Using Electrical Stimulation to Provide Reliable Haptic Feedback in Virtual Object Classification Tasks

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Haptic feedback has a range of applications in virtual reality technology and robotic devices. Current haptic feedback systems limit motion and make their use less intuitive due to their cumbersome design. The goal of this study is to provide intuitive haptic feedback that does not restrict the movement of the user and does not require the use of wearable mechanical devices. Non-invasive electrical neurostimulation was used to provide haptic feedback to participants interacting with virtual objects. A hand aperture tracking system titled Leap Motion was used; this device uses infrared cameras to track hand position without the use of wearable markers. Validation tests were completed to characterize the accuracy of the Leap Motion device. The hand was recorded using a webcam as the Leap Motion sensor recorded the distance between the index finger and thumb. These values were compared to the actual grasp distance in the webcam videos. A calibration curve was derived to correct the sensor output, reducing tracking error from 38.38 +/- 12.71% to 10.01 +/- 10.92%. The participant was asked to categorize each virtual object into one of four profiles describing its size and firmness, which differed in behavior of pulse frequency and pulse width as the subject opened or closed the hand. The participant identified 37 out of 40 objects correctly (92.5% accuracy). These results show the potential to use surface electrical stimulation for reliable haptic feedback. Future trials will include an intermediate category of size and firmness to increase classification specificity.