EECS16A Lab: Touchscreen 3
Capacitive Touchscreens
Electronic Systems

Most systems perform 3 tasks:

✘ Sense (Physical to Electrical)
✘ Process (Signal Conditioning)
✘ Actuate (Electrical to Physical)

- Touchscreen senses a capacitive touch
- Signal Conditioning & Processing
- LED is turned on
Goals: Touch 3

✘ Understand charge-sharing circuit for a capacitive touch sensor
✘ Understand comparators
✘ Build a functioning Touch Pixel
New Tools

Introducing: EECS16A Lab Boosterpack
Capacitive Touchscreen

✗ Exploits capacitive properties of finger/body
✗ Touching the screen changes the capacitance
✗ No moving parts
✗ Multi-touch is possible
✗ More sensitive

How to measure capacitance?
Capacitance and the touchpad

What is a capacitor and how does it work?
Capacitive Touch Sensor

✘ Screen + finger = unknown capacitance
✘ In parallel with known capacitance

Let’s try to figure out a way to detect this increase in capacitance!
Measuring Capacitance

Start by charging our capacitor touch sensor
Measuring Capacitance

Charge-sharing invariant: \( Q = CV \)

- \( Q \) remains constant
- What happens to capacitors in parallel?
Measuring Capacitance

$C_{\text{pixel}}$ is a variable value – may contain our finger or not

- Model finger as another capacitor in parallel with our capacitive touch sensor
- How does the capacitance of what we’re charging change?

$C_{\text{sensor}} = \text{OR}$
Measuring Capacitance: Full Cycle

1. Connect capacitors to ground to discharge fully
Measuring Capacitance: Full Cycle

2. Disconnect clean switch from ground to enable charge storing
Measuring Capacitance: Full Cycle

3. Charge touchscreen ( + finger?)
Measuring Capacitance: Full Cycle

4. Share charge between $C_{\text{pixel}}$ and $C_{\text{fixed}}$
Measuring Capacitance: Full Cycle

\[ C_{\text{pixel}} \]

\[ V_{DD} \]

\[ C_{\text{ref}} \]

\[ C_{\text{ref}}/V_+ \]

Phase 1

Drive Switch

OUT

X

Y

Clean Switch
Process Comparator

Compares input voltage at positive terminal to a reference voltage at negative terminal (think “>” symbol)

Essentially does:
if $V_{in} > V_{ref}$:
    return $V_{dd}$
else:
    return GND = 0V
Full Circuit - Sense Process Actuate
Notes

✘ Unplug MSP before moving circuit components

✘ Op Amp goes across middle of breadboard

✘ Make sure your circuit is grounded and has a common ground

✘ Initial charge sharing diagrams are theoretical--don’t start building right away