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Comparative Evaluation of Sensor Devices for Micro-Gestures

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Abstract

This paper presents a comparative evaluation of two gesture recognition sensors and their ability to detect small, movements known as micro-gestures. In this work we explore the capabilities of these devices by testing if users can reliably use the sensors to select a target using a simple 1D user interface element. We implemented three distinct gestures, including a large gesture of moving the whole hand up and down; a smaller gesture of moving a finger up and down and; and a small movement of the thumb against the forefinger to represent a virtual slider. Demo participants will be able to experience these three gestures with to sensing devices, a Leap Motion and Google Soli.

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 without the need of large interface devices. This paper explores the use of micro-gestures, small sub millimeter movements [WNRM11]. Micro-gestures can greatly improve the fidelity of gesture control but require fine-tuned sensors to be able to accurately reflect the intended movement.

In this demo, we will demonstrate hand and finger micro-gestures with two devices (Figure 1): 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 a 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].

We will present a prototype application that requires users to use one of three different gestures to select a randomly selected target using a selection slider. The three gestures are Palm, Finger and Slider (Figure 2), 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.These gestures were chosen to present a set of different challenges to the sensors. The Palm presents a large, easy target for the sensors, while the Finger presents a smaller, more difficult target. The Slider

Figure 1: *The Google Soli (top) and Leap Motion (bottom) devices can both detect micro-gestures.*

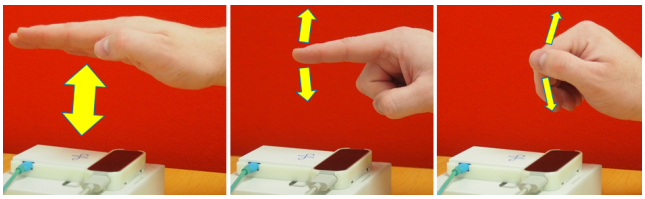

Figure 2: *Hand (left), finger (middle) and thumb (right) slider 1D micro-gestures provide different sensing challenges.*

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requires thumb motion to be differentiated from the other fingers that are also within sensor range.

2. Implementation

The Program (Figure 3) was created in C++ on OSX and was developed using Open Frameworks to create the GUI. It features six possible configurations of gesture and device, with the ordering based on the user's participant number. When mapping data from the devices to the range of the selection slider, each of the six possible gesture-device combinations had to be custom tuned.

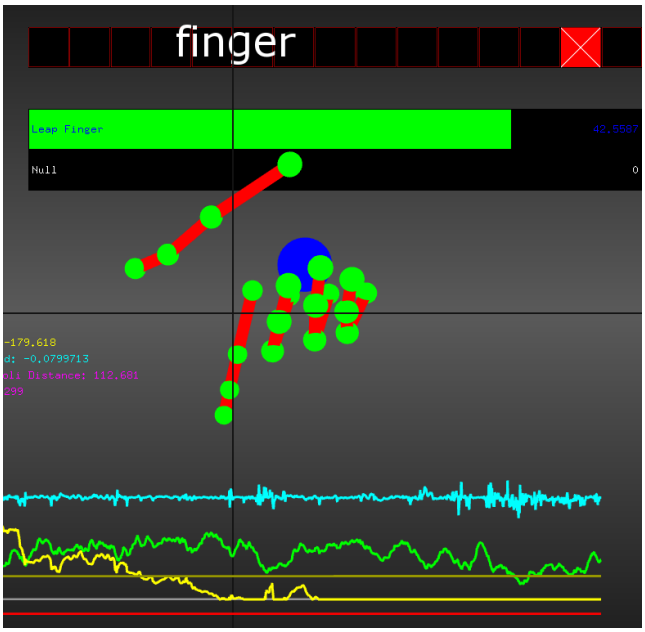

Figure 3: *The user interface, showing the Leap hand skeleton and various data readings from the Soli sensor. The selection slider (green bar at top) is manipulated to select a randomly chosen box (red 'X'). Our demo allows users to experience differences between the sensors and among the three implemented gestures.*

2.1. Leap Sensor

The Leap Motion was the easiest to configure as the sensor kept constant track of the absolute hand position, along with the full hand skeleton. The finger and slider gestures could then be configured relative to the user's hand. For example the palm was simply the y-axis distance from the user's palm to the device, the finger was the y-axis distance of the user's index fingertip, relative to their palm, and the slider was the y-axis distance from the thumb tip relative to the palm.

2.2. Soli Sensor

The Soli sensor doesn't track the absolute position of each individual finger like the Leap. Instead, motion along the y-axis above the sensor surface is detected through the Soli's Fine Displacement feature, which is capable of sensing very small movements. This reading provides relative, not absolute motion, so is passed through a band-pass filter to help stabalize drift and to reduce spikes in the data. Once applied to a selection slider, input is further smoothed with another low-pass filter to reduce noice. The minimum and maximum values of the selection slider were configured to be easily reachable within the range of each gesture.

Because our setup is configured to fine micro-gesture mostions, we were not able to completely eliminate drift of the Fine Displacement value. As a result, the selection slider's value tended to sometimes dip below the minimum set value. To allow users to correct for drift, we implemented a button to reset the slider value, allowing the task to continue from a comfortable position.

2.3. Data Collection

On each attempt made to select a target, data was collected including the time taken to complete or fail the attempt (taken in milliseconds), the number of false selections made, and the number of times the slider entered the range of the target and then left it (recorded as an overshoot). These were all recorded into a spreadsheet to be analysed later.

3. Conclusion

In this demo, we present an interface that allows users to complete a 1D selection task using micro-gestures. Demo participants can experience using three implemented gestures that provide a range of challenges to the sensors. For comparison, these three gestures can be used with two different sub-millimeter-capable sensing devices, a Leap Motion sensor and a Google Soli sensor.

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