

# Haptic Perception of Virtual Spring Stiffness Using ExoTen-Glove

This paper presents a study of haptic perception of virtual stiffness and the influence of visual feedback in virtual reality. In this study, a novel and lightweight haptic glove (ExoTen-Glove) based on Twisted String Actuation (TSA) system is presented and evaluated. This system has two independent TSA modules with integrated force sensors and small-size DC motors. ExoTen-Glove provides force feedback to the users during the execution of grasping virtual objects. The overall design, the controller and the preliminary experimental evaluation of the ExoTen-Glove have been shown in this paper. Different experiments have been performed in virtual reality environment using HTC VIVE headset with 2 degrees of freedom grasping tasks, squeezing a pair of virtual springs with the participant's thumb and index fingers. The aim of this study is to illustrate the benefit of using ExoTen-Glove to distinguish stiffness of a pair of virtual springs and the role of the visual feedback. The results show that the users use not only haptic cues but also use visual cues in detecting spring stiffness difference.

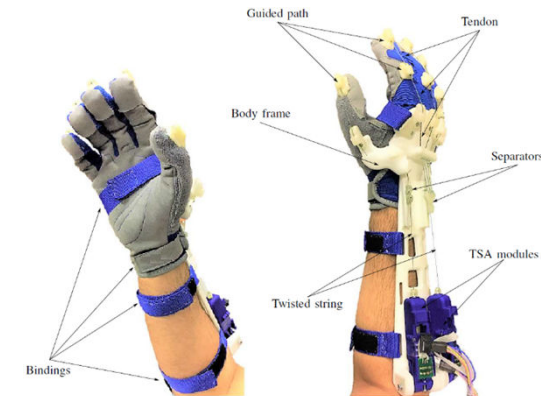


Fig. 1. Overview of the TSA-based haptic glove.