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HapEar: Vibrotactile Array around the Ear for 3D Spatial Cues

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***Abstract*—We present *HapEar*, a headset-mounted vibrotactile display that delivers 3D spatial cues through eight ERM actuators positioned around the ears. This demo allows participants to experience and compare single and multi-point stimulations for spatial localization, and to reflect on their performance, providing insights into ear-based tactile feedback for multisensory interaction.**

I. Background and Motivation

We present *HapEar*, a vibrotactile display integrated into the earcup region of a headset, designed to deliver 3D spatial cues using eight symmetrically arranged ERM motors. This demonstration is based on a work-in-progress paper currently under review for WHC 2025, which reports that ear-adjacent skin can support accurate localization of both single-point and phantom stimuli, achieving up to 3.94 bits of information transfer.

Future work will focus on reducing high-frequency noise to minimize auditory interference, as well as improving skin contact and reducing acoustic output to enhance the system's usability and spatial resolution.

II. Scope

This hands-on demonstration is intended for researchers, designers, and practitioners interested in non-visual feedback channels, wearable haptics, and spatial interaction. It particularly targets those working in multimodal interaction, assistive technology, and immersive systems who seek practical alternatives to visual and auditory feedback in spatial cueing.

The primary goal of this demo is to enable participants to experience how spatial directions can be encoded and delivered through vibrotactile stimuli applied to the skin around the ears. By engaging with the system firsthand, attendees will gain insight into the feasibility and intuitive nature of ear-based spatial haptic feedback, and consider its applicability to domains such as virtual navigation, situational awareness, and multisensory design.

In addition, this demonstration serves as an opportunity for the authors to gather direct feedback from the haptics research community and to refine future iterations of the system based on critical discussion and observation.

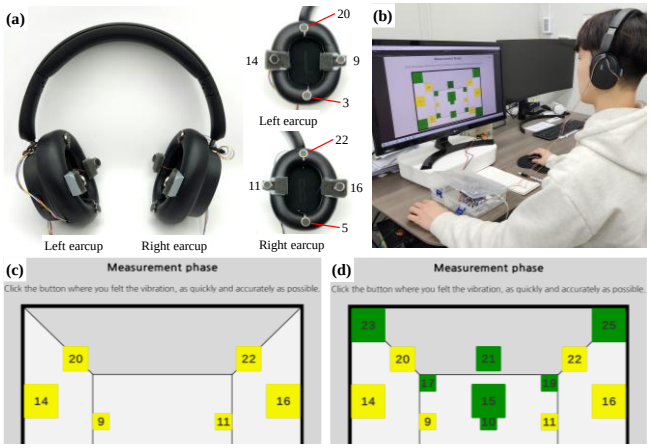

Fig. 1. (a) Experimental headset equipped with eight coin-type ERM actuators, symmetrically mounted around the left and right earcups. (b) Demo setup (c) User interface used during the single-point localization, (d) multi-point localization.

III. Demo Overview & Goals

In this demonstration, participants will be seated at a table facing a monitor and will wear a headset equipped with eight symmetrically arranged ERM vibration motors positioned around the earcups. The system delivers brief vibrotactile pulses to specific skin locations corresponding to spatial directions such as front, back, top, and bottom. Participants will view a graphical user interface on the monitor and respond to each stimulus by clicking with a mouse on the location they perceive.

The demo includes both single-point and multi-point stimulation. Participants will perform a series of point localization tasks with random stimulation. After completing the tasks, they will receive feedback on their own performance, including accuracy and response time, enabling reflection on the clarity and discriminability of each encoding method.

The goal of this demo is to provide attendees with hands-on insight into the perceptual characteristics and design considerations of spatial tactile cueing around the ears. Through structured interaction with both standard and alternative encoding methods, participants can evaluate the potential of ear-mounted vibrotactile feedback in the context of multisensory interfaces for immersive and assistive applications.