Augmenting Media Experiences with Affective Haptics

Within our Distributed & Interactive Systems research group, we focus on affective haptics, where we design and develop systems that can enhance human emotional states through the sense of touch [1]. Such artificial haptic sensations can potentially augment and enhance our mind, body, and (virtual) social connections. In three works (voice communication, news consumption, virtual embodiment), we explore the effects of enriching media experiences with thermal and vibrotactile affective haptics, and how such stimulation influences our affective perception.

1. ThermalWear

In ThermalWear [2], we explore how a Peltier element and heatsink embedded in an upper chest-worn vest can thermally augment the valence of neutrally-spoken voice messages. This requires fast thermal stimulation, given the brief duration of voice messages. We do this by controlling the Peltier behaviour using a custom-built ESP microcontroller. Given wearability and thermal conductivity properties, we designed a neoprene vest with a silk cutout, avoiding direct Peltier-to-skin contact. We learned that warm stimuli increase the perceived valence of voice messages, while cool stimuli lower it.

Insert image: "Thermalwear.jpg" with caption: (a) ThermalWear hardware components. (b) Peltier embedded in neoprene vest. (c) Participant experiencing the ThermalWear prototype.

2. FeelTheNews

In FeelTheNews [3], we built on our earlier prototype, but additionally include vibrotactile stimulation using a Lofelt L5 actuator. We explored the augmentation of 1-minute news videos. Stepping away from wearability and fast thermal stimulation requirements, this prototype houses the hardware in a box which users can place their hand and forearm on. We designed three stimulation patterns: (a) Matching, i.e. vibration mimics audio and temperature matches video valence, (b) Negative, i.e. 70Hz vibration and 20°C, (c) Positive, i.e. 200Hz vibration and 40°C. In contrast to ThermalWear, we find no statistical differences in perceived valence ratings. Participants mentioned actively suppressing the induced sensation, or being distracted by the video. Some mentioned that inappropriate intensification of the news content and neutralization of the emotional impact of the video content also played a role.

Insert image: "FeelTheNews.jpg" with caption: (a, b) FeelTheNews hardware components. (c, d) Pilot participants experiencing the FeelTheNews prototype.

3. HapticBiosignalProxemics

Whereas in FeelTheNews we had fixed haptic stimulation intensities, we wanted to explore how haptics using varying intensities influence users under Virtual Reality (VR) proxemics settings. In HapticBiosignalProxemics, we are currently exploring how equipping an embodied virtual agent in VR with artificial biosignals (vibrotactile heartrate and thermally-actuated body temperature) influences users' inter-personal distance (IPD) and affective perceptions. Here we embedded the Peltier element in a neoprene and silk armband to ensure suitability for VR. For vibrotactile stimulation, we use the Oculus Touch' internal actuator. The stimulations become more intense (i.e., higher amplitude vibration and warmer) as users approach an agent. One key finding is that whereas thermal stimulation decreased objective but not subjective IPD, vibrotactile heartbeats increased both.

Insert image: "HapticBiosignalProxemics_0" with caption: Peltier element prototyping: (a, b) the initial design of the armband using tape to hold the element in place which was later upgraded to a 3D-printed casing (c).
Insert image: "HapticBiosignalProxemics_1" with caption: (a) Hardware components. (b) Participant's view of a trial with a male agent, telling a positive story at a large interpersonal distance, and (c) Trial with a female agent, telling a negative story at a short interpersonal distance.

From these projects, we learned that augmenting media experiences using affective haptics is complex. Evaluations revealed several areas for design: high variance across human skin sensitivities; differing preferences for actuator body placement and social acceptability issues; undesirable effects and secondary interactions (e.g., moving in VR makes you sweat); misinterpretation of the actuation intent; and the complexity of experimenting with and creating custom hardware to meet design requirements. These observations, we believe, pave the way for the next phase of exploration and a more human-centric experiential research on combined thermal and vibrotactile affective haptics.

References:
[1] D. Tsetserukou, A. Neviarouskaya, H. Prendinger, N. Kawakami and S. Tachi, "Affective haptics in emotional communication," 2009 3rd International Conference on Affective Computing and Intelligent Interaction and Workshops, Amsterdam, Netherlands, 2009, pp. 1-6, doi: 10.1109/ACII.2009.5349516.

[2] Abdallah El Ali, Xingyu Yang, Swamy Ananthanarayan, Thomas Röggla, Jack Jansen, Jess Hartcher-O'Brien, Kaspar Jansen, and Pablo Cesar. 2020. ThermalWear: Exploring Wearable On-chest Thermal Displays to Augment Voice Messages with Affect. In Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems (CHI '20). Association for Computing Machinery, New York, NY, USA, 1–14. https://doi.org/10.1145/3313831.3376682

[3] Simone Ooms, Minha Lee, Pablo Cesar, and Abdallah El Ali. 2023. FeelTheNews: Augmenting Affective Perceptions of News Videos with Thermal and Vibrotactile Stimulation. In Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems (CHI EA '23). Association for Computing Machinery, New York, NY, USA, Article 137, 1–8. https://doi.org/10.1145/3544549.3585638