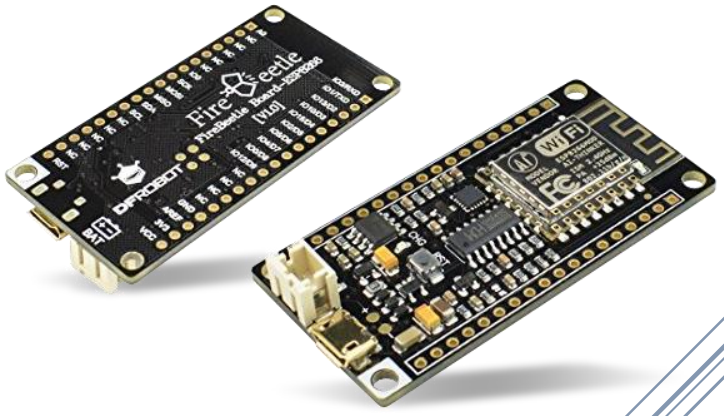
INTERACTIVE SKIN INTERFACE

Smart Tattoo Lab



Wearable Technology Laboratory (BME/CS 479)

Spring 2022 – Lab 4

Materials:

1. Vinyl
2. Copper Tape
3. MPR 121 Breakout Board

Background:

Our goal in this lab is to build a Smart Tattoo that would allow us to control external devices. Imagine, commanding devices from a simple swipe of a tattoo on your arm. The Media Lab at MIT has created DuoSkin as shown in Figure 1. This implementation of the DuoSkin allows the user to control a tablet as a directional pad. In this lab, you will be creating a design similar to the DuoSkin. In order to achieve this goal, we will create a Smart Tattoo embedded with capacitive sensors that could be used for interfacing with external devices. Hence, let's get familiar with capacitive sensors.

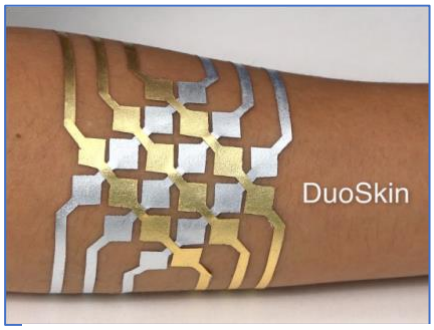


Figure 1: DuoSkin smart tattoo interface created by the MIT Media Lab

Capacitive Sensors

We use capacitive sensors every time we swipe on a touchpad or use a smartphone's screen. Capacitive sensing is based on capacitive coupling, and it can be detected by a medium that has a conductive or dielectric difference from the air. In order to detect the touch events, in this lab, we use the MPR 121 board. When touching a capacitive sensor (electrode), in Figure 2, the total capacitance sensed by the board changes from C_p to $C_p + C_F$, which is attributed to a coupling effect with the conductive finger that acts as ground. The change in capacitance in turn changes the charging and discharging Time Constant detected by the board. When the finger contacts the electrode, the capacitive sensor triggers a change hence detecting the touch event.

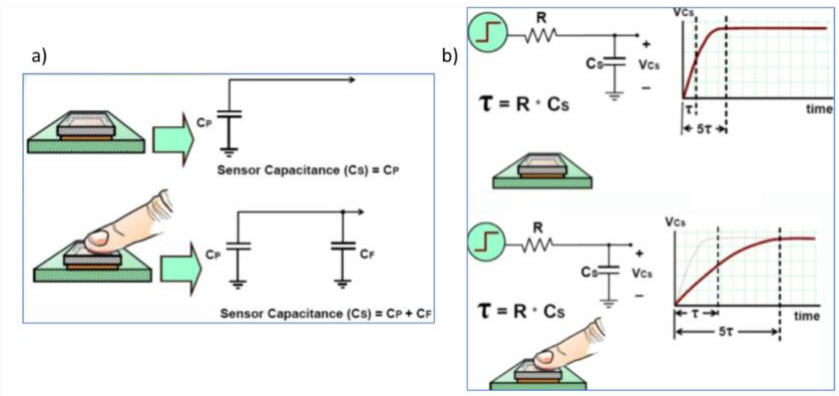


Figure 2: a) The capacitive equivalent of each sensor in the events of touch and no-touch. b) The equivalent RC circuit and time constant associated with the touch and no-touch event.

MPR 121 Breakout Board

The MPR121 Breakout board has the capability of sensing 12 individual capacitive sensors, 0 through 11. On the restart, the system recalibrates these sensors, therefore, make sure that you are not touching these sensors when powering up the device.

In order to connect the MPR121 Breakout board to the FireBeetle board, we use I2C protocol. Connect the VIN pin to 3.3V, GND pin to ground, SDA pin to SDA/data line, and SCL pin to SCL/clock line on FireBeetle.

Follow the following link to download the required library and learn from the example codes:
https://learn.adafruit.com/adafruit-mpr121-12-key-capacitive-touch-sensor-breakout-tutorial

Device Design:

Our goal is to design a smart tattoo capable of interacting with external device such as a computer in order to perform a variety of tasks (playing a game on processing, writing text onto a screen, controlling a slider or anything else that you can think of that is interesting to your team).

Step I: we will first create and test a simple version of the smart tattoo and familiarize ourselves with the cap-sensing board. At this step do not attach the tattoo to the skin. Create a simple version of the Smart Tattoo, that consists of copper tape on top of two layers of vinyl that are bigger than the copper tape according to the video. Simply cut out 4 same-size keys of copper tape and arrange them similar to a directional pad. Connect the wires from the electrodes directly to the MPR121 board. Write a code that would allow you to control a game with 4 directional arrows on Processing. After you verify that this step works, connect the tattoo to your skin and repeat the same game.

Step II – Design Your Version Smart Tattoo

Now that you know how to design smart tattoos and how to interact with a computer, what cool application can you come up with? Design a fancy tattoo that you could wear on your skin to achieve this goal. Just a random thought, but can you add electronics like diodes to make your Smart Tattoo even cooler but still safe?

Module Requirements: You will be graded on:

- *This lab is truly based on your creativity and implementation of your idea, so make you give it your best.*
- A working prototype at the end of the module.
- A well organized and scientifically composed presentation. 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.