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Demonstrating Fiery Hands: A Thermal–Tactile Thermal Gloves using Thermal Masking

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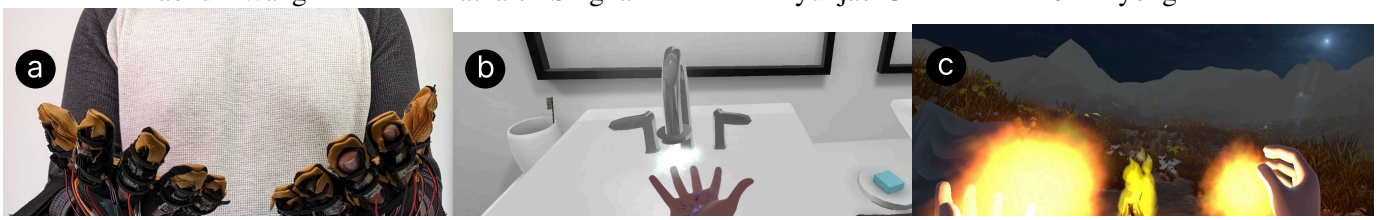

Fig. 1: Fiery Hands. (a) A user wearing the glove, (b) water faucet scene, (c) magic fireball scene.

***Abstract*—We present Fiery Hands, a wearable thermo-tactile glove interface that introduces a novel approach for delivering spatially resolved thermal sensations through thermal–tactile integration. By leveraging the phenomenon of thermal illusion, our system reduces the number of thermal actuators required while maintaining high perceptual fidelity. Strategically placed flexible Peltier-based thermal actuators and low-cost vibrotactile motors are synchronized to create compelling thermal illusions, enabling natural and immersive hand interactions in virtual reality (VR) while preserving finger mobility.**

I. Introduction

Unlike conventional thermal gloves that apply direct heating at contact points, Fiery Hands [1] decouples the physical location of thermal stimulation from the perceptual target area. This decoupling [2] enables unobstructed use of the palm and fingertips, improving dexterity, comfort, and the visual realism of hand-object interactions in VR. The glove is built on a HydraHyde leather glove (model R3267M) and integrates four flexible Peltier actuators (TEGWAY S017A026026) with heatsinks, along with 23 coin-style eccentric rotating mass (ERM) motors (JIEYI JYC0827), (see Figure1(a)) Actuators are powered by stable digital power supplies (Korad KD6005P) and controlled through a Unity3D–Arduino pipeline via a custom microcontroller-based unit that supports precise spatial and temporal activation.

We designed two interactive VR scenes that highlight different aspects of thermal illusion and object-based thermal patterning with visual content:

- Water Faucet Scene: Users immerse their hands in a virtual basin of hot water while visible steam effects suggest warmth. As they attempt to rinse virtual ink from their hands, vibrotactile pulses and localized heating simulate warm water flow. Despite thermal actuators being positioned on the glove's dorsal side, users perceive heat at the palm due to thermal-tactile integration (see Figure 1(b)).
- Magic Fireball Scene: A fireball materializes in the user's palm, growing or shrinking as users flex or spread their fingers. Dynamic, time-varying thermal patterns are projected onto the palm and fingers, synchronized with changes in the fireball's size and location. Inter-hand interaction is supported: transferring the fireball between hands also transfers the corresponding thermal and tactile feedback (see Figure 1(c)).

The core scientific contribution of Fiery Hands lies in demonstrating how perceptual integration of temperature and touch can reduce actuator count and power consumption while improving wearability. The system supports real-time interaction using Meta Quest 3's built-in hand tracking, requires no external markers, and can be calibrated for individual users in under 30 seconds. With a total weight under 250g, the glove maintains ergonomic comfort and does not impede passive gestures or continuous use.

II. Demo Experience

At IEEE WHC 2025, we will demonstrate Fiery Hands gloves using a VR setup. After a brief onboarding and calibration session, participants will explore the two VR scenarios while receiving real-time thermo-tactile feedback. Each demo lasts approximately 4–5 minutes, including guided tasks as well as freeform exploration. Through this hands-on experience, we aim to showcase how induced thermal illusions enhance immersion and simplify the design of wearable thermal interfaces using thermal masking.

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References

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