Demonstrating Rolling and Sliding Sensations via Spatiotemporal Electrotactile and Vibrotactile Cues

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Abstract. Distinguishing between rolling and sliding sensations by one finger is a fundamental challenge in single-finger haptic interactions, especially when bulky force-feedback devices are impractical. In this demonstration, we present a lightweight haptic system that synthesizes distinct rolling and sliding sensations using a 64-channel spatiotemporal electrotactile array augmented by DC-motor vibration. Attendees will experience how carefully mapped contact geometry and kinematic movement ratios, together with vibration-based friction cues, can create compelling illusions of an object rolling or sliding under a single fingertip. This setup translates our latest psychophysical findings into a highly interactive, real-time sensory experience.

Keywords: Electrotactile · Rolling · Sliding · Vibrotactile · Haptic Interface.

1 Introduction and Demonstration System

When interacting with virtual objects using a single finger, distinguishing whether an object is rolling under the fingertip or sliding over a surface is crucial. Our recent study showed that this distinction can be rendered with lightweight cutaneous cues by combining spatiotemporal electrotactile patterns with vibration-based event cues [2]. This cue design is consistent with prior evidence that spatiotemporal skin-strain patterns can evoke distinct neural responses to tactile motion structure [1].

The demonstration system consists of a linear slider equipped with a DC motor and an 8×8 electrode array mounted on the slider carriage. A microcontroller synchronizes the electrotactile stimulation pattern with the finger's physical displacement on the slider, while the DC motor provides vibrotactile feedback to emulate surface roughness and frictional drag.

2 Attendee Experience and Interaction Modes

The attendee places an index finger on the electrode array and slides along the track. `Left`/`Right` cycles six material presets (fixed order in the demo sketch).

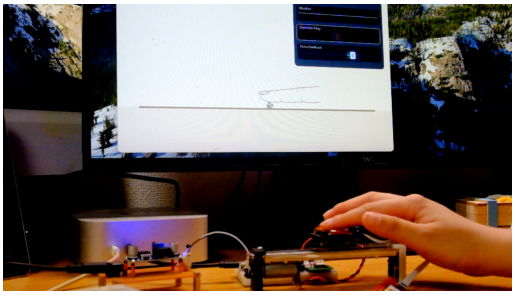

Fig. 1. Demonstration setup. A participant explores the linear-slider haptic device with one fingertip while the monitor displays the current rolling/sliding rendering condition and electrode/force/vibration pattern in real time.

All presets use the same anode-polarity baseline validated in our user study [2]; polarity is held constant here, and the differences between presets are produced by contact width, movement ratio, and added motor vibration.

Preset	Rows	k	Vib. (Hz)	Force
Classic Rolling	2	0.5	0	assist
Prism Rolling	2	0.5	20	assist
Faceted Rolling	2	0.5	100	assist
Glass	5	1.0	0	assist
Wood	5	1.0	20	resist
Sandpaper	5	1.0	100	resist

Rows: active electrode rows (Narrow = 2, Wide = 5). k: stimulus travel per finger travel (`movementRatio`). Vibration drives the slider DC motor at the selected frequency when the finger overlaps the active region.

3 Technical Requirements & Ethics Statement

Ethics: Exhibition only; no data recorded. Brief verbal briefing; participants set comfortable intensity and may stop at any time.
Demonstration Video: Demo video (Google Drive)
Technical:

- **Needed:** Table (∼150×60 cm), two chairs, power strip (≥2 outlets).
- **Preferred:** External monitor + HDMI (mirror for audience).

References

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2. Xu, Y., Kajimoto, H.: Synthesizing rolling and sliding sensations using spatiotemporal electrical stimulation augmented by physical event cues. In: Proceedings of EuroHaptics 2026 (2026), to appear

Space Planning Diagram