User Study: Locating Static Targets with Haptic Guidance

Using the haptic skin, we sought to determine whether or not users could locate static 1-dimensional virtual targets relying solely on haptic feedback, and if so, how long it would take them. 12 participants with no known neurological conditions were recruited for this study (X males and Y females, 20 – 36 years of age). Only 1 participant had previous experiences with the haptic skin.

Experimental Set-Up

A Vicon Motion Capture system was used in this study for capturing the marker translation which was attached to the tip of the participants index finger on the same hand the haptic skin was applied to. A MATLAB program was used to acquire the marker position in real-time from the Vicon whilst simultaneously acting as a TCP client, sending feedback on or off commands to a custom windows application which acted as the TCP server. The TCP server then sent the corresponding commands to the Arduino development board via a serial COM port which controlled switching of a power transistor. The haptic skin was connected to the output of the power transistor, with the supply voltage coming from a manually adjustable power supply. The voltage of the power supply was set at XX volts, the haptic skin had a resistance of XX ohms, thus corresponding to a constant power draw of XX W when the haptic feedback was on. This power draw was experimentally determined during our pilot test beforehand as being enough power for significant actuation to occur without causing excessive heating leading to the eventual breakdown of the actuator. Figure X shows the experimental set-up used during this user study.

Figure showing experimental setup

Procedure

Participants were seated in the center of a motion capture laboratory facing in the direction of the x-axis near the origin of the coordinate frame of the Vicon system and a reflective marker (10mm diameter) was placed on the end of their index finger for tracking the translation in the x-axis. The haptic skin was placed on their right index finger extending to the back of their right hand. Participants wore a blindfold throughout the duration of the experiment to prevent any possibility of visual feedback from the actuator. The participants were asked to point their finger in the direction of the x-axis and were told to locate the depth at which they felt a virtual static wall. If the participants finger extended past the target, the haptic skin would contract giving a constant feeling of lateral skin stretch and relax if the finger’s position was less than the target value. A practice target position of 100mm in front of the participant was set, participants were given 1-2 minutes to experience what the feedback felt like as they extended their finger past the target and back behind it again. After the practice trial, three separate trials with targets of 150, 250, and 350mm were set (in the random order for each participant). Each trial concluded when the participant was able to stay at or just behind the designated target by 10mm for 2 seconds. The participant was deemed unable to complete a trial if they exceeded a timeout period of 2 minutes. Participants were told under what conditions the trial would conclude but were not given any other instructions as to how they should move. There was a 1-minute break between each trial, with all three trials being completed in a single session.

Results

From the user study, it was observed that XX% of participants were able to reach the target values before the timeout period. The mean duration for the 150, 250, and 350mm targets for all participants were XX ± XX, YY ± YY, ZZ ± ZZ (mean ± SD) seconds, respectively, as shown in figure X below. Figure Y shows a plot of the typical depth trajectory over time for a single trial.

Figure Time duration VS Target value

Figure Trajectory VS Time