Remote and Zoom

Refresh your memory for what you did in Touch 1, either the remote or the in-person version
Last week: Soldering and Breadboarding

- Building the base of the resistive touchscreen
- Resistors in parallel and in series
- Debugging techniques
- Voltage divider intuition
This week: Resistive touchscreen

- Investigate a resistive touchscreen
  - Something that actually was used for a long time!
- Use voltage as a signal to determine position of touch
  - How?
Resistive touchscreen

- Physical touch results in physical contact between top and bottom layers
- Voltage dividers allow us to compute touch location

EX: Nokia N900, Nokia N97 Mini, LG Optimus, LG GW620, Nintendo DS™
Tools for today:

- Power Supply
  - Always set a current limit! (0.1 A)
- Multimeter - measuring device
- Launchpad - measuring device
- Voltage dividers
  - How we will detect location
- Falstad
  - Circuit simulation, has virtual Power Supplies and Multimeters
Touchscreen theory (Note 13/14)

- What’s the voltage at the top?
- What’s the voltage at the bottom?
- Voltage at u2?
Touchscreen theory (Note 13/14)

- Voltage divider:

\[ u_2 = V_S \times \frac{kR_1}{kR_1 + R_1} \]

\[ u_2 = V_S \times \frac{R_1(k)}{R_1(k + 1)} \]

\[ u_2 = V_S \times \frac{k}{k + 1} \]

Independent of the value of R!
Building it up

- What are the voltages at $u_2$ and $u_3$?

  $$u_2 = V_s \cdot \frac{k}{k + 1}$$
  $$u_3 = V_s \cdot \frac{k}{k + 1}$$

- What’s the voltage difference?

The Rs cancel out! All the matters is the proportion between the top and bottom resistors.
In fact, $u_3$ and $u_2$ are at the SAME VOLTAGE.
Building it up

- We know that $u_2 - u_3 = 0$
- How much current goes through $R_3$?

\[ u_2 = V_s \frac{k}{k + 1} \]

\[ u_3 = V_s \frac{k}{k + 1} \]
Building it up

- Add one more resistor divider...
- We get our touchscreen!
Resistive touchscreen - 2 layers

Bottom Layer: Resistive Layer
Resistive touchscreen - 2 layers

Top Layer:
Flexible Resistive Layer
What’s the difference?

- Nothing
  - The ink is a bunch of resistors
    - The resistor values don’t matter because we showed only the proportions matter for this circuit
  - Their circuit diagrams are the same
- One is flexible so we can actually move it to make contact
- We use two so that we can measure with one and apply voltage to the other without changing our circuit
Computing a location

- Measure some voltages, compute location based on value
- Can you find any two horizontal locations that would output the same voltage?
- What about vertical?
Computing a location

- We can only determine vertical position
- What about the other orientation?
  What if we turned it sideways?
Computing a location

- Let’s turn it sideways
  - Apply voltage so we power the horizontal direction
  - Find “vertical” location in horizontal orientation
- This gives horizontal location
Computing a location

- If we take two readings, one in each dimension can uniquely determine our location in 2D
- More on this in the lab notebook
Taking the limit

- 9 touch points is kinda... meh
- How do we get more?
Taking the limit

- Add more resistors!
Taking the limit

- But what if I don’t want to increase the size of the circuit
  - Add more, but make the resistors smaller!
- What happens as the resistors approach infinitely small sizes?
  - Isn’t that just a resistive sheet?
  - This is how all resistive touchscreens work
  - Review lecture note 12, note 13, note 14
Lab Notes

- There are coordinates on the PCB (use them)
- Read carefully for which coordinates you should be connecting the multimeter and the power supply to
  - One wire will be free & 3 wires will be in use
- Have fun learning how to use Falstad!
- Checkoff assignment will be a Quiz on Gradescope
  - ‘Touchscreen 2 Quiz and Checkoff’ assignment
  - Must complete all questions and forms linked to get credit for the lab
  - Must also submit notebook as a PDF
    - Information linked in the Gradescope assignment
- All labs are remote, must complete this to receive credit!