
Touch, Taste, & Smell User Interfaces: The Future of Multisensory HCI

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Abstract

The senses we call upon when interacting with technology are very restricted. We mostly rely on vision and audition, increasingly harnessing touch, whilst taste and smell remain largely underexploited. In spite of our current knowledge about sensory systems and sensory devices, the biggest stumbling block for progress concerns the need for a deeper understanding of people's multisensory experiences in HCI. It is essential to determine *what* tactile, gustatory, and olfactory experiences we can design for, and *how* we can meaningfully stimulate such experiences when interacting with technology. Importantly, we need to determine the contribution of the different senses along with their interactions in order to design more effective and engaging digital multisensory experiences. Finally, it is vital to understand what the limitations are that come into play when users need to monitor more than one sense at a time. The aim of this workshop is to deepen and expand the discussion on touch, taste, and smell within the CHI community and promote the relevance of multisensory experience design and research in HCI.

Author Keywords

Touch; Taste; Smell; Multi-sensory; User Experiences; Multi-sensory Interaction; Interaction Modalities.



Figure 1: *Digital taste interface*: A digital method for simulating the sensation of taste by actuating the human tongue through electrical and thermal stimulation methods [12].



Figure 2: The Scentee 'balloon', attached to the earphone jack of your smartphone, sprays the aroma of choice. Air-freshener-like cartridges so far include scents of rosemary, lavender and coffee (see <http://adrianchek.info> for more information).

ACM Classification Keywords

H.1.2 User/Machine Systems: Human factor

Background

Despite the fact that interactive technologies have a dominant role in our environment (e.g., mobile, ubiquitous computing) and have become an essential part of our everyday life (e.g., work, leisure, education, health), the medium through which we interact with them is still limited. That is, although we are equipped with at least five major senses, interactive technologies predominantly focus on our senses of vision and hearing, and increasingly our sense of touch (e.g., think only of vibration in mobile phones). The chemical senses (taste and smell) are under-exploited in HCI research [6,7,11].

Both psychologists and neuroscientists have advanced the field on multisensory perception over the last 50 years [1,2,3,15]. For example, they have provided key insights on the multisensory interactions that give rise to the (psychological) 'flavor sense' [10,13,14]. Despite the scientific advances, the development of taste and smell interfaces, and subsequently flavor interfaces, is still in its infancy and much work will be required in order to create multisensory-based systems that are meaningful to people and at the same time scalable.

Relevance of the workshop theme

It is increasingly evident that the design of interactive systems changes from a focus on problems, tasks, and functions to a perspective of possibilities, meaning, and emotion. (Multi-)Sensory experiences involving the chemical senses in HCI are still not fully understood. That said, technology is advancing and we can see one-off design examples (e.g., LOLLio [4], MetaCookie+

[5], and Tongue Mounted Digital Taste Interface [12] – see Figure 1, scent emitting phones – see Figure 2).

Nevertheless, there are opportunities to enhance the multisensory scope of both designers and developers in terms of their ability to create meaningful interactions and make use of the whole spectrum of sensory experiences. A fundamental difficulty with taste and smell interfaces, is that olfaction and gustation are difficult to measure quantitatively (e.g., based on frequency sensing). Sound and light are measured based on frequency and therefore can easily be converted to a digital medium (bits). Smell and taste are known as the chemical senses because they rely on chemical transduction, and therefore we do not entirely know how to digitize these senses yet.

Multisensory experiences involving touch, on the other hand, have been increasingly used in the last decades. While progress has been made, it is still key to take advantage of the full range of tactile sensations (vibrations, pressure, force, balance, heat, coolness/wetness, electric shocks, pain and itch etc.) and to articulate them with the other senses. Indeed, touch is a physical sense that involves active and passive modes, making it useful to explore in multimodal contexts [8,9,16].

As a community, we need to explore design methods and frameworks that provide both quantitative and qualitative parameters for stimulation of the senses of touch, taste, and smell. Obrist et al. [6], for instance, investigated the characteristics of the 5 basic taste experiences (sweet, salty, bitter, sour, and umami) and suggested a design framework that highlights the temporal, affective, and embodied qualities for each of the basic tastes (see Figure 3).

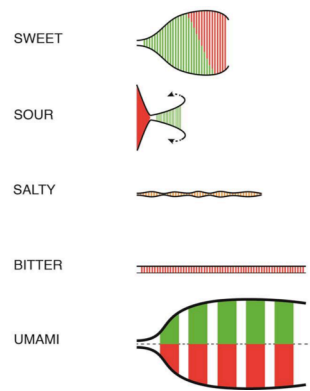


Figure 3: Three characteristics of taste experiences combined for each of the 5 basic tastes [5]. *Temporality* (the duration of the taste experience indicated from left to right); *affective reactions* (green pleasant, red unpleasant, and orange neutral experience); and the *embodied mouth feeling* for each of the five tastes.

Research of this kind could prove useful for designers and developers to meaningfully harness touch, taste, and smell in human-computer interaction and opens up a new ways of talking about the sense of taste and related experiences. People often use terms and descriptions such as “I like it”, “It’s sweet”, but the underlying properties of the specific experience remain silent and consequently inaccessible to designers. Therefore having a framework that includes more fine-grained descriptions such as “it is lingering”, “it is like a punch in my face” can lead to the creation of a richer vocabulary for designers and evoke interesting discussions around interaction design.

Furthermore, it is crucial to determine the meaningful design space for multisensory interactive experiences. For example, we rarely experience the sense of taste in isolation. Perhaps, aiming for the (psychological) flavor sense would be a way to go, as we combine, at least, taste, olfactory, and trigeminal/oral-somatosensory inputs in our everyday lives whenever we eat or drink. At the same time, it is key to understand the unique properties of each sensory modality before designing for their sensory integration in the design of interactive systems.

Studying these under-exploited senses not only enhances the design space of multisensory HCI but also helps to improve the fundamental understanding of these senses along with their cross-sensory associations.

Workshop aim and challenges

This workshop will draw together an international and interdisciplinary group of researchers, designers, and developers from academia and industry to collaborate and explore the opportunities around multisensory

design, and the user experiences surrounding this design in human computer interaction. We will challenge current interaction paradigms, mainly based on audio-visual and increasingly tactile user interfaces, and explore meaningful design spaces and map future trajectories for touch, taste, and smell for interactive systems.

More specifically, this workshop focuses on three grand challenges in multisensory experience research:

- Discuss what tactile, gustatory, and olfactory experiences we can design for.
- Explore different ways of how to design multisensory experiences for both touch and the chemical senses.
- Capture meaningful application contexts and interaction scenarios for multisensory stimulation.

This workshop is only defining the beginning for a new generation of research endeavors in HCI, with a strong foundation in, and potential impact on, other disciplines such as the sensory and cognitive sciences.

Organizers

Below we provide short biographies on each workshop organizer. Expertise and interests are complementary and reflect the interdisciplinary perspectives on the workshop topic. The lead author has successfully collaborated with other organizers in previous events (CHI’14: joint publication on taste, WorldHaptics’15: panel on touch).

Marianna Obrist (*main contact person*) is a Reader in Interaction Design at the University of Sussex, UK. She leads the Sussex Computer Human Interaction (SCHI) Lab integrated in the Creative Technology research

group established within the School of Engineering and Informatics. Her research focuses on the systematic exploration of touch, taste, and smell experiences as future interaction modalities. She has been active in organizing workshops, SIGs, panels, courses at previous CHI conferences. Further information: <http://www.sussex.ac.uk/schi/>

Carlos Velasco is a Postdoctoral Research Fellow at the Imagineering Institute, Iskandar, Malaysia. He obtained his D.Phil. in Experimental Psychology at Oxford University in 2015. His research focuses on crossmodal perception, in particular, in crossmodal correspondences and their applications. He is the co-founder of Neurosketch (Colombia) and Flying Fish Research (UK) and has worked with a number of national and multinational companies in multisensory experience design. Further information <http://carlosvelasco.co.uk/>

Chi Thanh Vi is a Postdoctoral Research Fellow at the SCHI Lab at the University of Sussex. He received his PhD in Computer Science in 2014 from University of Bristol, UK. His research interest falls into the HCI multidisciplinary domain, where there is a cross feeding between Computer Science, Neuroscience, and Psychology. More specifically, he is interested in using different brain sensing methods (e.g., EEG and fMRI) to understand the neural basis of different user states and investigating how it can benefit to HCI users.

Nimesha Ranasinghe is a Research Fellow at the National University of Singapore. His current research interests include digital multisensory interactions (including taste and smell), wearable computing, and HCI. During his Ph.D. at the Department of Electrical and Computer Engineering, National University of

Singapore, he invented the virtual taste technology, which simulates primary taste sensations by stimulating the human tongue through electrical and thermal stimulation methods. He demonstrated his work in numerous academic conferences and his work on Digital Lollipop was selected as one of the best ten innovations in the world in 2014 by netexplo forum in UNESCO. Further information: <http://nimesha.info>

Ali Israr is a researcher and engineer in Disney Research, where he explores opportunities of haptic feedback in educational, entertainments, training, social, and assistive applications. Ali obtained his doctoral from Purdue University, and his basic training in Mechanical Engineering from UET Lahore, Pakistan. Ali has actively contributed in haptics sciences and research, took his research to new product development, and has demonstrated critical haptic components to create realism and immersion. Currently, Ali is exploring the role of haptics in multimodal and multisensory settings, such as in VR/AR, wearables and handhelds, and in gaming.

Adrian David Cheok is Director of the Imagineering Institute, Iskandar Malaysia and a chair Professor of Pervasive Computing at City University London. He is Founder and Director of the Mixed Reality Lab, Singapore. He has previously worked in real-time systems, soft computing, and embedded computing in Mitsubishi Electric Research Labs, Japan. He has been working on research covering mixed reality, human-computer interfaces, wearable computers and ubiquitous computing, fuzzy systems, embedded systems, power electronics. Further information: <http://adriancheok.info>.

Charles Spence is the head of the Crossmodal Research Laboratory, University of Oxford, UK. He is interested in how people perceive the world around them. In particular, how our brains manage to process the information from each of our different senses (such as smell, taste, sight, hearing, and touch) to form the extraordinarily rich multisensory experiences that fill our daily lives. His research focuses on how a better understanding of the human mind will lead to the better design of multisensory foods, products, interfaces, and environments in the future. His research calls for a radical new way of examining and understanding the senses. Further information:
<http://www.psy.ox.ac.uk/team/charles-spence>

Ponnampalam Gopalakrishnakone is Professor Emeritus in Anatomy at the Yong Lin School of Medicine, National University of Singapore and Chairman of the Venom and Toxin Research Programme at the National University of Singapore. He holds adjunct appointments at Interactive Digital Media Institute (IDMI), Defence Science Organization (DSO) and Defence Medical and Environmental Research Institute (DMERI). He was the President of International Society on Toxinology till 2012. He shares his expertise in "Natural toxins" with many national, regional and international organizations.

Website

The workshop website will promote the workshop theme, engage a broader audience in discussions, and facilitate submissions of position papers. The website is available through: <http://multi-sensory.info/>

Pre-Workshop Plans

The workshop's *Call for Participation* will be distributed via mailing lists (e.g., ACM SIGCHI, ACM Multimedia) to

researchers in the field of HCI, UX and related areas interested in multisensory research (e.g., WorldHaptics, IMRF, SenseAsia). We will use the workshop website to promote submissions to the workshop and will later be used for networking and further community building platform. The website will serve as a reference point for researchers, designers, practitioners and interested audience in exploring touch, taste and smell for interactive technology. We will provide a section on "Relevant readings" with relevant questions to be further discussed in the workshop. Thus people interested in the topic can be supported in writing up their position papers.

Workshop Structure

The one-day workshop starts with an introductory round (speed dating) and an overview on the grand challenges in multisensory research in HCI.

- 9:00-9:10: Brief welcome to the workshop by the organizers.
- 9:10-09:30: *Get to know each other*: each attendee receives a touch, taste, or smell card and will have 2 minutes to write down a personal sensory experience, which they then share with another person they do not know. At the end, all cards are collected on a whiteboard/wall categorized by senses.
- 9:30-10:00: Inspirational Talks on "Basics of Touch, Taste and Smell" by **Ponnampalam Gopalakrishnakone** (National University of Singapore) and/or "Multisensory Experiences" by **Charles Spence** (Oxford University).
- 10:00-10:30: Clustered overview on the different perspectives from the position papers. Each participant will have 1 minute to present the "main message" of his/her paper (e.g. using any medium).
- 10:30-10:45 *Coffee break*

- 10:45-11:30: Participants will be divided into groups (3 to 4). Each group will brainstorm solutions for a challenge given by the organizers (e.g., design an interaction task based on taste?). There will be at least one organizer at each table as facilitator.
- 11:30-12:30: Each group has 10min for presenting their solution plus 5min discussion (assuming 6 groups in total).
- *12:30-13:30 Lunch (organizers will arrange joined lunch for the workshop participants)*
- 13:30-14:30: Inspirational talks plus Demos on "Digital smell and taste interaction" by **Nimesha Ranasinghe** (National University of Singapore) and "The challenges of touch interaction" **Ali Israr** (Disney Research).
- 14:30-15:00: For 10min everyone thinks individually about "*what interaction scenario would you imagine in 5 years time based on touch, taste and/or smell?*" Then we build groups of 3 to 4 people, and present your idea to the group. The group chooses one idea for further discussion and elaboration.
- *15:00-15:30 Coffee break*
- 15.30-16:30: Each group builds a prototype for the chosen idea of the "future multisensory interaction". Organizers will provide some prototyping materials.
- 16:30-16:50: Each group presents their prototype and the other groups give points, which will define the winner of the best idea.
- 16:50-17:00: Wrap up on what the future might look like on multisensory HCI, actions for follow-up activities (summary report to be published on the website, and ACM Interactions contribution).

- After 17:00: After workshop wrap up, exchange of contacts, informal discussion and brainstorming continues during drinks and dinner.

At day's end, we also plan to arrange a simple experiment to encourage attendees to continue their reflection on the workshop topic, but also find out who is a supertaster (paper test strip used in [8]).

To facilitate the workshop activities we would require the following resources:

- Flipchart boards for 6 groups
- Large wall that can be filled with post-it notes
- Flexible table arrangements
- Post-its of different colors
- Pens and different color markers
- Scissors, cutters, staplers, glue, scotch

Post-Workshop Plans

We intend to further collaborate with the participants of the workshop but also use this workshop as opportunity for the organizers themselves to establish a global community of interest on multisensory research within the HCI field and beyond. Furthermore, we want to foster plans for collaboration studies on multisensory experiences across various contexts, application areas, and engage industrial leaders. To foster this research direction, we will also aim to organize a Special Interest Group on multisensory research in HCI at CHI'16.

All accepted submissions to the workshop will be made public on the website. Authors of the submissions will be invited to send updates on follow-up-studies related to the workshop submissions. In accordance with the authors, these updates will also be published on the website. Furthermore, the outcome of the workshop will

be submitted as a summary report to ACM Interactions to reach out to a larger community of academics and practitioners interested in new frontier research in HCI.

Call for Participation

We invite position papers for the CHI 2016 Workshop on "*Touch, Taste, & Smell User Interfaces: The Future of Multisensory HCI*". This one-day workshop will offer an interdisciplinary forum of discussion for both academics and practitioners interested in research beyond audio-visual interaction with technology.

This workshop focuses on three grand challenges in multisensory research:

- Understanding what tactile, gustatory, and olfactory experiences we can design for in HCI.
- Exploring different ways of how to design and stimulate multisensory experiences for both touch and the chemical senses (taste and smell).
- Capturing meaningful application contexts and interaction scenarios for multisensory stimulation.

Researchers from both academia and industry with an interest in multisensory research are invited to submit a position paper. The paper should be at most four pages in the *CHI Extended Abstracts format*. This position paper should address one or more of the workshop's three grand challenges. All submissions are reviewed based on the three grand challenges by the workshop organizers. Demos are encouraged and will get space in the workshop agenda!

Participants will be selected on the basis of the quality of their position paper. At least one author of each accepted paper must register for the workshop and for

one day of the conference itself. Participants will be invited to present a position statement at the workshop and will actively engage in an interdisciplinary discourse on the meaningful design space for touch, taste, and smell in HCI.

Please submit your paper via the easychair system. You can find the link and details for the submission on our workshop website: <http://multi-sensory.info/>

Important dates:

- First submission date: 11-Dec 2015 (if you need to leverage 2015 Q4 budget)
- Notification date: 21-Dec 2015
- Second submission date: 13-Jan 2016
- Notification date: 12-Febr 2016

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