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ElectroRing: Subtle Pinch and Touch Detection with a Ring

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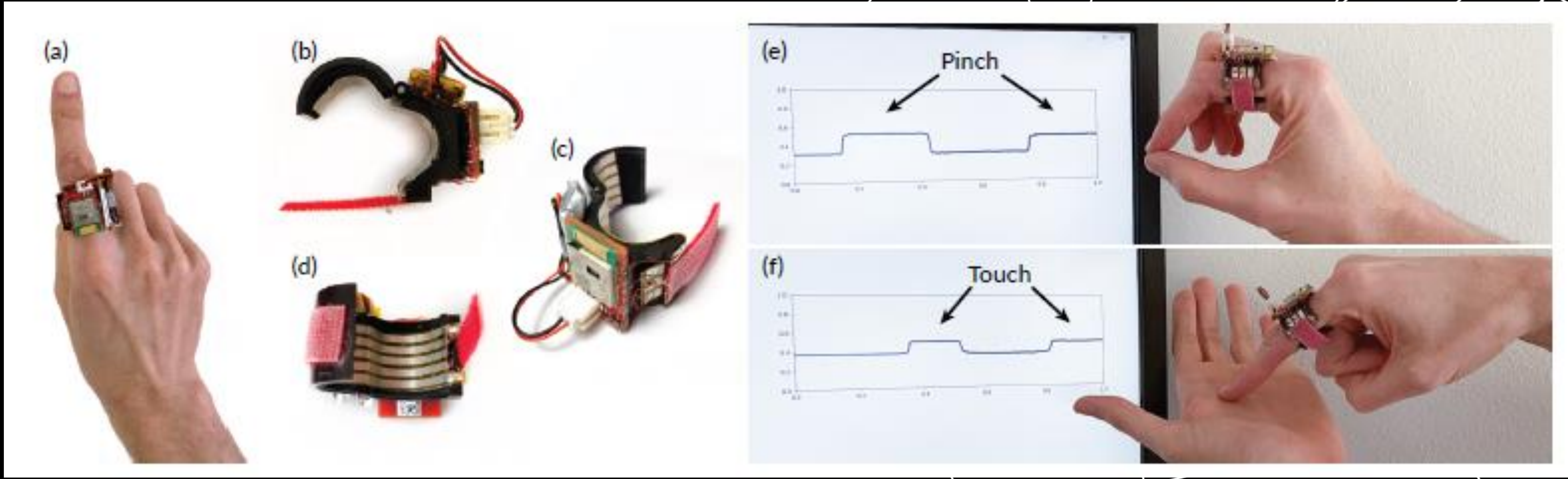


ElectroRing is implemented on a custom PCB that measures 27 mm by 17 mm. It is powered by a small 407 mW h lithium polymer battery afxed to the side of the ring. Overall, the sys-tem consumes approximately 220 mW of power (for a lifetime of 1-2 hours).

KEYWORD

smart ring

touch detection

mixed-reality

ABSTRACT -- ELECTRORING展示了

一種可穿戴的基於指環的輸入設備，可靠地檢測到細微手指捏合的開始和釋放，更一般地說，指尖與用戶皮膚的接觸。

解決了無處不在的觸摸界面中的一個常見問題，微妙的觸摸手勢幾乎沒有運動或力量可穿戴式相機或 IMU 無法檢測到。

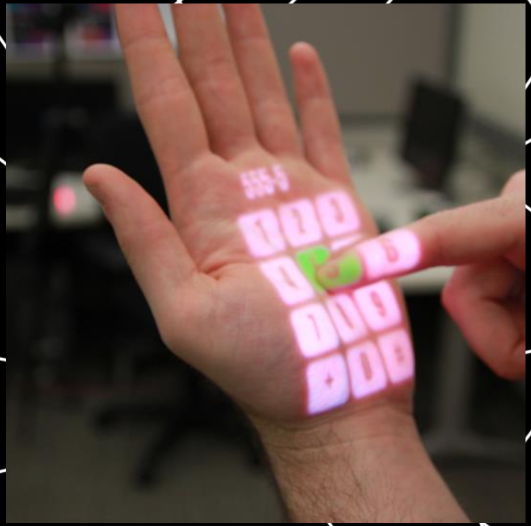
活躍電氣傳感方法提供了類似階梯函數的變化在原始信號中，對於觸摸和釋放事件，可以是僅使用基本的信號處理技術即可輕鬆檢測到。 尤其，

不需要第二個儀器點，但是只有環本身，這使它與現有的電子觸摸區分開來檢測方法。 我們構建了三個演示應用程序來突出顯示結合簡單的方法時，我們的方法的有效性基於 IMU 的 2D 跟踪系統。

INTRODUCTION

用戶移動性的提高需要新的與計算機交互的方式超越觸摸屏、鼠標和鍵盤。一個有希望的策略是使用戶的皮膚適合觸摸輸入[16,17,52]。

例如，在增強現實 (AR) 應用程序中，用戶可以按下他們張開的手掌或前臂上的虛擬按鈕。除了始終可用，作為輸入表面的皮膚提供了觸覺和本體感受反饋，它可以提供額外的代理感。不幸的是，這種方法的有效性取決於強大的、低延遲的觸摸檢測，這是具有挑戰性的使用可以佩戴的小型、不顯眼的傳感器來實現一天而不妨礙用戶[52]。

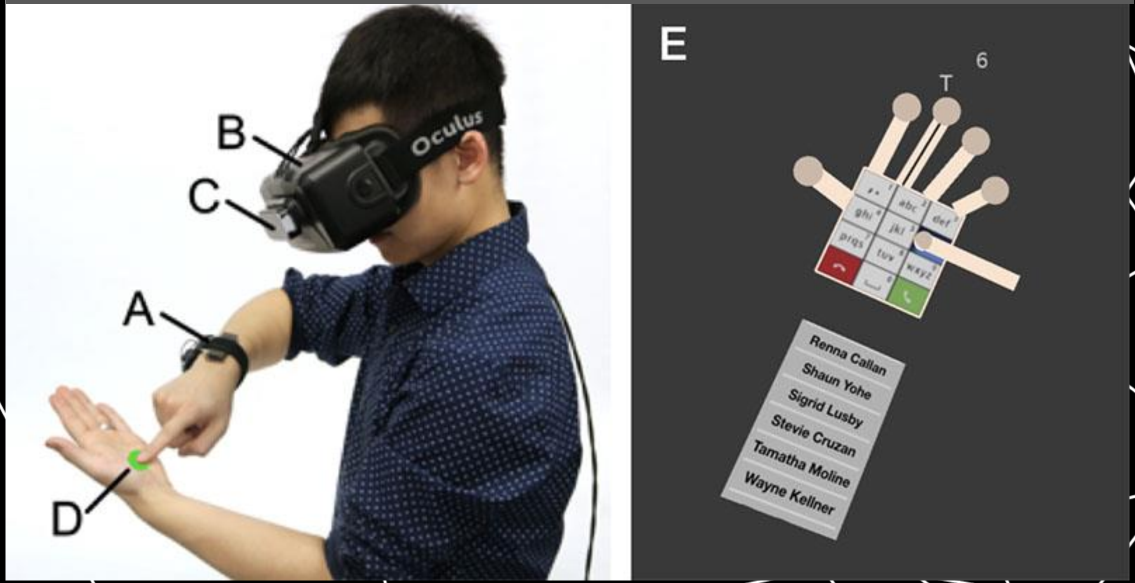


在這裡，我們展示了 ElectroRing，一種始終可用的、可穿戴輸入設備，用於在用戶的觸摸屏上進行接觸檢測皮膚。

ElectroRing 使用有源電感應方法，類似到 [52, 55]。與相機或 IMU 相比（慣性測量單位），這種電氣方法的優點是提供了一個觸摸和傳感器輸出的階躍函數變化釋放，即使是微妙的手勢。

因為ElectroRing 專注於檢測觸摸的精確時刻，而不是什麼或在哪裡!

ActiTouch: Robust Touch Detection for On-Skin AR/VR Interfaces



[52, 55]

*Inertial Measurement Unit –IMU慣性測量單元

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RELATED WORK

以自我為中心的相機是無處不在的觸摸輸入的有吸引力的解決方案，因為它有可能在一個設備中解決觸摸分割和触摸定位。商品深度相機的普及，例如 MICROSOFT KINECT，使這個問題變得更加容易處理

Microsoft Kinect v2 sensor.

MRTouch [45] 使用 Microsoft HoloLens 中的深度感應系統改進了這項工作，但仍然存在近距離觸摸模糊的問題

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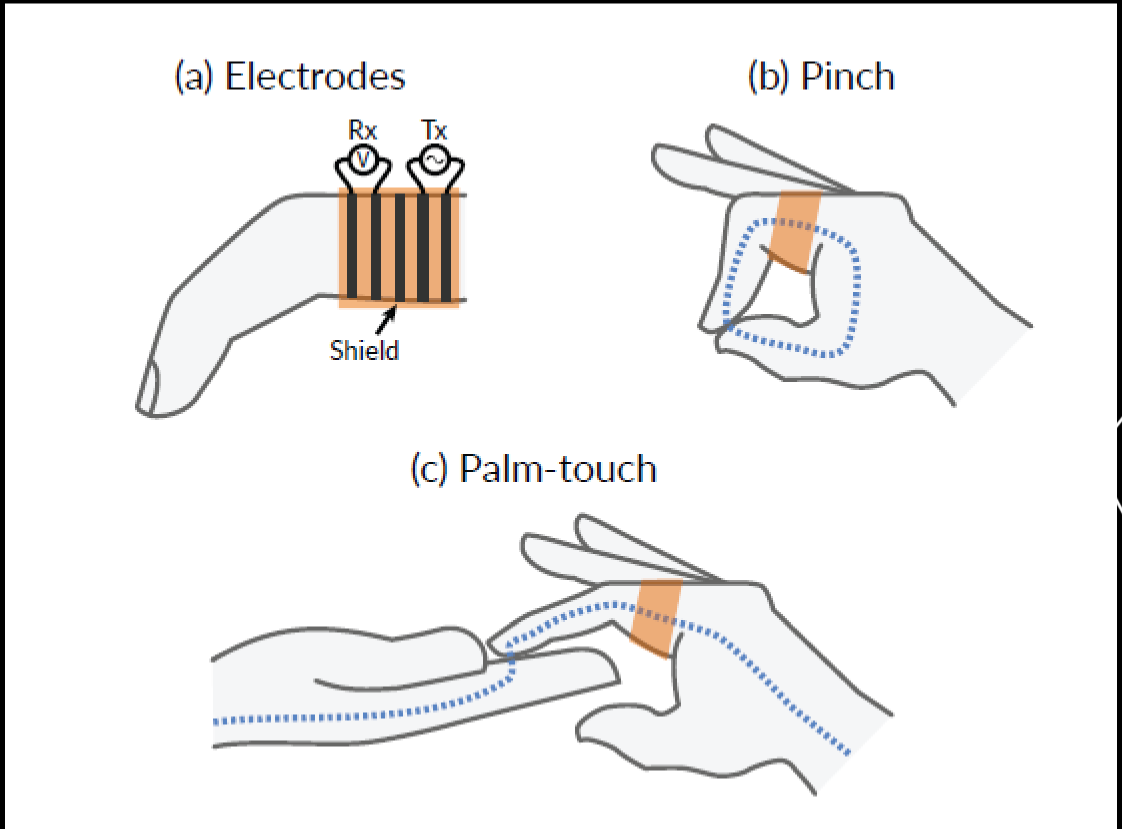
Design / Implementation

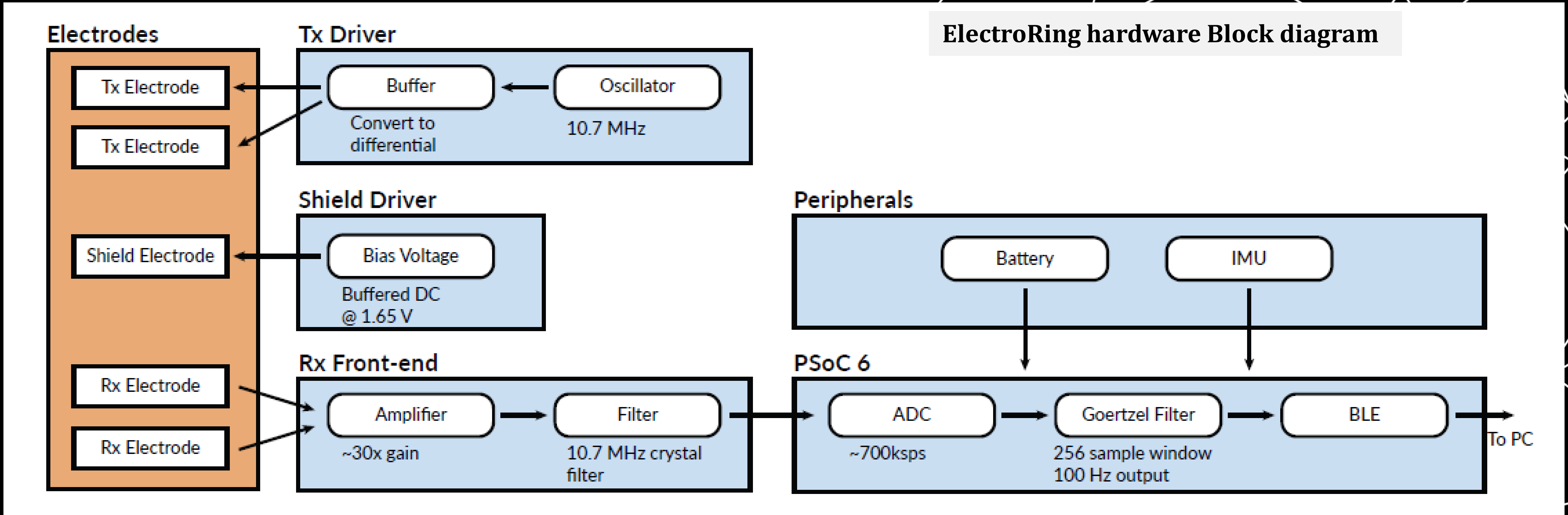


(a) ElectroRing uses 5 electrodes: 2 transmit electrodes (closest to the palm) diferentially couple the AC signal to the finger, the middle electrode shields direct coupling between the Tx and Rx electrodes, two receive electrodes (distal) measure the gradient of the signal along the finger.

(B) DURING A PINCH, THE SIGNAL TRAVELS THROUGH THE THUMB AND GALVANICALLY BACK TO THE TRANSMIT ELECTRODE.

(C) TOUCHING THE OPPOSING PALM CREATES A GALVANIC PATH THROUGH THE BODY BACK TO THE PROXIMAL TRANSMIT ELECTRODE.

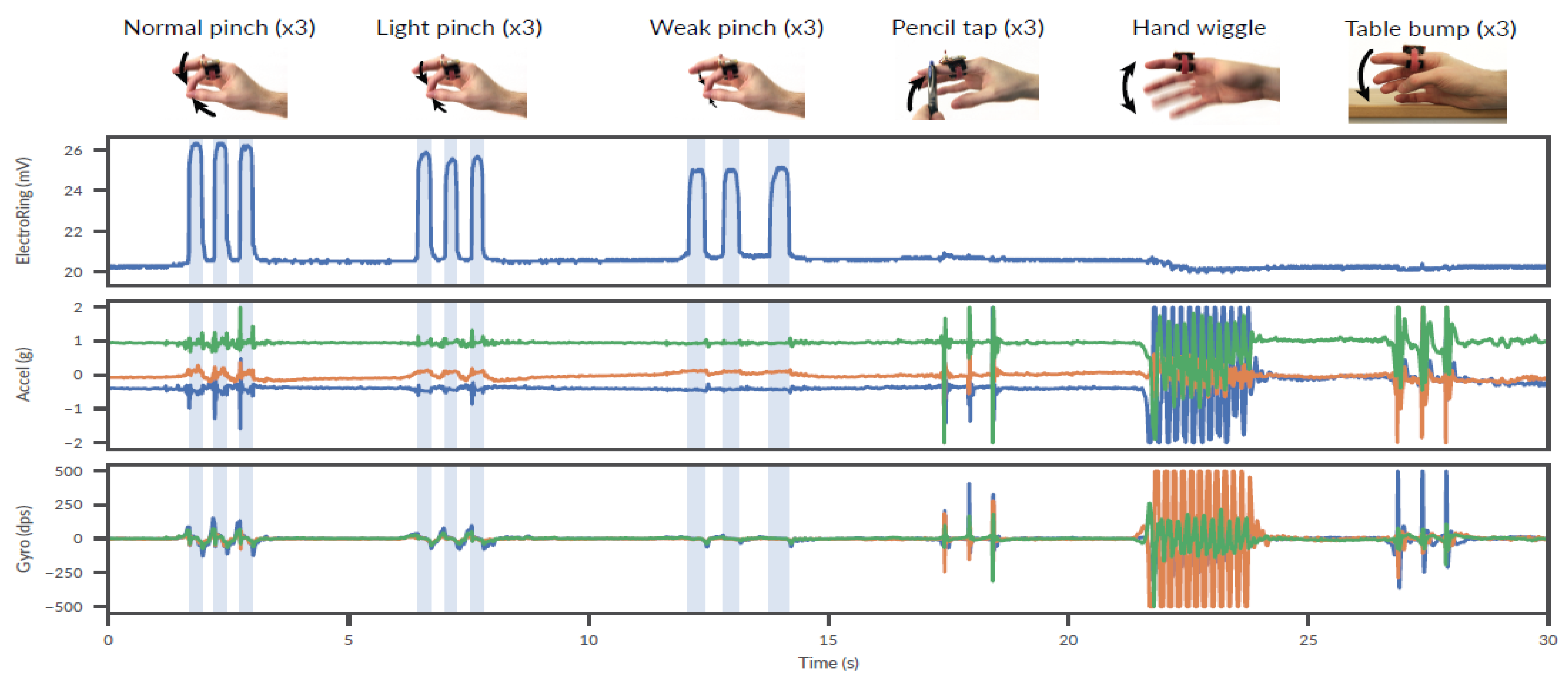
Design: **ElectroRing hardware Block diagram**



The transmit driver buffers a 10.7 MHz signal and applies it to the two transmit electrodes.
A shield driver holds the shield electrode at a DC voltage.

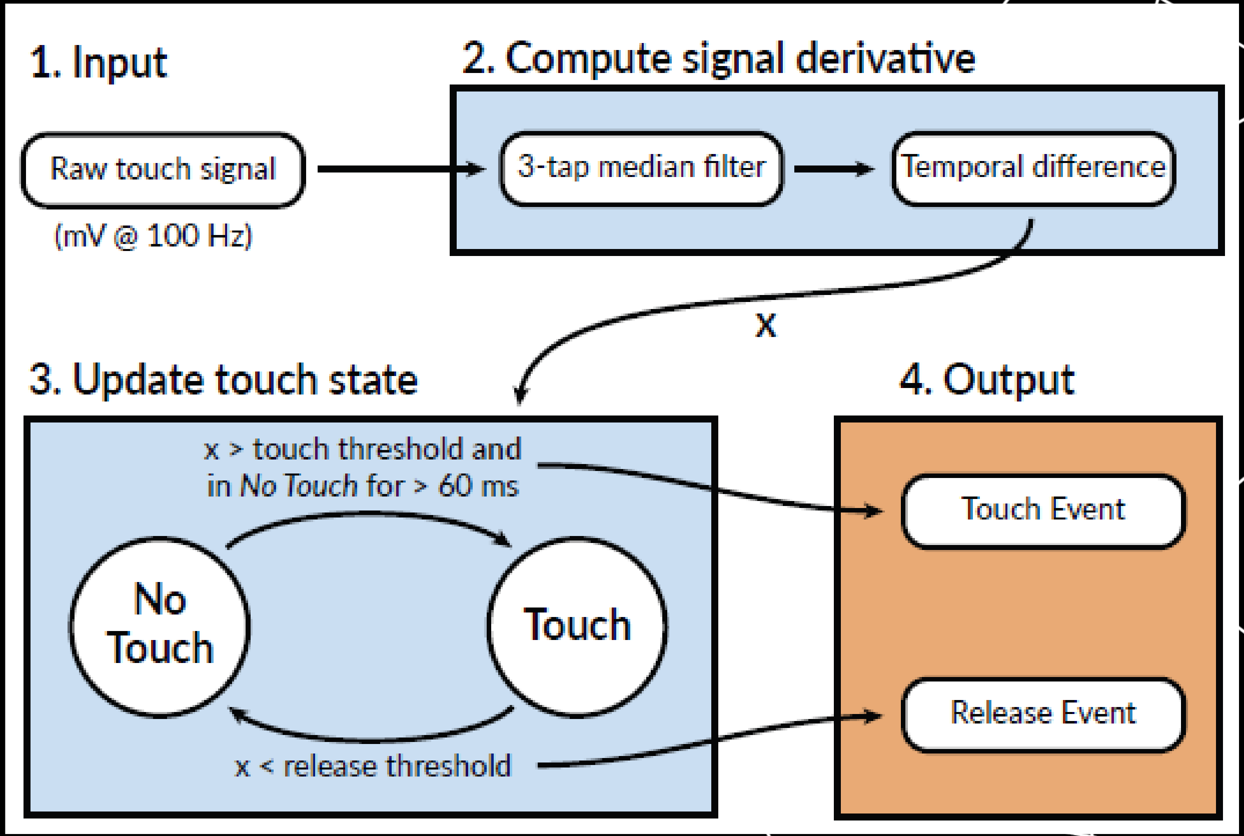
The receive front-end amplifes and flters the signal, which is sampled by an ADC on the PSoC.
The PSoC applies a Goertzel flter and streams the values to a PC.

Design: **ElectroRing hardware Block diagram**



Raw touch sensor (top), accelerometer (middle), and gyroscope (bottom) data for 6 different activities: as function of time: normal pinch, light pinch, weak pinch, and three non-touch distractor activities.
Pinch states are shown as shaded vertical bars. Note how subtly the third set of pinches was performed—peak acceleration (middle plot) and angular velocity (bottom plot) during these "weak" pinches are close to noise level.

Design: **ElectroRing Touch Block diagram**



Touch detection pipeline—

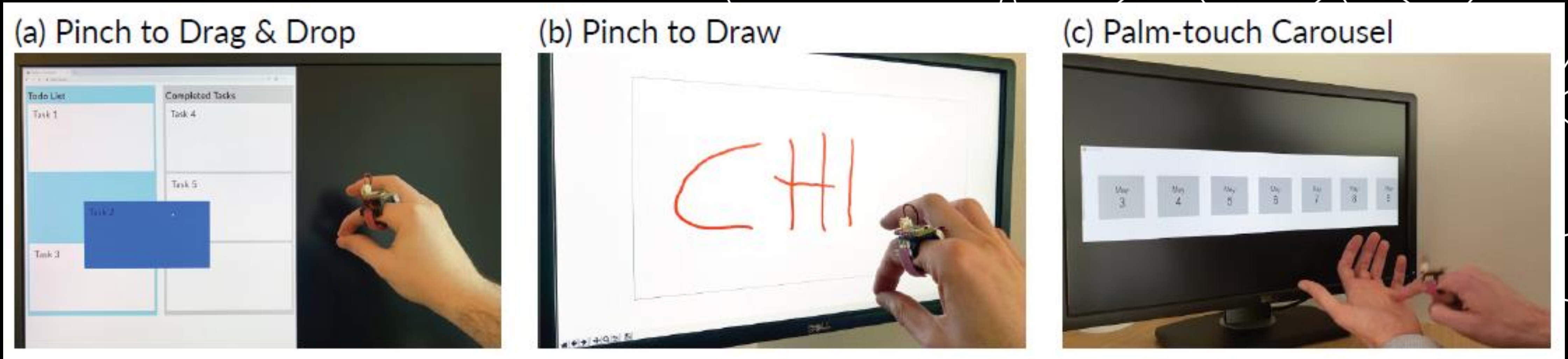
The raw signals from the ElectroRing hardware are filtered and temporal differences are computed.

This signal drives a state machine that detects touch and release events. Simple touch and release thresholds are used to determine state transitions.

ElectroRing’s ability

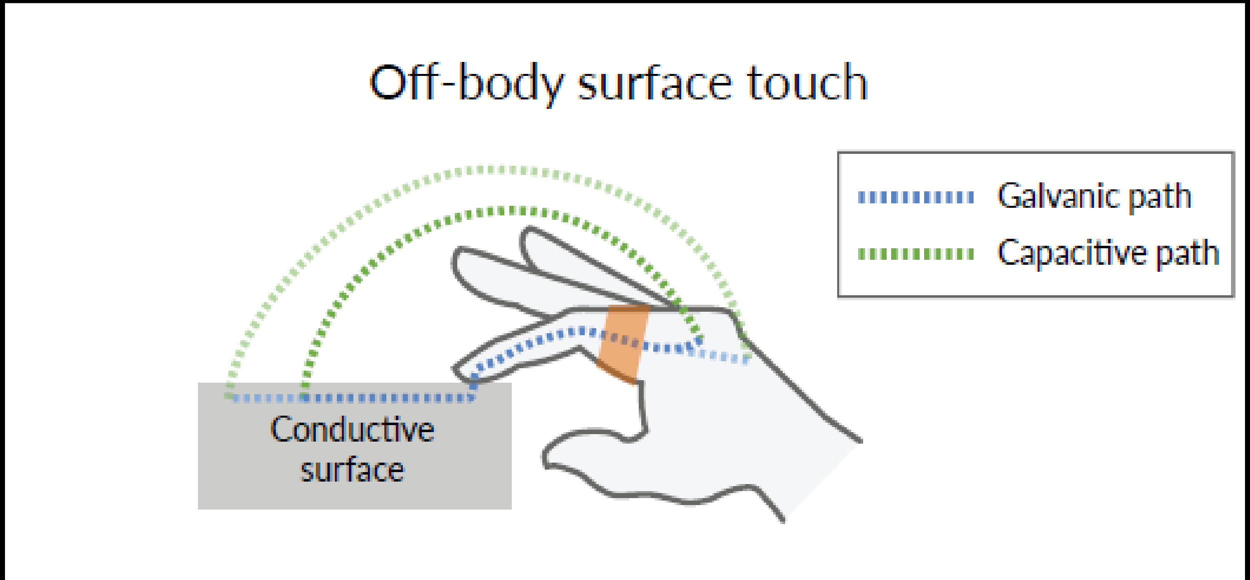
DETECT SUBTLE TOUCH/RELEASE EVENTS WITH PRECISE TIMING ENABLES A NUMBER OF USEFUL APPLICATIONS WHEN COMBINED WITH A POINTING TECHNIQUE SUCH AS AN IMU:

(A) IN-AIR DRAG & DROP USING FNGER PINCHES.
(B) PINCH TO SEGMENT STROKES WHILE DRAWING IN MID-AIR.
(C) CAROUSEL/SLIDER WITH INERTIA CONTROLLED BY TAPS/SWIPES ON THE PALM.



OFF-BODY SURFACE TOUCH

觸摸導電錶面會產生電容基於表面和之間的耦合返迴路徑用戶的身體。



CONNECTION

2nd SKIN (Cindy)

https://duoskin.media.mit.edu/duoskin_iswc16.pdf

Touch & Hold

https://dl.acm.org/doi/fullHtml/10.1145/3411764.3445099