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

Compact Multimodal Haptic Glove for Realistic Cutaneous and Kinesthetic Feedback

Jihyeong Ma
Dept. of Mechanical Engineering
KAIST, KRISS
Daejeon, Republic of Korea
wlgudak123@kaist.ac.kr

Jae-Ik Kim
Dept. of Electronic Engineering
Korea National University of Transportation, KRISS
Chungju, Republic of Korea
kji1023@ut.ac.kr

Baekgyeom Kim
Dept. of Mechanical Engineering
Ajou University
Suwon, Republic of Korea
www7541@ajou.ac.kr

Jongseok Nam
Dept. of Mechanical Engineering
KAIST
Daejeon, Republic of Korea
tgb02388@kaist.ac.kr

Hyungseok Seo
Dept. of Mechanical Engineering
Ajou University
Suwon, Republic of Korea
hyungss123@ajou.ac.kr

Nakhyeong Lee
Dept. of Mechanical Engineering
KAIST
Daejeon, Republic of Korea
nhl0113@kaist.ac.kr

Taewook Oh
Dept. of Mechanical Engineering
Ajou University
Suwon, Republic of Korea
phew7432@ajou.ac.kr

Min-Seok Kim
Convergence Research Group for Meta-Touch
KRISS
Daejeon, Republic of Korea
minsk@kriss.re.kr

Je-sung Koh
Dept. of Mechanical Engineering
Ajou University
Suwon, Republic of Korea
jskoh@ajou.ac.kr

Tae-Heon Yang
Dept. of Mechanical Engineering
Konkuk University
Seoul, Republic of Korea
thyang@konkuk.ac.kr

Ki-Uk Kyung
Dept. of Mechanical Engineering
KAIST
Daejeon, Republic of Korea
kyungku@kaist.ac.kr

***Abstract*— We present a haptic glove that enables realistic haptic feedback in virtual environments by providing vibrotactile, pressure, and kinesthetic sensations. For vibrotactile feedback, piezoelectric actuators are used at the fingertips, while pressure feedback is provided by a shape memory alloy (SMA) actuator with a displacement amplification mechanism. An electrostatic clutch mounted on the back of the hand restricts finger movement through tendons, providing kinesthetic feedback. This combination allows users to perceive the contact, as well as surface texture and protrusions of the virtual object.**

Keywords—Haptic Glove, Multimodal, Kinesthetic, Pressure, Vibrotactile

I. INTRODUCTION

Haptic gloves are used for realistic simulation, training, and interaction in virtual environments. To achieve realistic interaction, there is a rising demand for multi-modal haptic feedback that replicates real-world sensations. However, delivering haptic feedback such as kinesthetic, vibrotactile, and pressure feedback requires different actuation mechanisms, which often leads to bulky, heavy, and expensive gloves with limited wearability. In this study, we propose a compact multimodal haptic glove by integrating piezoelectric actuators, shape memory alloy(SMA) wires, and an electrostatic clutch. The glove provides kinesthetic feedback upon contact with virtual objects and allows users to perceive surface roughness and protrusion of virtual objects.

II. COMPACT MULTIMODAL HAPTIC GLOVE

As shown in Figure 1, the glove consists of thimbles located at the fingertips, an electrostatic clutch at the wrist, and tendon and wire guide components on the back of the hand. The proposed haptic glove delivers haptic feedback to the index and middle fingers. The thimbles incorporate an SMA wire actuator and a piezoelectric actuator for pressure and vibrotactile feedback. The SMA wire, combined with a displacement amplification mechanism [1], is extremely lightweight (<350 mg) and capable of generating high forces (>2 N), enabling users to perceive millimeter-scale protrusions on virtual object surfaces. The piezoelectric actuator is placed near the nail and transmits vibrations to the side of the finger through a vibration transmission plate, allowing users to perceive a wide range of vibrotactile cues from 50 to 500 Hz. The electrostatic clutch, which provides variable friction depending on the applied voltage, connects to the fingertip thimble via tendons. This design provides free finger movement when voltage is not applied and restricts movement when activated, providing users with kinesthetic feedback upon virtual contact.

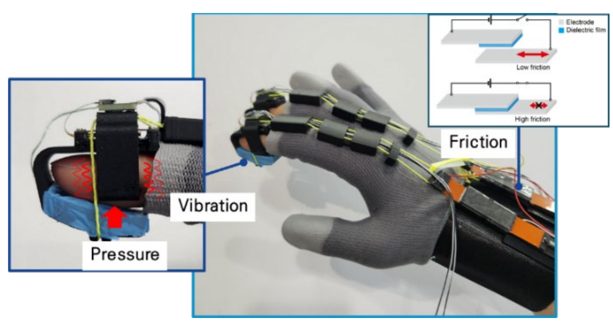

Figure 1. Overview of the proposed compact multimodal haptic glove, showing the fingertip thimbles, electrostatic clutch, and tendon/wire guide structure.

REFERENCES

[1] Kim, D., Kim, B., Shin, B., Shin, D., Lee, C. K., Chung, J. S., ... & Koh, J. S. (2022). Actuating compact wearable augmented reality devices by multifunctional artificial muscle. Nature communications, 13(1), 4155.

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