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HLEDs: Haptic Light-Emitting Diodes

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I. Demonstration

The demonstration we will present at the 2025 World Haptics Conference showcases a 5 cm × 10 cm × 4 mm surface haptic display composed of an array of 9 independently addressable haptic pixels. Each pixel is actuated by an individual LED, forming a tactile interface that allows users to physically interact with dynamic patterns while simultaneously receiving visual feedback. Users engage with the device through direct touch, with each pixel measuring 5 mm in diameter and arranged with an approximate display pitch of 6 mm.

The display works via rapid photomechanical transduction, converting light into tactile actuation, a technique previously shown by Linnander et al., and demoed at the 2024 Haptics Symposium [1]. The advance introduced here is that each pixel integrates an LED optical source, as opposed to being operated via a laser. When activated, the LED emits light that is absorbed by a photoabsorber within the pixel, producing localized transient heating. This heating induces a mechanical response that generates a surface deflection, providing tactile feedback to the user. The entire actuation cycle occurs over tens of milliseconds, enabling quick refresh rates necessary for displaying dynamic and time-varying tactile information. The display allows for programmable control of stimulation parameters, including amplitude, frequency, and duration, through software-based modulation of the optical driving signals. This programmability supports the creation of a wide range of tactile sensations and dynamic patterns that can be synchronized with the visual content.

A key feature of this system is its flat, lightweight form factor, achieved by relying entirely on LED-based light-delivery without the need for a bulky optical system. The demonstrated platform highlights potential applications in multimodal user interface design, where combined visual and tactile outputs can enhance the interactivity and accessibility of digital content. It also has potential applications in educational applications, automotive interfaces, or interactive wall surfaces, where planar visuo-haptic displays can be implemented.

Attendees at the conference will have the opportunity to interact directly with the device through hands-on demonstrations. Through this experience, participants will be able to assess the tactile fidelity, responsiveness, and practical form factor of the system and engage in discussions regarding its potential for future developments in haptic technology, user interface design, and accessible educational tools.

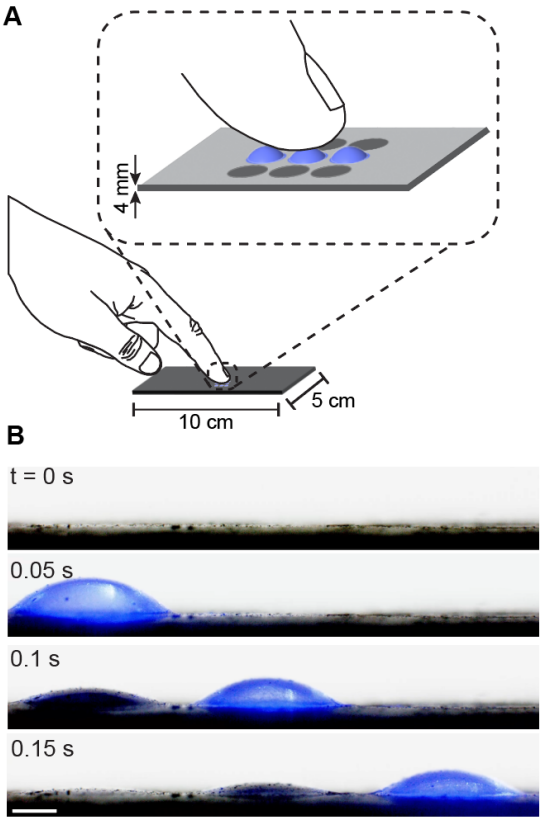

Fig. 1. **A.** Concept figure of the haptic display demo. The setup is a rectangular box, approximately 5 cm x 10 cm x 4 mm, on top of which is an array of 9 vibrotactile pixels. **B.** Side view of a 1x3 array of pixels being actuated.

II. Technical Requirements

The demonstration requires a single table. The entire apparatus (total dimensions 5 cm x 10 cm x 4 mm, interactive region: 17 x 17 mm) will rest on the table, alongside a computer system and a power supply. The demonstration requires two standard AC power outlets.

References

[1] M. Linnander et al. Tactile displays driven by projected light. *arXiv*, 2410.05494, 2024.

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