2025 IEEE World Haptics Conference (WHC)
Suwon Convention Center, Suwon, Korea
July 8 ~ 11, 2025

TouchArt: Vibrotactile Interaction for Color Perception in Virtual Painting

Gyuna Lim[1], Anney Vo[1], Eunhye Choi[2], Jinah Park[1]

***Abstract*—We present *TouchArt*, an interactive demonstration utilizing vibrotactile technology to facilitate the perception and exploration of colors through haptic feedback during virtual painting. Using a lightweight haptic glove equipped with piezoelectric actuators, participants receive real-time vibration feedback, where distinct frequencies and intensities correspond to specific colors. Upon completing their artwork, users can explore the canvas by touch, effectively identifying and distinguishing painted regions through haptic feedback. This demonstration highlights the potential of tactile color representation as a method of sensory substitution, with implications for applications in inclusive education and VR/AR environments. Beyond the demonstration, TouchArt enables exploration of perceptual, emotional, and memory-based responses to color–vibration mappings, supporting research in cross-modal perception, embodied interaction, and non-visual access to color.**

I. Introduction

Prior studies show that brief vibrotactile stimuli can evoke consistent color associations, with chroma increasing with amplitude and specific hues varying by frequency–amplitude combinations [1], [2]. Building on these findings, *TouchArt* introduces an interactive haptic system that delivers distinct color-based vibrotactile feedback through a glove equipped with a piezoelectric actuator on the forefinger. Although visual arts have traditionally relied on sight, this approach enables users to engage with visual content through touch, offering a novel sensory pathway for artistic interaction. In this demonstration, users can experience color perception through touch during virtual painting, emphasizing the potential of tactile feedback for inclusive artistic expression and accessible design.

II. TouchArt

A. Hardware description

The hardware setup consists of a lightweight and wearable glove specifically designed for haptic interaction. A piezoelectric actuator mounted on the forefinger of the glove provides localized vibrotactile feedback to users. The glove prototype was developed by the Convergence Research Center for Meta-Touch at the Korea Research Institute of Standards and Science (KRISS). Hand tracking is performed using a Leap Motion Controller 2, enabling users to interact naturally with the virtual canvas without physical contact. During interaction, the actuator modulates vibration frequency and intensity according to the system's color mapping.

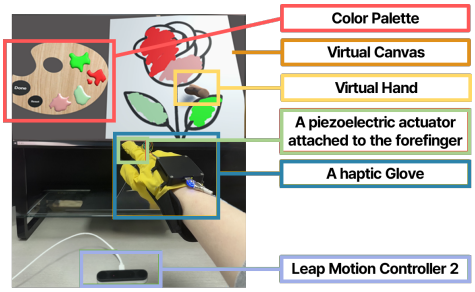

Fig. 1: Photograph showing the user interacting with a virtual canvas using a haptic glove and Leap Motion Controller 2. The virtual hand is coloring the virtual canvas using a color selected from the color palette.

B. Color-based vibrotactile feedback

The system defines four distinct colors, each mapped to specific vibration frequencies and intensities, creating distinguishable tactile sensations based on the cross-modal correspondence findings of Delazio et al. [1]. Red and green hues correspond to vibrations of 20 Hz and 200 Hz, respectively, both at 15 N. For lighter colors, the intensity is reduced to 7.5 N.

C. Interaction Modes: Paint and Exploration

The system supports two distinct interaction modes for delivering vibrotactile feedback:

(1) Paint Mode: As users paint on the virtual canvas, they experience real-time vibrations corresponding to each color, enabling them to quickly associate different colors with distinct tactile sensations.

(2) Exploration Mode: After painting, users can explore the surface both visually and through haptic feedback based on hue and saturation. Vibrotactile cues at each touch point reflect the underlying color, enabling users to identify and distinguish painted regions by touch.

Acknowledgment

This work was supported by the National Research Council of Science & Technology (NST) grant by the Korea government (MSIT) (CRC23021-000).

References

[1] A. Delazio, A. Israr and R. L. Klatzky, "Cross-modal correspondence between vibrations and colors," 2017 IEEE World Haptics Conference (WHC), Munich, Germany, 2017, pp. 219-224.

[2] I. Neto, I. Soares, A. Paiva, and H. Nicolau, "Investigating crossmodal correspondences between vibrotactile stimuli, colour, and emotions," International Journal of Human-Computer Studies, vol. 197, p. 103459, 2025. [Online]. Available: https://doi.org/10.1016/j.ijhcs.2025.103459

[1] School of Computing, Korea Advanced Institute of Science and Technology (KAIST), Daejeon, South Korea. {gyuna.lim, avo23, jinahpark}@kaist.ac.kr

[2] Gradudate School of Metaverse, Korea Advanced Institute of Science and Technology (KAIST), Daejeon, South Korea. eunhye0323@kaist.ac.kr