



Towards Robot and Technologies that Touch Well – Shaping an Experience-driven Design Paradigm

A full day workshop at DIS24

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ABSTRACT

Inter-human touch plays a vital role in social communication and bonding, maintaining physical and emotional well-being. Advances in robotics, alongside novel haptic technologies such as shape-changing interfaces, are leading to increasing opportunities for technologies to touch humans in different settings. This includes future touch-based interaction design to support remote and robot care, physical and mental well-being, social bonding, and novel sensory experience for the metaverse, entertainment and everyday life. However, the key to unlock these potentials depends on whether the technology can touch *well*, i.e. whether the felt quality, or experiential affordance matches the expectation for the intended use cases. In these applications, the touch function and its experiential affordances are two sides of the same coin and need to be investigated simultaneously. Currently we identify two main challenges. First, human touch is a highly complex matter to study and evaluate, with a wide range of variables impacting its experiential qualities, while authoring touch is laborious and demands cross-disciplinary expertise and skills. Second, these investigations are often conducted separately in different disciplines. In responding to this design issue, this one-day workshop aims to bring together scholars, designers and practitioners from diverse disciplines in order to initiate an experience-driven design paradigm, where the felt (somaesthetic) qualities, technical realisation, and ethical dimensions can be studied more holistically. Through a mixture of activities including presentations, hands-on interactions with haptic technologies samples, and group discussions, this workshop also aims to discuss principles, terminologies, methodologies, tools, opportunities, and challenges for such an experience-driven design paradigm, one that enables richer and more fine-grained technologies of touch.

CCS CONCEPTS

• **Human-centred computing**; • **Interaction design**; • **Human computer interaction (HCI)**; **Interaction techniques**; **Interaction paradigms**;

KEYWORDS

haptics, touch design, robot touch, design paradigm, experience-driven, affective touch, aesthetics of touch

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1 BACKGROUND AND MOTIVATION

Inter-human touch plays a vital role in social communication and bonding, helping maintain physical and emotional well-being [1], [2]. Technical advances in robotics, alongside novel haptic technologies such as shape-changing interfaces, are leading to increasing opportunities for technologies to touch humans in different settings. This includes future touch-based interaction design to support remote and robot care, physical and mental well-being, social bonding, and novel sensory experience for the metaverse, entertainment and everyday life. However the complexity of studying, designing and evaluating touch raise key design issues and call for an experience-driven design paradigm, where the felt (somaesthetic) qualities, technical realisation, and ethical dimensions are studied more holistically.

1.1 The experiential affordance of touch

Touch is an essential part of human existence [3], and is a highly nuanced mode of interaction. The hand, perhaps the part of the body that we touch with most, is adept at creating a whole array of skillful touches imbued with intent and meaning [4][5]. Distinctive gestures of interpersonal touch (e.g., tapping, stroking,



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holding) are used for different purposes (e.g., getting someone's attention, soothing, expressing affection) [6]. Within one gesture or haptic interaction, very different meanings can be conveyed, each affording different felt experiences. Something so seemingly straightforward as a pat, for example, can be fast or slow, gentle or hard, and can be used to affirm an action, to provide comfort, to scold, or to affirm social hierarchies of gender or power. Unlike other types of interactive technologies in which the functional component can be the core for achieving a utility goal while the aesthetic components considered a beneficial addition to the user experience. Touch interaction has this distinctive nature that its sociobiological function (e.g. to soothe) is dependent on the experiential affordance, which is expressed through the attributes (gentle stroking). Thus the function and the experiential affordance together form an inseparable whole. This relationship is noticed, for example, in healthcare contexts, where a nurse's empathetic touch can blur perceived distinctions between 'instrumental' and 'emotional' touch [7] by combining them into a single caring social touch. Such experiential qualities help form the basis of everyday embodied experiences within human social groups, and such 'felt life' encounters can be marked by a sense of fulfilment [8], [9]. The experiential qualities of touch include not only the more frequently investigated affective qualities, such as communicating affective messages and modulating emotions [10], [11], but also broader somaesthetic appreciation [12] and meaning making [13].

The haptics community has an established trajectory of designing haptic devices and equipping robots with touch to help perform a functional task (such as grasping) well [14], or, as a symbolic form of touch to provide humans with information [15]. More recently, there has been a rapid growth of research interest in both HCI and HRI on exploring touch from technologies and robots for affective communication [16], modulating emotions [17] and elderly care [18]. Nonetheless, current haptic devices are still very limited in the range of sensations that they can deliver, and there is still the bottleneck of developing richer and more fine-grained sensations [10]. The role of design in human-robot interaction can be helpful here. For example, somaesthetic explorations through soft robotics and shape-changing interfaces show the promising potential of materials to offer touch experiences that are both physically and social-emotionally valuable, that might raise body awareness [19], [20], social bonding [11], enable self-care and intimate care [12], [21], support healthcare aims [22], or patient care [23].

However, the key to unlock these potentials depends on whether the technology can touch *well*, i.e. whether the felt quality or experiential affordances match the expectation for the intended use cases. For example, how can a robot touch feels 'inviting', or how can a touch addressing more intimate parts of the body feel 'dignified'? In these applications, the function of touch and its experiential affordances are two sides of the same coin that need to be investigated simultaneously.

1.2 The complexity of studying and designing touch from robots and technologies

Human touch is a complex matter to study, for the felt quality is affected by a myriad of factors. A touch is a physical contact. By

default, the dynamic variables of such contact, including the contacting force, duration, and pattern of movement, make a difference. Particular physiological states of the hand that performs the touch, such as moisture level or temperature, also make a difference. The gestures used to introduce and withdraw physical contact also play a role [13]. Furthermore, where on the body the touch happens, and of course who is doing the touching, also constitute important context. As research moves forward, this list may well extend. However documented knowledge on the association of experiential affordances and the attributes of touch is rather limited in the literature [6].

Designing technologies and robots that touch involves appropriation of the material constituting the body and surface of the touching artefact, the computational structure that enables and commands the dynamic forms of touch, as well as the mechanism of output actuators and associated hardware. Some of these have already been recognised as part of the grand challenge for advancing expressive technologies [24]. Furthermore, being touched by robots and interfaces without consent or invitation can be disruptive and brings with it further ethical complexities [25], [26].

In this emergent design space, knowledge of material design, experience evaluation, computational algorithms, sensing/actuation mechanisms [27], [28], and the ethics of touch are often investigated separately and within different disciplines. This raises a key design issue. Authoring touch is a laborious process and requires inter-disciplinary expertise and skills. Often, designers who are excited by the experiential quality discovered from open-ended exploration lack the skillset to develop rigorous technical realisation, while engineering and computer science researchers sometimes lack the knowledge or the context to determine the most desirable attributes to translate into mechanical language. Since authoring touch is at the edge of non-incremental research, it suggests even the need for trans-disciplinarity.

1.3 Towards robots and technologies that touch well

The challenges brought by the complexity of studying, designing and evaluating the experience of being touched call for cross-disciplinary endeavours to advance the field towards designing robots and technologies that touch *well*. To this end, this workshop will facilitate conversations and synergies between roboticists, engineers, designers, social scientists, and others to work together towards this new design paradigm. By touching *well*, we mean that the touch technology effectively performs the intended quality technically, sensorially, socially, and ethically. We argue that the more the field knows how to purposefully and intentionally achieve and control particular experiential qualities when technology touches the body, the more imaginative and successful the field can be in achieving the desired aesthetic or felt experiences.

2 WORKSHOP THEMES AND GOALS

The primal agency of touch needs to be coupled with the formative power of technology. Our workshop brings design and other related disciplines together to discuss a design paradigm that facilitates the creation of robots and technologies that touch humans better, to touch *well*. The DIS conference is an ideal venue and opportunity for

this to occur. Although there has not been a workshop themed on designing touch from interactive technologies in DIS, we consider this workshop as a timely addition to DIS, building on our work conducted in prior workshops and panels on touch, including CHI18 [29] and HRI 2020 [30][31].

This workshop will prompt a range of practical questions about the mechanics involved, along with more conceptual questions about the shaping of a holistic, experience-driven paradigm. In addressing such questions, we expect a synthesis of cross-disciplinary expertise across material and bodily practices, haptics design, social science, health professionals, and the wider participation of future users. The theme of this year's DIS conference is particularly appropriate, inquiring about the role of design in uncertain times. Our workshop aims to further this inquiry by engaging discussions around the following themes:

- What is an experience-driven paradigm for touch-based interactions? What are the principles, assumptions, and conceptual tools that lie behind this, and what kinds of cross-disciplinary collaboration and synergies should be involved?
- What kinds of knowledge production has to happen to map the experiential qualities of touch in different contexts? What kinds of approaches are fruitful across the design process, from computational and sensing approaches to somaesthetic approaches (such as soma design)?
- Problematising 'touch': It is not one thing, or occurring in one location (e.g. the hand). It often involves other related sensations (e.g. proprioception, thermoception). What instruments, design process, tools and toolkits facilitate learning and designing this expanded notion of touch?
- From an engineering meets design perspective, how can more creative engagement be fostered with novel materials, actuation and sensors, our senses and bodies, and the engineered imaginarity of touch?
- How to ethically design and design ethical touch interaction? What is a design process that unpacks ethical implications, and how could it relate to the process of the designing and deploying artefacts?

To facilitate the discussion and synergies, a mixture of activities including presentations, videos, demos and group discussions will be facilitated. The organizing committee will also present several pneumatic and motor-based touch design toolkits and material swatches for hands-on activities during the workshop.

3 ANTICIPATED OUTCOMES

The anticipated outcomes of this workshop include:

- A network of scholars, design practitioners and researchers from diverse fields and practices who can work together on cutting-edge issues related to the study and design of technologies that touch;
- One collaborative publication. The committee has extensive experience in organising interdisciplinary workshops in flagship conferences in interaction design such as CHI[29][32], and human-robot interaction design, such as HRI [30]. We would seek to develop the workshop outcome into general

audience publication such as a special section of ACM Interactions magazine, and eventually into a journal special issues such as THRI [31] or ToCHI.

- Based on contributions, discussion, and the sharing of resources during the Workshop and in its aftermath, an online platform as repository of touch experiences, with photographs and videos of equipment, public dataset, open to the research community to populate. This can formulate a base for developing into future touch swatches for designers across disciplines to inspire and compare.

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