A Compliant, Sensorized Finger for a Prosthetic Hand

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***Abstract*— In this paper, we describe the design of a compliant sensorized finger for a prosthetic hand. We designed a flexible printed circuit board that houses three pressure sensors and can easily wrap inside our compliant finger. Our flexible printed circuit board will enable the finger to measure pressure while still being robust to impact from multiple directions.**

I. Introduction

In this paper, we describe the design of a compliant, sensorized finger for a prosthetic hand. This work is an extension of our previous work [1] in which we designed a low-cost prosthetic hand capable of providing touch/pressure sensory feedback. The fingers of the prosthesis were designed to withstand sharp impact forces applied from anterior, posterior, and lateral directions [2]. In order to accommodate the compliance of the joints while still allowing pressure sensing, we designed a flexible printed circuit board that houses three pressure sensors and can wrap around the proximal interphalangeal joint of the finger (Fig. 1).

II. Methods

The finger is able to detect pressure through the use of three MPL3115A2 pressure sensors (Freescale, Austin, TX) mounted on the flexible PCB. We cast the sensors in silicone (Dragon Skin 20, Smooth-On, Macungie, PA) to turn them into sensitive touch sensors, using the method described in [3]. The three sensors are placed over common areas of contact (fingertip, finger pad, and lateral finger) when making power and lateral grasps. The sensors communicate over I^2C, selected using an I^2C multiplexer (TCA9548ARGER, Texas Instruments, Dallas, TX). The I^2C multiplexer interfaces with a Teensy 3.1 microcontroller (PJRC, Sherwood, OR), which processes the data. To correct for drift and hysteresis, a reference baseline is established at the beginning of the pressure recording. The mean and standard deviation of the first ten pressure measurements establish the initial baseline parameters. A time-domain filter is applied to subsequent measurements that resets the baseline to zero whenever the mean of ten pressure measurements is within 5% of that of the previous baseline and the standard deviation is within 1.5 times that of the previous baseline.

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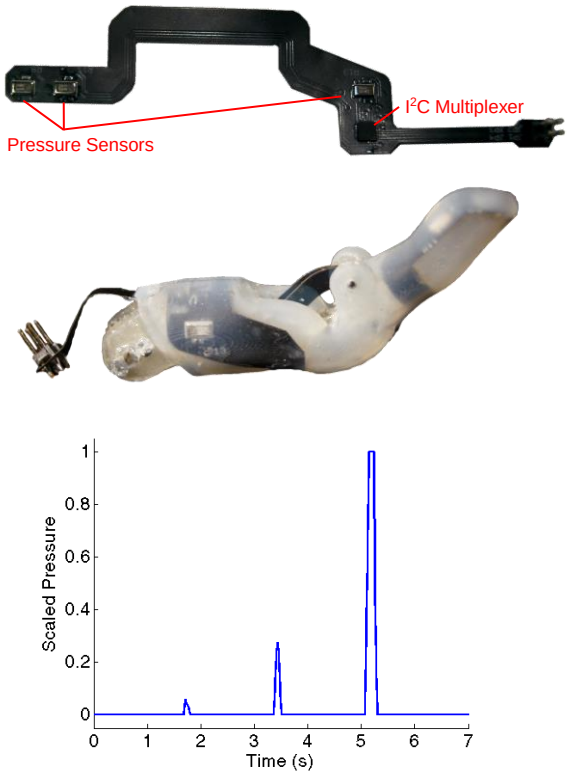

Figure 1. Pressure sensors and I^2C multiplexer mounted on a flexible printed circuit board (top) embedded into a compliant finger (middle). The bottom image shows a plot of the pressure after applying a light, medium, and hard touch.

III. Results

Figure 1 (bottom) shows a plot of the pressure after applying a very light touch, followed by a medium touch, and finally a hard touch that saturates the sensor. Similar measurements were obtained for all three sensors, giving our device the ability to measure fingertip, fingerpad, and lateral contact forces in a robust form factor that should be able to withstand impact from multiple directions.

References

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