DUO SKIN

Tattoo Lab

Wearable Technology Laboratory (BIOE 494/ CS 491)

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Materials

1. Arduino Bluefruit Feather
2. Protoboard/ Breadboard
3. Micro USB Interface Cable
4. Battery
5. Vinyl
6. Gold Leaf
7. Wire Wounding Wire + Tool
8. Wire Cutter
9. Vinyl Cutter
10. Resistor

Background

Soon, you could potentially command many devices from a simple swipe of a tattoo on your arm. In fact, in this lab we will make that (almost) possible. The Media Lab at MIT created DuoSkin (Figure 1), which is similar to what you will be creating in this lab (http://duoskin.media.mit.edu). Figure 1 displays an implementation of the DuoSkin that allows the user to control a tablet as a directional pad.

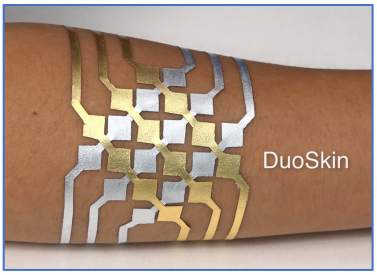

Figure 1:DuoSkin tattoo form the Media Lab at MIT.

In this lab you will be recreating and improving a design similar to the DuoSkin. You could either implement your design on a slap bracelet, or directly using vinyl place it as a tattoo on your skin as shown in Figure 2, note that this implementation could add a lot of noise. Your team will create an end device which is capable of controlling an external device or a computer to perform a variety of tasks, such as: writing text onto a screen, controlling an onscreen mouse, playing/pausing music, opening/closing/ programs, controlling volume with an slider, or anything else that you can think of!

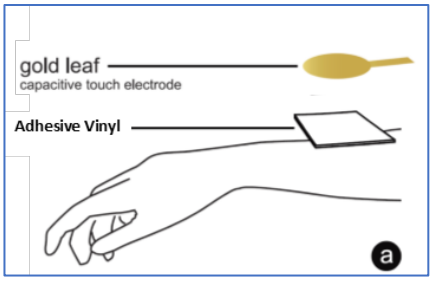

Figure 2: Diagram showing the different layers of the wearable circuit

This lab involves creating a substrate embedded with capacitive sensors that could be used to interface with external devices. Therefore, let's get familiar with capacitive sensors.

Capacitive Sensors

We use capacitive sensors in our everyday life when we use our smartphone's touch sensitive monitor. To measure a touch event on the sensing substrate (capacitive sensor) in this lab we will utilize the Arduino Capacitive Sensing Library. Follow the link below to familiarize yourself with this library:

https://playground.arduino.cc/Main/CapacitiveSensor/

When touching a capacitive sensor, as shown in Figure 3, the total capacitance sensed by the Arduino changes from C_p to $C_p + C_F$, which is attributed to a coupling effect with the conductive finger acting as ground. The change in capacitance in turn changes the charging and discharging Time Constant (!), that is detected by the Arduino module.

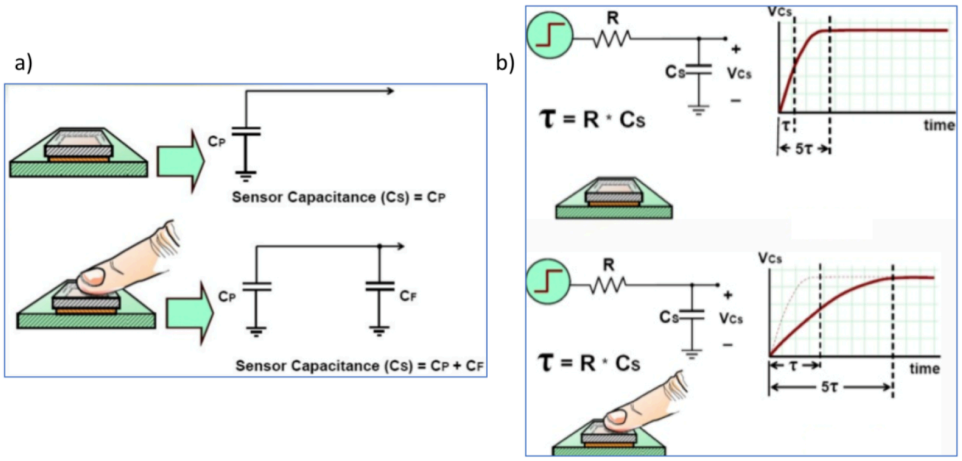

Figure 3: a) The capacitive equivalent of each sensor in the event touch and no-touch. b) The equivalent RC circuit and time constant associated with the touch and no-touch event.

When the electrode makes contact with the finger, the capacitive sensor triggers a change in the feedback value to the Arduino. This change initiates a cascade of events to accomplish the task the coder assigned. For the Adafruit module to be able to sense touch events, one pin of the Adafruit needs to be connected to all of the available touch pads (capacitive sensors). This shared common pin is called the *send pin*. The send pin sends out a constant pulse at a constant frequency that will charge each capacitive touch sensor just like a capacitor. Additionally, a unique connection must be made to each touch sensor; this connection will be called the Receive Pin. The receive pin will read the value from the touch pad and send it to the Arduino, in turn detecting the event of a touch. A 10 Mohm resistor is used to connect each send and receive pin as shown in Figure 4.

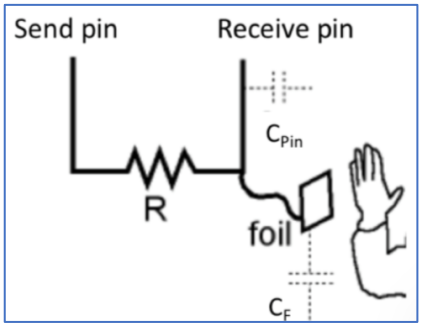

Figure 4: The Send and Receive pin configuration when used in connection with Arduino.

Human Interface Device (HID) commands

In order to utilize the Arduino Capacitive Sensing Library and the Adafruit module to control a smart phone or a computer, Human Interface Device (HID) commands need to be utilized. HID commands are similar to AT commands in which they allow the user to control the Adafruit module. In theory, you could connect your Adafruit module to a smart phone or a computer and use HID commands to emulate the mouse or the keyboard. The HID standard was created to allow quick pairing of various devices to a computer such as a mouse and a keyboard. The HID commands allow your capacitance-sensitive device alongside with the Adafruit to mimic a mouse

or keyboard when paired to a smart phone or a computer. In the Adafruit module tutorial pdf, various AT commands which enact HID protocols are provided:

https://cdn-learn.adafruit.com/downloads/pdf/adafruit-feather-32u4-bluefruit-le.pdf

D – Pad!

Now it is time to put our acquired knowledge to use. Your task is to use the HID protocol and the capacitive touch library to create a directional pad controller. Your group will acquire a substrate upon which to place 4 directional buttons. You could will use copper tape or gold leaf in order to make the directional buttons. To interface with the directional buttons, you could solder pieces of wounding wire to the copper tape. Write a code that would utilize the capacitive touch code and HID protocol code to control the computer mouse in the X and Y plane.

Your idea!

What else can you think of that you could use the D-Pad for, try to implement that application

Module Requirements:

You will be graded on:

- A working prototype at the end of the module which your group will present.
- A well organized and scientifically composed presentation in which you present the required presentation elements.
- Your presentation includes all required graphs and visuals with accompanying interpretations of results.
- All team members are knowledgeable and able to build and use the circuit and accompanying GUI system. Everyone needs to present a section of the work.
- Your creativity in representing implementing your idea and presenting your data.