The Physics Behind Touchscreens

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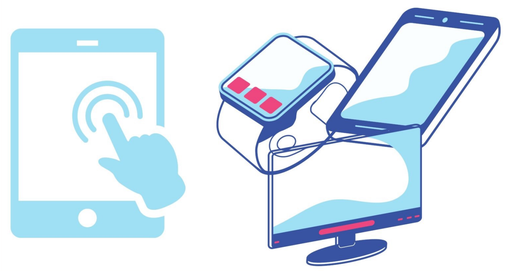

Introduction

- Touchscreens are something most people are familiar with
- Its uses extend beyond smartphones. For example, they are used in grocery stores for self-checkout and in restaurants to self-order
- However, most people are also unaware of how they work
- Overall, there are two main types of touchscreens: resistive and capacitive.

Components of Touchscreens

- There are three essential components to a touchscreen. These are:
- **Touch sensor**: Detects a physical entity as input and converts it to an electrical format (Chepuri, 2014)
  - Three types: resistive, capacitive, surface acoustic
- **Controllers**: Converts analog touch signals to digital touch signals that the computer can understand (Chepuri, 2014)
- **Software Driver**: Software which enables touch system to interact with computer (Chepuri, 2014)

Resistive Touchscreens

- Two layers of resistive flexible sheets which are coated with resistive material
- First layers is called **matrix**, in which striped electrodes on glass face each other
- Second layer is called **analogue**, in which transparent electrodes with no patterning face each other
- When contact is made, two sheets are pressed together and determine the precise location of the touch event
- Input from any object (finger, stylus, pencil, etc.) will generate a touch event (Downs, 2005)

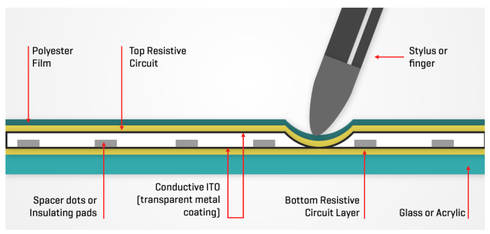

Fig 1: Resistive Touchscreen Diagram

Capacitive Touchscreens

- There is a layer that stores electric charge placed on glass panel of monitor
- When user touches monitor some change is detected in the touch sensor
- Capacitive touchscreens divided into surface-capacitive and projected-capacitive methods (Nam et al., 2021)

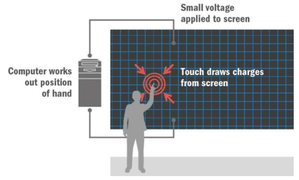

Fig 2: Capacitive Touchscreen Diagram

Surface-Capacitive

- Consists of one conductive layer, in which the four corners are connected to four synchronized AC voltage signals
- Finger touching screen creates current difference in four voltage sources
- Touch locations extracted through ratio of currents over four voltage sources (Nam et al., 2021)

Projected-Capacitive

- Use two patterned conductive layers that are separated
- Detect touch by measuring capacitance at each addressable electrode
- Finger touching electrode alters capacitance
- Change in capacitance converted to XY locations to detect touch (Barrett & Omote, 2010)

Surface Acoustic Wave Touchscreens

- Only requires one wave guide layer
- Consist of two **transducers**, one sending and one receiving, that are placed along x and y axes of monitor's glass plate
- **Reflectors**, also on glass plate, reflect electrical signal sent from one transducer to another
- Receiving transducer able to determine whether wave has been disturbed by touch event at any instant, and locate it accordingly if it has

Comparing Different Touchscreens

Resistive

- ADVANTAGES
  - Able to work with anything
  - Lowest cost
  - Insensitive to contaminants on fingers
  - Does not respond to external stimuli such as water droplets
  - Do not consume much power
- DISADVANTAGES
  - Easy to get scratches
  - Not sensitive, must apply pressure to activate touch event
  - Multi-touch, such as zoom, not supported
  - Extra layers => poor visual appearance (Wang & Jiao, 2022)

Capacitive

- ADVANTAGES
  - Scratch resistant
  - Sensitive to touch => smooth dragging and swiping
  - Multi-touch supported
  - Great visual appearance
- DISADVANTAGES
  - Only work with fingers and specific types of materials
  - More expensive (Wang & Jiao, 2022)

Surface Acoustic Wave

- ADVANTAGES
  - Best visual appearance
  - Sensitive to touch
- DISADVANTAGES
  - Longevity
  - Sensitive to surface contaminants and water (Wang & Jiao, 2022)

Literature Cited

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