalmente, que, a su vez, influye en los objetivos de la investigación y el diseño.

Mediante el análisis de varios diseños hápticos, se agrupan algunos objetivos de investigación y parámetros de diseño, que a continuación se asignan a tres distintos modelos filosóficos del tacto: el modelo físico-sensorial, el modelo psicológico-humanístico y el modelo de campo (Weber, 1990). Parece que incluyendo diferentes modos y sentidos en el proceso de interacción, esta va a ser más «natural» e «intuitiva». Investigaremos lo que los sentidos hápticos pueden añadir específicamente a la interacción y a la comunicación digital, dependiendo del punto de vista del diseñador/investigador.

Palabras clave

háptica, filosofía, corporización, percepción, sentidos, diseño de la interacción

1. Introduction

When designing for and reflecting on the sense of touch (haptic), it is important to consider philosophical contexts. Each research approach embeds assumptions and ideas concerning our self in relation to the world and others. Both scientific and artistic developments benefit from awareness of philosophical and cultural boundaries, to extend, or even side-step them. The way bodily experiences and relations have been portrayed and viewed during the centuries provides a comprehensive framework in which to view a current rediscovery of the haptic sense and especially the belated consideration within interface design.

The social sciences have seen a surge of scholarship around the senses, and particularly touch: Paterson (2007), Howes (2005), Getzinger (2005), Classen (2005) collectively chart the cultural and political construction of the sensorium, which they argue can shift with social and historical changes. The way we view our senses, mind, self or consciousness is dependent on the philosophical context we belong to. Also, the value we place on each sense is dependent on the philosophical climate at the time – some of the authors cited above would argue, that we have developed a kind of hierarchy of the senses, resulting in the recently dominant ocularcentrism, or visual culture. Visual culture has seemingly become the dominant form, with written language and other visual coding systems being an essential way to communicate. This in turn could be seen to influence the way digital interfaces and interactive experiences have been designed, focusing on the provision of visual, symbolic systems of representation. This paper seeks to assess the re-emergence of the body and the senses, especially touch, in human-computer interaction – why this interest in touch, now?

2. Historical and Philosophical Framework

In 350 BC, Aristotle laid the foundation for idea of the five senses in 'De Anima', and while he considered touch to be crucial, he developed a hierarchy of the senses that placed sight at the top – these are all ideas still popular today, although psychophysical research suggests anything up to 21 senses. To see the sense of touch for example as one unit is problematic – can the capacity to feel pain, distance, weight or texture - to name but a few - really be classed as just one sense?

The discussion of the organization of the brain and the interaction of the senses, historically philosophical, is now enriched with new findings from neuroscience (Paterson, 2007; Johnson, 2007). Although technology presently splits sensory experience into channels, this may be a fairly reductive way of viewing perception, and a contemplation of synaesthetic processes and multimodality seems timely. The need for this kind of research and thinking has only come to light in the era of Embodiment, however.

A great period of influence for the current Western view of the senses was the Enlightenment, with its focus on scientific, observable data as the most valuable knowledge to strive for. The Empiricists valued senseable data, but not each sense was valued the same. The visual sense was considered as most accurate, as it allowed distance

and therefore implied objectivity. Any of the proximal senses, anything entering the realm of 'feeling' was considered as tainted by subjectivity and therefore undesirable and useless data. The proximal senses were devalued as prone to errors and moral decline. With the Rationalists, the emphasis was on human reason creating the world from within, separated from bodily sensations. The philosopher Renée Descartes, in the 17th Century, believed the senses cannot 'grasp' clearly and that only children or 'unreasonable' people believe them. This dualistic view of body and mind has dominated Western thought ever since.

Sensory, and especially haptic experiences are often excluded in favour of the more 'objective' visual sense, evident in the development of scientific instruments to support the visual sense (i.e. the telescope and microscope), to ensure measurements do not have to rely on human perceptions only, and through creating distance (Getzinger, 2005). In medical diagnosis and therapy, the 'feeling' of the patient or the doctor are less playing a role, with technological devices being developed to avoid touching the body too much and emphasising the visual - for example, the X-ray machine allowing us to peer straight through the flesh without being anywhere near it.

It is argued here, that in the 20th century, we (re-)enter the era of Embodiment – a return to a holistic view of the body and the mind, and a re-evaluation of the senses and the physical, as in Maurice Merleau-Ponty's work on the primacy of perception (2002, p. 1962). J.J. Gibson investigated the senses as interacting systems, rather than completely separate modalities – interacting with each other, and with the environment (Gibson, 1966). Noe (2004) developed further the idea of enactive perception, of the body acting and interacting, in a sense the activity of the body being fundamental to perception. Recent philosophical treatment of touch and the body necessarily considers new research on the neuroscience of the brain, which seems to back up the importance of the bodily foundation for thought, meaning-making and communication (Johnson, 2007).

There is some indication, that the haptic sense is enjoying a renewed interest and increasingly recognised value – Getzinger (2005) observes this in more strenuous and engaging exercise and leisure activities, such as extreme sports and artificial adventure parks. Western science is moving from an empiricist, dualistic standpoint to accept theories of unity and interconnectedness like relativity theory and quantum mechanics, suggesting a more systemic understanding of the senses. The concept 'Therapeutic Touch' , historically rejected by Western science, has been shown by the very same science to have an observable effect in the alleviation of pain or anxiety. Scientists now talk about the idea that every organism is as well as a physical entity also a system of energy fields, which permanently interact with all other organisms' energy fields - so in a way, we are constantly 'in touch' with and influence each other.

In wider contexts, embodiment is increasingly considered, for example in education, health care, science, art and, most relevant here, interaction with digital environments. The development of a Haptics research community and a general interest in physical interfaces, as well as a general revival of the senses in social sciences could be considered evidence for a potential awakening of the sense of touch in Western society, and a re-orientation towards embodiment is observable in some areas.

3. Haptic and Embodied Interfaces

The Haptic Research and Interaction Design community have designed and developed various prototypes to allow the human user to interface with digital content through touch, using a range of parameters and involving a diversity of body parts to interact with, literally from hands to feet. One of the most ubiquitous haptic devices in research labs is the PHANToM, developed and distributed by Senseable since the early 1990s. The PHANToM is a stylus-based interface delivering force feedback with varying degrees of freedom (the different angles the force feedback is able to display). The Cyber Grasp Glove by Virtual Technologies enabled the whole hand to be involved in grasping and manipulating digital content, by incorporating sensors and force feedback actuators into an exoskeletal glove. These devices are fairly iconic and even indexical for a plethora of devices developed in Haptics Engineering labs, although plenty of variations and approaches do exist.

Virtual reality and other 3D environments allowing spatial and gestural interaction have been driving developments in multi-sensory interaction, often with the mission to increase the realism of simulatory experiences and to incorporate the whole body, with various manifestations, i.e. through hand-held wands, body suits or gloves. Early experiments by Myron Krueger with VIDEOPLACE in the early 1990s were aimed at devising interactive systems that would allow perceptual experiences that allowed full body interaction through visually tracking movement.

The Tangible Interfaces Group led by Hiroshi Ishi at MIT strive to combine digital bits and physical atoms - to renegotiate the physicality of interaction. The term TUI (Tangible User Interface) is now almost as well known as the term GUI (Graphical User Interface). Data can be embedded into objects and physical surroundings, for example by miniature technology being incorporated into the built environment – as in Ambient Wood (2004), where children explore the forest with digital devices in search of digital traces.

Outside of research labs and design think tanks, touch technology is now commercially available and mainstream, visible in market successes like Nintendo's 'Wii' and 'Fitboard', Apple's 'iPhone'/'iPod Touch'/'iPad', Microsoft's 'Surface' as the main examples. Most of these enable multi-touch (which allows several fingers to be registered at once) or gestural input (measuring body movements) – but are mostly devoid of haptics in the engineering sense, as they do not 'push back', or produce any touch feedback. However, some of the most

successful entertainment apps for the iPad are games incorporating engines for physical interaction, which simulate haptic feedback involving parabolic ballistic trajectories, predicting an objects' flight path after a throw for example. Some speculate the appeal of these games may be that they provide a satisfying physical interaction for the human user, on the grounds that these skills were important for human evolutionary success. This seems to allude to a way of incorporating haptic interaction without the obligatory vibrotactile add-on.

This brief overview of some of the main interface developments involving touch is by no means exhaustive, but contains some pointers towards key areas of Haptic and Interaction Design.

4. Situating Haptic Design

In this section, some common research aims and design parameters drawn from Haptics Research will be grouped and mapped onto three philosophical models of touch. These models (physical-sensory, psychological-humanistic and field model) were originally devised by Renee Weber (1990), drawing on more general ideas about the human mind, body and soul, and are here specifically used to categorize Haptic Design.

4.1. Haptics that just Touches You

The physical-sensory model according to Weber (1990) is aligned with the aims and assumptions of Anglo-American philosophy – here, touch is seen as pure contact, made up of sense impressions. Historically, it seems to be fairly influenced by the Empiricist and Rationalist tradition. This utilitarian approach can be found in haptic devices used as tools designed for sensory substitution and augmentation. In this view, the source of touch would be irrelevant and the mechanical can therefore replace the human. The haptic device acts as a replacement of eyes, hands and ears to provide information to us, and the sense of touch is seen as one sensory channel that information is passed through. The design parameters available for this approach are based on simulation, the attempt to replicate reality: Icons (Hapticons, Tacticons), realistic attributes (e.g. robotic arms) and multiplexing of information are key features.

4.1.1. Multiplexing Information

If the senses are seen as separate 'channels', then this corresponds very well with how interfaces are currently set up – and it then stands to reason, that to have more than one 'channel' to transmit information would be beneficial for the human user. A visual interface can be 'added to' by supplying a sound interface, or in this case a haptic interface. It is often assumed that this would build up a much richer 'picture' more akin to our natural interaction.

Within this paradigm, it is also worth considering that each medium / mode / sensory channel might have different affordances, which is important for interaction design – for example, can meaning be translated from one sense to another? If the senses are separate entities, can a circle be expressed as a sound? So this becomes interesting when rather than adding to, we try to transpose meaning.

4.1.2. Sensory Substitution and Augmentation

Similar to multiplexing, and philosophically consistent with the physical-sensory model, are projects that utilize the haptic sense in HCI in situations where other senses are not available or desired, biologically or environmentally. This situation could be in the form of sensory impairment, for example people with disabilities will benefit from using the sensory channels available to them. Sensory impairment could also be seen in situations, where we are temporarily hindered from using the whole spectrum of sense impressions (difficult to reach, remote or hazardous spaces often means restricted visibility – for example working in extra-terrestrial or submarine space, or during laparoscopic surgery). Again, challenges arise however when it comes to transposing meaning, as for example in verbal descriptions of visual scenes in a film, or in the area of Haptics, in the design of Tacticons (vibrotactile text messages on a mobile phone).

4.1.3. Bidirectionality

Haptic perception performs best through active exploration (Lederman & Klatzky, 1987). An actively moving hand is able to perceive more differentiated impressions than a passive one. A lot of interface hardware limits the hand to point-and-click activity, with no feedback other than audiovisual stimulus. In Haptics, the general drive is therefore to provide feedback in form of a vibrotactile buzz or a robotic arm that pushes back – mostly to aid the user in completing tasks correctly and quickly. If we create our own unique reality through active touch, the individual angle to perception here could take on a greater meaning – this also relates to the idea of affordances and considering an actor in their environment – and there may be potential to utilize this individual, expressive capacity in other interaction models.

4.1.4. Increase of Realism – The Experience of Presence

There is also the notion, that through multiplexing information, the sense of realism and therefore engagement with digital content can be increased. Particularly in the area of Virtual Reality, there has been a drive to provide haptic stimulus to enhance the realism of interaction with virtual environments – in the notion of 'presence' or 'telepresence', which relates to the feeling of being in the environment, and also to the perception of others in terms of collaboration (Kim *et al.*, 2004). VR researchers are continuously striving to convince us to suspend our disbelief and submerge ourselves in the virtual worlds they are creating. Relevant to the discussion here is the way this is attempted through an increase in sensory information available. Outside of VR labs this is also evident in the vibrotactile feedback on gaming devices, for example delivering a haptic buzz during an

explosion or gunshot, hoping to engage the user further into their gameplay. The question remains whether engagement is always best achieved through more realistic sensory attributes.

4.1.5. Support for cognitive processes

An often-stated reason for including touch in interface design is to relieve the work of the strained audio-visual senses, enabling peripheral perception and avoiding cognitive overload. Touch is extremely useful as an alert mechanism, due to its psychophysical abilities and its place in evolutionary survival methods. An interactive device can tap the user or nudge them to alert them that an event has just happened, leaving them free to perform other tasks in the meantime. This is a highly effective way of shifting attention only when necessary. Again, touch here is seen as one channel amongst others, where the sense impressions and 'pure contact' are most relevant. Computer interface designers are also increasingly contemplating a tangible, haptic dimension for learning. It is being considered that to 'grasp' something physically may ease the cognitive load of interacting with abstract, arbitrary digital content. The double meaning of 'grasp' in this context is no coincidence - our naming in language reflects how the physical and cognitive act are linked.

The design paradigms listed above are mostly treated within the physical-sensory model; however, the complex nature of touch means that this will not always suffice, and consideration of other models may help to further develop answers to some of the research problems raised here.

4.2. The Profound Touch

Weber (1990) classes the second philosophical model of touch, the psychological-humanistic model, as expressing the concerns of contemporary European philosophy, i.e. phenomenology and existentialism – touch here is mainly concerned with humans' interactions and the feelings that come with human relationships. Most philosophers within this tradition, Weber suggests, would see feelings like sympathy and empathy similar to, and best expressed through, touch, as in both acts the other is brought closer, physically and psychologically.

This model assumes, building on the physical-sensory model, that we can also use touch to reach out and communicate with another person. In this case touch functions to create a connection. This approach can be found in Haptics projects aiming to facilitate communication of affect, presence and personal expression. The design materials here extend past copying physical actualities to embrace meaning-making through metaphors and personal affordances.

4.2.1. Affective Communication

The sense of touch in the process of communication is as complex as it is compelling – intuitively, it seems to have a lot to offer. Over the last ten years or so, there has been a surge of design projects aiming to incorporate a 'personal touch', specifically to humanize interactive devices and allow for emotional experiences and affective communication (Brave&Dahley, 1997; Hug Shirt, 2005). Touch has a particular role to play in nonverbal communication - due to its early development in infants, it is the first sense for us to engage with the world and the people around us. It therefore seems crucial for a sense of authenticity, affirmation and emphasis. It is important for establishing and maintaining relationships. Touch has been named as potentially lacking in the expression of precise, logical content such as numbers, but may perform better at communicating affect and pleasure (Dobson *et al.*, 2001). There may also be unexplored potential for a range of individual expressions, and creating systems of personal, intimate communication, which may subvert or extend systems of symbolic communication. It seems that along with a fuller consideration of the sensorium, a re-orientation towards the inclusion of emotions and individual perceptions is taking place. This equally aligns with recent research reinstating emotions as a valuable asset, rather than something to be avoided, and actually essential to human reason, judgement and meaning-making (Johnson, 2007). This approach also considers that the creation of a Haptic Language following a linguistic model, which would require a straight translation, is perhaps not as desirable as allowing some of the pre-linguistic, nonverbal characteristics to emerge.

4.3. Always in Touch

> To treat a holistic sense such as touch within a reductionistic framework seems problematic to me; to see it as an expression of a general holistic framework is more consistent and philosophically more appealing. On these grounds, as well as others, the field model of touch strikes me as the most interesting and promising one (Weber, 1990, p. 15).

The third philosophical model of touch, the field model (Weber, 1990), is inspired by and harmonizes with Eastern philosophy and a holistic view of the world. Such a model is gaining acceptance, as not just physical actions, but thoughts and emotion can be seen as energy fields with a definite, noticeable effect on others. Regarding haptic design, intent and context are the most characteristic design parameters in the field model. In Telematic Dreaming by Paul Sermon (1992), the interactive installation basically succeeded in participants 'feeling' touched, without any physical contact taking place. There may be more metaphysical and spiritual ways to make someone 'feel' touched, and motivation, context and intent to communicate seem to be the main factors here.

These three philosophical models provide a potential way to categorise the foci of approaches taken by haptic investigators in terms of interaction – building layers of sensory feedback in the case of the physical-sensory model, establishing exchange of affect in the psychological-humanistic and facilitating potential systemic change via the field model.

5. Conclusion

In a world where content and information are becoming digital, virtual and ephemeral, the urge to touch something, to have something tangible, to grasp and manipulate, has been neglected. The rising interest in incorporating the body and the sensory environment in HCI is reflecting this need, which may be related to how important touch is to our fundamental and aesthetic experience, development, trust, connection and well-being.

This paper has shown that there is a trajectory in philosophical thought that has de-valued the touch sense for some time, which has been reflected in human-computer interaction design. By embracing the unity of body and mind in our understanding of perception, and highlighting the importance of the individual and their actions in their environment, this has allowed for a more holistic approach to human-computer interaction design.

It appears that Haptic Design can mean different things in different contexts, and therefore demands appropriate design paradigms – whether one aims to replicate the exact physical sense impressions in order to aim for accuracy, or whether it may be more fruitful to emulate a 'feeling', which may not require any particular touch, but rather a rich and expressive design, which evokes meaning rather than directly stimulate nerve cells.

The three philosophical models, introduced as ways of thinking about touch, and specifically Haptic Design, build on each other and do not necessarily present a hierarchy of values – they may overlap at times and it is considered here that they each suit particular design contexts and applications particularly well.

The exciting area is where philosophy, neuroscience and design meet – each discipline seems to draw on each other (if they do it well) and is able to add to each other. With designing artificial environments involving technology, perception can be deliberately skewed and distorted, but also controlled and reduced, and questions of how an experience can be synthesised out of digital bits become not only interesting from a design perspective. They fundamentally touch on our aesthetic experience – the common denominator between philosophy, neuroscience and design. Building relevant interfaces and digital environments can therefore not just provide satisfying interactive experiences, but also allows us to research processes of perception, and thereafter further discuss the philosophy of human experience.

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