

Introduction to the Special Issue on Digital Touch: Reshaping Interpersonal Communicative Capacity and Touch Practices

Sara Price

UCL Knowledge Lab, University College London, London, UK, sara.price@ucl.ac.uk

Nadia Bianchi-Berthouze

UCLIC, University College London, City, London, nadia.berthouze@ucl.ac.uk

Carey Jewitt

UCL Knowledge Lab, University College London, London, UK, c.jewitt@ucl.ac.uk

Jürgen Steimle

Department of Computer Science, Saarland University, Germany, steimle@cs.uni-saarland.de

1 Introduction

We are at a tipping point for digital communication: moving beyond ‘ways of seeing’ to include ‘ways of feeling’. Much as optical technologies transformed sight and the visual (from the telescope and microscope to Google Glass), the rapid expansion in digital touch technologies is set to reconfigure touch and the tactile in significant ways. Advances in haptics, virtual reality, and physiological sensing provide new sensory ways of communicating, as well as new ways to capture the quality of touch. These state-of-the-art digital touch technologies promise to supplement, heighten, extend and reconfigure how people communicate. They are reshaping what and who can be touched, as well as when and how they can be touched, changing existing forms of communication and giving rise to changes in co-located and remote communication between humans, and between humans and robots. These developments sit alongside social discourses of concern and loss, with the digital being associated with the removal of touch from the material sensory landscape (Jewitt et al., 2020). Yet, in our current climate of social distancing and disengaging with touch in our everyday interactions, the promise of the digital becomes increasingly appealing and significant, in re-enabling touch possibilities. As the global population emerges from and comes to terms with their experiences of the COVID-19 pandemic, these questions become all the more significant.

The breadth and interdisciplinary interest in this growing field— across designers, artists, computer scientists, engineers, psychologists and social scientists, with interests in robotics and touch, affective computing, wearables, and digital installations – brings attention to the growing need to engage with ‘social’ aspects of digital touch, moving beyond technologies and physiological foci to engage with touch practices (Jewitt et al., 2021). We argue for the need to think about touch beyond the physiological act of sensing and perceiving to a more rich and nuanced interpretation of touch that takes account of its emotional and psychological significance, the social, cultural and historical evolution of touch practices in human communication, and approaches to touch of the “lived, social body as a site of meaning-making, where the skin acts as both a boundary between and a point of connection with others” (Karpashevich et al.).

Given this landscape, this special issue addresses timely and important questions around the need to think about touch in different ways. This provides a new direction in the field that seeks to address the complexity of human touch and interrogates the limitation of today’s haptic devices. Papers in this special issue contribute to understanding this gap by engaging with socio-cultural issues around digital touch communication and identifying new ways to study touch, specifically aiming to explore the nuance and subtlety of touch and an expanded view of touch.

2 Thematic strands

This editorial focuses on five key thematic strands that emerge from and cut across the papers in the special issue collection: an expanded notion of touch and body; the cultural and material experience; whose touch is it; the duality of touch communication; and methodological approaches to researching digital touch.

2.1 Expanded touch and the body

Much work in the area of haptics for social communication focuses on the hand, both in understanding touch mechanisms (Hertenstein et al., 2009) and in developing means for the conveying and interpretation of tactile communication (e.g. Singhal et al., 2017; Gooch & Watts, 2012; Eichhorn et al., 2008). Similarly, many haptic devices focus on hand-mediated interaction, which has given rise to haptics embedded in controllers (such as mice, joysticks, VR controllers, omni-phantoms) or in gloves. This is unsurprising given the central role that our hands play in touching both things and people around us. Indeed, active touching of another often involves the hand – certainly in the ‘giving’ of touch, for example, stroking someone to soothe them, patting a child, holding hands, or shaking hands in greeting. Nonetheless, the wider body remains important in tactile communication – both in the giving (e.g., hugging) and the receiving of touch (e.g., a stroke on the arm or hair, tickling, a pat on the back).

Whilst acknowledging research – especially in wearables – that has embraced the wider body (SwarmHaptic Kim & Follner, 2019; POKE, Park et al., 2013; Huggy pajama, Teh et al., 2009), there remains a clear need to bring the body further into the haptics field. Several papers in this special issue speak to the critical role of the body beyond the hand in tactile communication. In terms of the physical body, papers in the special issue expand the location of the body for thinking about touch beyond the hand to consider the foot (Ticklefoot; Elvitigala et al.) and the torso (Soma Corset; Karpashevich et al.). Ticklefoot engages with tickling (the foot) as a ‘social touch’ mechanism of communication. Users reported having positive fun and joyful sensations with the device, pointing to three key application contexts: supporting remote playful affective communication; eliciting mirth for entertainment (linked to movie watching, for example); and relieving stress through distraction. The Soma Corset uses shape-changing materials in a corset-like garment that dynamically respond to bodily rhythms (e.g., breathing). It moves beyond replication or mimicking of physical touch qualities to bring new perspectives on how we experience touch through new forms of digital experiences, highlighting the subtleties and nuances of human-technology relationships. From a more technical standpoint, Anisma (Messerschmidt et al.) offers new ways to enable the development of diverse prototype applications across the body from wrist and arm to places such as the face and heart/chest, through on-skin haptic devices that enable pressure, stretch and motion sensations. In doing so, it also reminds us of the richness of the mechanics of physical touch whose role in building meaning and sensation is not yet fully explored in digital touch communication. Price et al. show the importance of the need for an in depth understanding of these mechanics together with their physical effects (e.g., sweat) to inform and empower digital touch.

Several of the special issue papers (Karpashevich et al., Price et al. and Elvitigala et al.) speak to wider bodily *experiences* in touch communication. These papers engage with affect and emotion as a route to bring in further bodily engagement with touch communication. Karpashevich et al’s paper focuses on the breath as a mediator of touch communication, to extend the conceptual space of the body and touch, raising the possibility of research bringing bodily processes more into haptic design; actuation that changes bodily perception and sensation *under* the skin. This also speaks to the role of movement in the touch communication experience. Elvitigala et al’s paper brings the foot into the tactile experience, while user feedback in the Tactile Emoticon (Price et al.) study points to the importance in bringing in the wider body for conveying affective touch messages.

Collectively the special issue points to the importance of an expanded notion of touch, not only anatomically (in terms of location on the physical body), but also kinaesthetically (through the movement in touch experience), emotionally, and experientially.

2.2 The cultural and material experience

Across several papers in this special issue, we see that touch emerges from cultural and material experience. This socio-cultural underpinning to meaningful touch experience is central to the Design Fictions paper (Rüller et al.). The authors note that “it is important to draw upon existing cultural norms and values and the use of everyday objects in everyday activities when undertaking the design of technologies for illiterate populations”. We argue that this point is true across populations and contexts and is critical for designing touch into the digital communication space. The Tactile emoticon (Price et al.) shows how prior experience of touch, cultural practices within different relationship contexts (e.g., work or romantic partners), and knowledge of the other all shape how touch messages are differently created (using vibration, temperature and/or pressure) and interpreted. Materiality comes into focus both in terms of new materials, and in terms of the perceived mapping between material and touch type. One important direction for haptics is bringing new materials into this space. New materials and accompanying fabrication processes enable tactile devices that are ultrathin, soft and lightweight, extending the form, distribution and capabilities of touch interaction and communication (Bisvas & Visell, 2019; Cruz et al., 2018). A promising area is on-skin technologies where ultra-thin tactile interfaces benefit from the wearability and haptic transmittance of functional materials (Withana et al., 2018). In this special issue, Messerschmidt et al. address the important question of how to support haptic designers in creating such functional prototypes with new materials. They present Anisma, a prototyping toolkit for creating on-skin interfaces that use shape-memory alloys (SMAs) to render pressure, stretch and motion stimuli. A graphical design tool with a built-in simulator allows designers to rapidly design interfaces and preview how the SMAs will actuate the user’s skin. The cultural approaches embedded in other papers in this special issue highlight the importance of recognising the essential role that culturally appropriated materials and practices play in moving forward with developing digital touch technology. Findings from the Soma Corset (Karpashevich et al.) show how materials themselves offer diversity in terms of touch experience. Specifically, they showed how different participants perceived different types of touch with the same material, their experience being shaped by different bodies and different past experiences.

Collectively, these papers foreground the socio-culturally situated nature of touch and highlight the recognition of this in designing for digital touch experiences. Through this, materiality emerges as central to the touch experience, calling for the creative development of new materials and fabrication processes.

2.3 Whose touch?

Several of the special issue papers engage with a topic that relates to the question of ‘whose touch’ is this? This topic is core to Tajima et al.’s paper, which explicitly examines the sense of agency in ‘assisted touch’ contexts, where haptic devices ‘control’ the touch actions of users (e.g., exoskeletons or systems based on electrical muscle stimulation). Here the authors designed experiments to understand who the user attributes touch to – themselves or the computer – when their own body is actuated by a haptic device. Their findings inform a framework that supports researchers and practitioners of digital touch systems in prioritising between haptic-assistance and sense of agency.

Linked to this sense of agency is the notion of control; a topic that emerges in other papers in this special issue. The Soma Corset (Karpashevich et al.) raises issues of control related to one’s own body processes, in exploring the use of sensor pillows around the torso that inflate and deflate to bring awareness to breathing. Here, the users’ relationship with the corset exposed a sense of the ‘frictional’ and ‘disconcerting’; one user

describing the corset as being a lifelike 'other' that was intimately moving on their body; while another user had a sense of the corset developing its own intentionality, bringing questions around whose body it is.

Concepts of agency and control also link to questions of consent and the ownership of touch raised in Ticklefoot (Elvitigala et al.), specifically around the notion of consensual touch. Here the authors note that research on tickling shows that consensual tickling is critical in eliciting laughter and ask, with a remote tickling device, what does this mean for enabling consensual touch? User feedback highlighted the importance of the tickling coming from someone that they have a close relationship with. Users of the Tactile Emoticon (Price et al.) raise similar questions around the need to know who was touching them and to maintain control over the type of touch being received, depending on the context and their relationship with the sender. Their paper also highlights how the perceived identity of who touches biases the interpretation of the received touch.

These papers in the special issue are illustrative of key challenges that arise with many emergent communication technologies, yet that seem particularly significant in the context of touch, given its very intimate and directly physical and well as emotional essence. This also speaks to the wider ethical considerations that a social sensorial approach to thinking about digital touch brings into focus (see Jewitt et al., 2020).

2.4 The duality of touch communication

A substantial body of work on touch focuses on individual touch sensations – physiological touch mechanisms, how people *feel* when touched as well as the types of touch. Indeed, in this special issue, this singular notion of touch is evident. The Anisma (Messerschmidt et al.) toolkit aims to enable a wide range of sensations on the skin, delivering touch to a wearer; Tajima et al. focus on felt sensation of the user, and Ticklefoot (Elvitigala et al.) similarly so, but through a tickling sensation. While these papers give insight into some critical social considerations around digital touch related to the user experience, several papers in this issue explicitly and importantly recognise the dynamic nature of touch, and the complexity this brings to digital touch development for touch communication. The Tactile Emoticon highlights the need for haptic technology working towards achieving finer control of the kinematics of the tactile gesture (i.e., speed, duration, direction and frequency) and the movement involved in touch actions to effectively modulate emotional messages and create more complex messages. Touch is also dynamic in the sense of its duality; implying that simultaneously touching and being touched are mutually involved in one communicative act, a combined physical and felt experience. This notion emerges in the Tactile Emoticon (Price et al.) where users commented on the lack of ongoing feedback in the communication experience. While participants could 'feel' the tactile qualities of the message they were sending to another, they did not receive any response from the 'other' to their touch. In the Design Fictions stories (Rüller et al.) exchanging touches and reciprocating to touch was central to participants' emotional needs. Extending this, the Soma Corset (Karpashevich et al.) highlights dynamics in the sense that touch communication, relationships and meaning change and develop over time, through these dualistic and responsive interactions. In this space, these dynamic experiences are discussed in the context of a cyborg relationship, rather than human-to-human relationship. Across the papers we see a variety of tactile qualities or mechanisms for synthetically generating touch sensations. Three papers differently bring pressure-output into the tactile experience but with different underlying motivations (Messerschmidt et al., Karpashevich et al. and Price et al.). Anisma incorporates this actuation method into the on-skin prototyping toolkit; the Soma Corset uses pressure to bring awareness to the wearer's breathing, whereas the Tactile Emoticon uses it as a means to convey emotional messages – typically participants using this sensation to generate 'reassurance' or 'comfort'. Different from other papers, the Tactile Emoticon also makes use of temperature and vibration to convey emotion from one participant to another. Interestingly, given the fairly typical use of vibration in digital touch contexts (e.g., Isra & Abnoui, 2018; Huisman et al., 2016; Gao et al., 2012), vibration was found to be less

popular with users, being described as 'unpleasant' or 'unnatural'. Ticklefoot engages with a more novel actuation of tactile sensation through brushes attached to a moving magnet (Elvitigala et al.).

Across the special issue, we see the different ways that touch is presented and conceptualised; as individual touch sensations or a dynamic, dualistic interaction. This is significant in how the role of the digital touch is shaped and raises alternative considerations for digital touch design (Price et al., 2021).

2.5 Methodological approaches

Across the special issue the papers use and/or propose a variety of methodological approaches for the study of digital touch from the more conventional and familiar approaches within HCI and Computer Science to methods from outside HCI. This is exciting and promising, as it extends the methods available to researching digital touch and opens the methodological space to new kinds of interdisciplinary collaborations. In so doing, it encourages engagement in innovative approaches to researching and developing digital touch communication; both of which we suggest are vital to the development of the field given the complex research space of haptic communication.

Prototype design is a common approach in contexts with new technologies and is used by three papers in this special issue: Ticklefoot (Elvitigala et al.) comprises a tickling actuator embedded in a flexible sole that contains brushes which lightly touch the foot sole using a magnetic field; the Tactile Emoticon (Price et al.) comprises two hand-based 'mitts' that enable tactile messages to be sent remotely between two people using vibration, pressure and temperature; the Soma Corset (Karpashevich et al.) uses shape-changing actuation (sensor pillows around the torso that inflate and deflate according to how it is programmed) to bring awareness to breathing, disrupt and expand breathing patterns. Anisma (Messerschmidt et al.) addresses the process of prototyping itself and presents an exploitable software and hardware toolkit to enable more widespread prototyping of on-skin haptic devices. We suggest that Anisma extends the use of prototypes in that the authors propose a method for how rapid prototyping can be made faster and easier for non-material experts. This points to the benefits of further easing design and prototyping of haptic interfaces and an interesting challenge is raised for how the social aspects could be captured through this method. The design tools that exist today usually model basic haptic parameters of stimulation and/or perception, however, do not cover the subtle and hard-to-formalize social aspects.

Two of the papers in this special issue draw on lesser used approaches within the field of digital touch, both engaging with the first-person experience to shape the research, foregrounding the 'felt' and 'lived' experience that bring more nuanced perspectives on digital touch. The Soma Corset (Karpashevich et al.) draws on somaesthetics combining body, emotions and thinking with the ability to appreciate and engage with these processes. They argue that engaging with the somatic experience enables exploration of uncomfortable interactions and frictions and that using a post-phenomenological analytical lens can usefully probe the limits of touch experience. Rüller et al. bring an ethnographic and socio-technical imaginary approach to researching interface design through design fictions. Specifically, these enable the engagement of local people with little or no digital literacy to engage through focusing on traditional customs (including body art like tattoos or henna and clothing like turbans or hijabs) that both speak to current potential haptic designs and foster wider social participation from the community.

This design fiction approach emphasises the importance of bringing 'context' into methodological approaches. The focus on people's everyday practices brings the social and cultural milieu into critical focus in shaping digital touch design. The focus on context is also reflected in the Tactile Emoticon (Price et al.) paper, where both scenarios of different emotional situations (excitement; anxiety) and the specific participant relationship context (work colleagues; romantic partners) enabled a nuanced understanding of how participants designed and interpreted tactile messages.

Collectively, the papers in this special issue bring new approaches to understanding digital touch communication, broadening our notion of what touch is, as well as demonstrate ways in which accepted methodologies can be extended and developed to forge new directions for technical development.

3 Future directions

This special issue brings focus to the sociality of touch in the context of the digital. This perspective moves digital touch beyond the physiological and physical sensation to attend to the social, sensorial, and experiential aspects of touch. It speaks to how digital touch influences and shapes meaning making, interaction and communication and the significance of the changes the digital brings to touch in mediating culturally situated touch practices; all of which raise questions around, for example, agency and control, accessibility, regulation of touch, and different levels of communication (e.g., presence/identity vs emotion/content). This perspective considers how touch is brought into and navigated in various spaces from personal relationships, parenting, health and well-being, learning and leisure, and the workplace.

Within this context, the papers in this special issue consolidate current research directions around digital touch communication. As a collection they highlight the many nuances of touch, suggesting the need for rethinking what and how we touch and the implications of this for reconfiguring haptic design. Several papers in this collection speak to the importance of a shift in understanding of technology from functional and mechanistic to embrace context, culture, materiality, and emotion, to foster digital touch integration into everyday life (Rüller et al., Karpashevich et al., Elvitigala et al. & Price et al.). As part of this, they also recognise and bring awareness to the significance of including the wider body in digital touch research and/or systems design and development (Messerschmidt et al., Rüller et al., Karpashevich et al., Elvitigala et al. & Price et al.). Not only is the wider bodily location of touch interactions highlighted, but also the wider emotional touch experience, specifically around the 'uncomfortable' (Karpashevich et al., Elvitigala et al.). For example, with Ticklefoot the authors note the need to develop ways to identify uncomfortable reactions, while the authors of the Soma Corset draw attention to how exploration of uncomfortable interactions and frictions can be a way to probe the limits of touch, and to understand what is both possible and (un)desirable. In so doing, the papers point to the need to continue reconceptualising touch, to understand the complex nuances of touch, and interrogate effective ways to integrate the digital with everyday practices.

An important step towards achieving this involves the development of new haptic materials. While Anisma (Messerschmidt et al.) offers a starting point for fostering wider engagement with digital touch prototypes, noting key future development needs (e.g., testing sequential or parallel actuation patterns, different factors to render smooth and rough textures on the skin, and extending to three-dimensional structures), other papers point to the need to broaden digital touch materials that are more flexible, comfortable, and usable on the wider body (Elvitigala et al., Rüller et al., Price et al., Karpashevich et al.). Related to this is a need for wider application of examples illustrated in this special issue: digital systems, materials, methods and contexts of use.

Tajima et al. highlight how technology development raises perhaps unexpected ethical issues and questions, highlighting the need for more attention to be given to ethical considerations of digital touch interactions. We call for more of an engagement with this, (alongside) other social concerns raised, much earlier in the design process, and suggest that this special issue contains papers that point to methodological approaches that may better enable this. In conjunction with this, we argue for the need to continue to develop interdisciplinary collaborations that effectively integrate the user, context, and technology.

4 References

Shantonu Biswas & Yon Visell. 2019. Emerging Material Technologies for Haptics. *Advanced Material Technologies*, 4, 1900042. <https://doi.org/10.1002/admt.201900042>

Manuek Cruz, Ki-Uk Kyung, Herbert Shea, Holger Böse and Ingrid Graz, 2018. Applications of Smart Materials to Haptics, in *IEEE Transactions on Haptics*, 11(1) 2-4, 1 Jan.-March 2018, doi: 10.1109/TOH.2018.2809058.

Elisabeth Eichhorn, Reto Wettach, and Eva Hornecker. 2008. A Stroking Device for Spatially Separated Couples. In *Proceedings of the 10th International Conference on Human Computer Interaction with Mobile Devices and Services (MobileHCI '08)*, ACM, New York, NY, USA, 303–306. DOI:<https://doi.org/10.1145/1409240.1409274>

Gijs Huisman, Aduén Darriba Frederiks, Jan B. F. van Erp, and Dirk K. J. Heylen. 2016. Simulating Affective Touch: Using a Vibrotactile Array to Generate Pleasant Stroking Sensations. In *Haptics: Perception, Devices, Control, and Applications*, Fernando Bello, Hiroyuki Kajimoto and Yon Visell (eds.). Springer International Publishing, Cham, 240–250. DOI:https://doi.org/10.1007/978-3-319-42324-1_24

Lawrence H. Kim and Sean Follmer. 2019. SwarmHaptics: Haptic Display with Swarm Robots. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, Association for Computing Machinery, New York, NY, USA, Paper 688, 1-13. DOI:<https://doi.org/10.1145/3290605.3300918>

Yuan Gao, Nadia Bianchi-Berthouze, and Hongying Meng. 2012. What Does Touch Tell Us about Emotions in Touchscreen-Based Gameplay? *ACM Trans. Comput.-Hum. Interact.* 19, 4 (December 2012), 1–30. DOI:<https://doi.org/10.1145/2395131.2395138>

Daniel Gooch and Leon Watts. 2012. YourGloves, hothands and hotmits: devices to hold hands at a distance. *UIST '12*.

Ali Israr and Freddy Abnoui. 2018. Towards Pleasant Touch: Vibrotactile Grids for Social Touch Interactions. In *Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems (CHI EA '18)*. Association for Computing Machinery, New York, NY, USA, Paper LBW131, 1–6. DOI:<https://doi.org/10.1145/3170427.3188546>

Matthew J. Hertenstein, Rachel Holmes, Margaret McCullough, and Dacher Keltner. 2009. The communication of emotion via touch. *Emotion* 9, 4 (2009), 566–573. DOI:<https://doi.org/10.1037/a0016108>

Carey Jewitt, Sara Price, Kerstin Leder-Mackley, Nikoleta Yiannoutsou and Douglas Atkinson. 2020. . Springer Briefs in Human Computer Interaction 10.1007/978-3-030-24564-1 [Interdisciplinary insights for digital touch communication](https://doi.org/10.1007/978-3-030-24564-1). Springer Briefs in Human Computer Interaction 10.1007/978-3-030-24564-1

Young-Woo Park, Kyoung-Min Baek, and Tek-Jin Nam. 2013. The roles of touch during phone conversations: long-distance couples' use of POKE in their homes. In *SIGCHI Conference on Human Factors in Computing Systems*, 1679–1688.

Sara Price, Carey Jewitt, and Nikolets Yiannoutsou. 2021. Conceptualising touch in VR. *Virtual Reality* 25, 863–877. <https://doi.org/10.1007/s10055-020-00494-y>

Samarth Singhal, Carman Neustaedter, Yee Loong Ooi, Alissa N. Antle, and Brendan Matkin. 2017. Flex-N-Feel: The Design and Evaluation of Emotive Gloves for Couples to Support Touch Over Distance. In *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing - CSCW '17*, ACM Press, Portland, Oregon, USA, 98–110. DOI:<https://doi.org/10.1145/2998181.2998247>

James Keng Soon Teh, Adrian David Cheok, Yongsoon Choi, Charith Lasantha Fernando, Roshan Lalintha Peiris, and Owen Noel Newton Fernando. 2009. Huggy pajama: a parent and child hugging communication system. In *Proceedings of the 8th International Conference on Interaction Design and Children - IDC '09*, ACM Press, Como, Italy, 290. DOI:<https://doi.org/10.1145/1551788.1551861>

Anusha Withana, Daniel Groeger, and Jürgen Steimle. 2018. Tacttoo: A Thin and Feel-Through Tattoo for On-Skin Tactile Output. In *Proceedings of the 31st Annual ACM Symposium on User Interface Software and Technology (UIST '18)*. Association for Computing Machinery, New York, NY, USA, 365–378. DOI:<https://doi.org/10.1145/3242587.3242645>