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Poster

Comparative Evaluation of Sensor Devices for Micro-Gestures

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Abstract

This paper presents a comparative evaluation of two hand gesture recognition sensors and their ability to detect small, sub millimeter movement. We explore the capabilities of these devices by testing if users can reliably use the sensors to select a simple user interface element in 1D space using three distinct gestures a small movement of the thumb and forefinger representing a slider, the slightly larger movement of moving a finger up and down and a large gesture of moving the whole hand up and down. Results of our preliminary study reveal that the palm provides the fastest and most reliable input. While not conclusive, data from our initial study indicates that the Leap sensor provides lower error, difficulty and fatigue than the Soli sensor with our test gesture set.

CCS Concepts
•***Human-centered computing*** → ***Gestural input;***

1. Introduction

Over the last few years gesture control has steadily gained momentum as a new method of controlling computers with-out the need of large interface devices. This paper focuses on the field of micro-gestures, small sub millimeter movements [WNRM11] that greatly improve the fidelity of gesture control but require fine-tuned sensors to be able to accurately reflect the intended movement.

The two devices that we have compared are the Leap Motion [Lea] and Google Soli [Goo], each device relies on a different method of gesture recognition. The Leap Motion is a camera based, low processing power device that gives accurate depth and distance tracking, allowing for sub millimeter accuracy [GJP*14] and low latency. The Google Soli is the world's first radar based gesture control sensor. It contains small millimeter-wave radar chip that can detect very fine gestures with fingers and hands with a high refresh rate (1000 Hz) and very low latency [LGK*16].

To evaluate the sensitivity of these devices for a 1D selection task, we ran a small user study with 6 participants. The goal of each trial was to select a randomly selected target using a slider controlled by one of three gestures used with each device. Results show that overall the Leap sensor provides better stability, faster selection and fewer errors with our test gesture set. For both sensors, a palm gesture provides better control than finger or thumb-slider.

2. User Study

We conducted a within-participants study with two variables: gesture and device. The three gestures are Palm, Finger and Slider, (Figure 1), with motion orthogonal to the sensor surface. The Palm gesture requires users to simply move their palm closer to the device and further away, while the Finger gesture requires moving the index finger up and down, and finally the Slider uses the thumb against the side of the forefinger to imitate a slider.

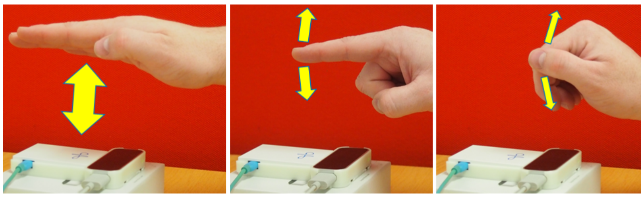

Figure 1: *Palm, Finger and Slider 1D micro-gestures provide different sensing challenges.*

Each gesture type presents a respective increase in the degree of challenge for obtaining motion accuracy. For example, the Palm provides a large sensing mass, with the largest range of motion of approximately 7 cm, while the Finger is smaller, with a shorter range of motion of about 5 cm. The Slider gesture uses the thumb placed against the side of the finger, which obfuscates the sensor readings and further limits the range of motion to about 4 cm. The intention was to highlight each device's ability to be successful with different hand configurations and movement ranges. Each study participant advanced through five sets of five selection trials for each pair of gesture and device, making six combinations overall. To mitigate learning effects, we balanced the order of the gesture and the device.

Each run of the user study was identical other than the participant number which informs the program which order the gestures are

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done. Participants were able to practice on a training set until fully comfortable in the gesture and the layout of the program before starting the test proper. For each task, the user must use the given gesture to increase or decrease the slider until it is under a randomly selected target box, then select it by pressing a key. Any selection made outside of the box is recorded as a *miss*, and anytime the slider goes within the range of the box and then back outside of the range again, it is added to an incrementing count of *overshoots*.

After each gesture-device pair, participants completed a short survey to rate the difficulty and fatigue of the interaction. Participants were asked to repeat the process until all three of the gestures have been used with each device.

3. Results

The results analysis includes task completion time, the number of errors and number of overshoots for each selection. The results for this user study are only preliminary due to the low number of participants, however some interesting results have already started to emerge.

An ANOVA yielded a significant main effect only of technique ($F2,10.00 = 5.721$, $p < .05$) on completion time. The means for each technique are displayed in Figure 2. Post-hoc comparison shows Palm (1810 ms, s.e.= 112) is significantly faster than both Finger (2327 ms, s.e.= 113 $p < .01$) and Slider (2616 ms, s.e.= 113, $p < .01$).

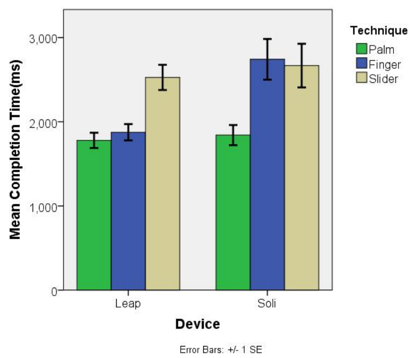

Figure 2: *Hand, finger and thumb slider 1D micro-gestures provide different sensing challenges.*

The mean number of misses and overshoots are summarized in Figure 3. While some differences are apparent in the charts, no significant effects were currently found.

Questionnaire results on perceived difficulty and fatigue are summarized in Figure 4. Again, there appear to be some emerging differences, however, these are not significant.

4. Conclusion

We conducted a user study that compared the performance of Leap and Soli sensors on three hand and finger micro-gestures on a 1D target selection task. Results from our small initial study show the larger Palm gesture allows fastest selection with both devices. No

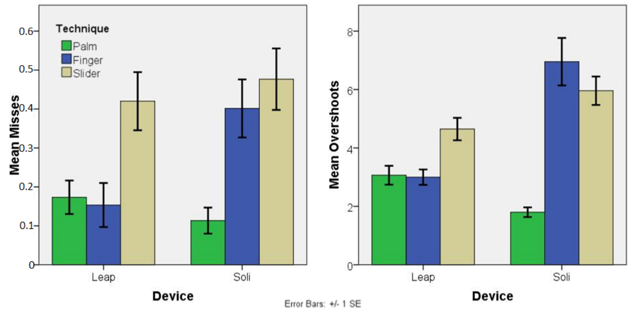

Figure 3: *Mean number of misses and overshoots per trial for each device and technique.*

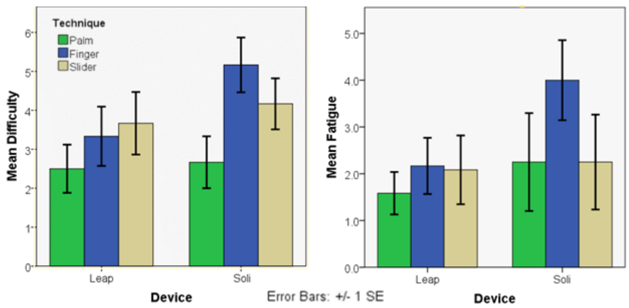

Figure 4: *Mean scores for difficulty and fatigue.*

definite results are revealed between the two devices, however, data appear to show a trend toward lower error rate, difficulty and fatigue with the Leap than the Soli device on our 1D test gesture set.

In ongoing work, we plan to supplement these results with a larger participant sample group. We would also like to investigate more complex gesture types, including those that present additional sensing challenges, such as occlusion of the hands and fingers.

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