Touchscreen Implementation for Multi-Touch

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Touchscreens & Graphical User Interface

- Guiding principles behind GUI
  - Displays relevant information
  - Intuitive technology
- Touchscreen
  - Electronic Display
  - Recognizes presence of user's touch
  - Provides GUI and user control

Touchscreen Technologies

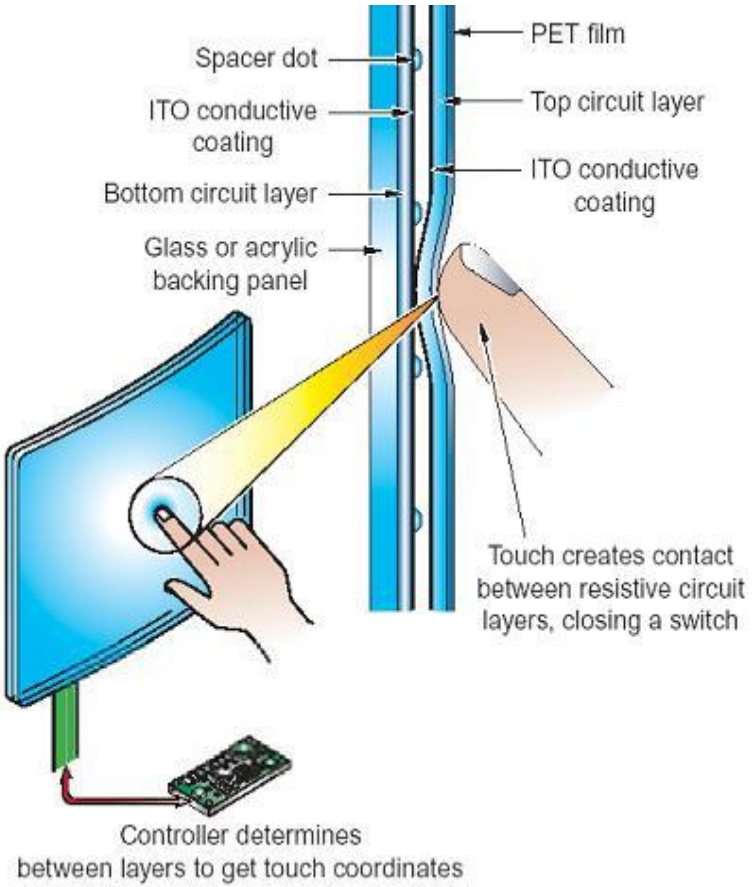
- Resistive
- Capacitive
  - Surface
  - Projected
- Optical imaging
  - Infrared

Resistive Touchscreen

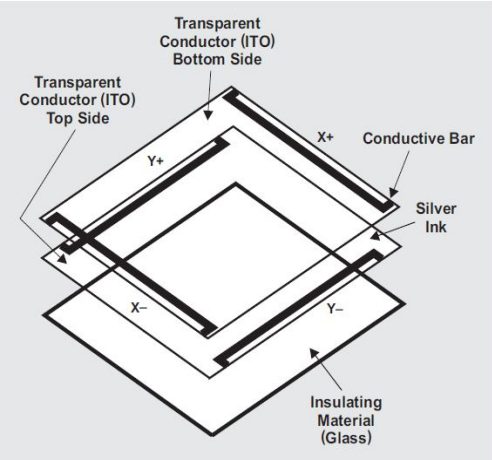
- Composed of multiple layers separated by thin spaces
- Using indium tin oxide (ITO) layers
- Different standards
  - 4, 5, and 8 wire types
  - Each have advantages

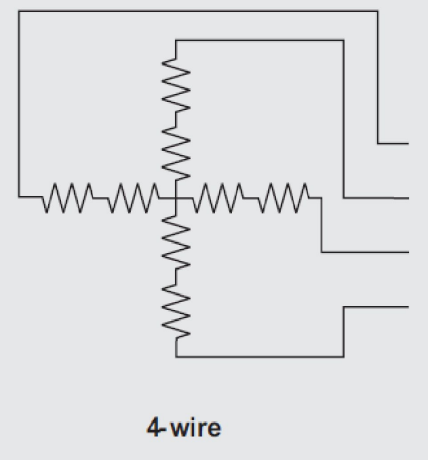
Resistive Touchscreen

- User Presses Down
- Contact is Made
- Uniform Voltage on First Screen for X
- Same on Second screen for Y
- Happens instantaneously



4-Wire design

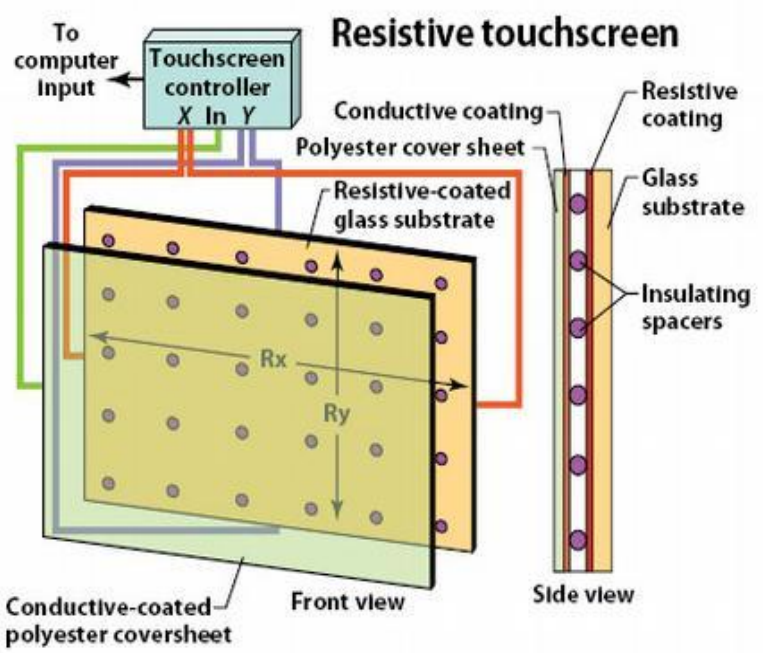




- One screen for X
- Another screen for Y
- Both create voltage gradient.
- Uses voltage divider

Advantages

- Works well with fingertip or stylus input
- Generally most affordable touchscreen technology
- Rugged/Durable
- Has multi-touch input capabilities
  - Stantum
  - Touchco



Disadvantages

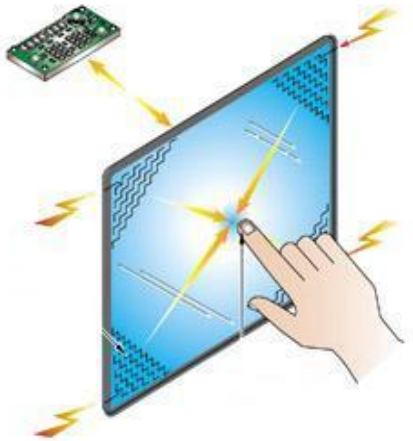
- Not as accurate
- Multi-touch much more complex
- Usually no discretion between stylus and hand
- More pressure needed

Capacitive Touch Technology

- Consists of:
  - Insulator (glass or Air)
  - Conductive coating (ITO)
- Two types:
  - Surface
  - projected

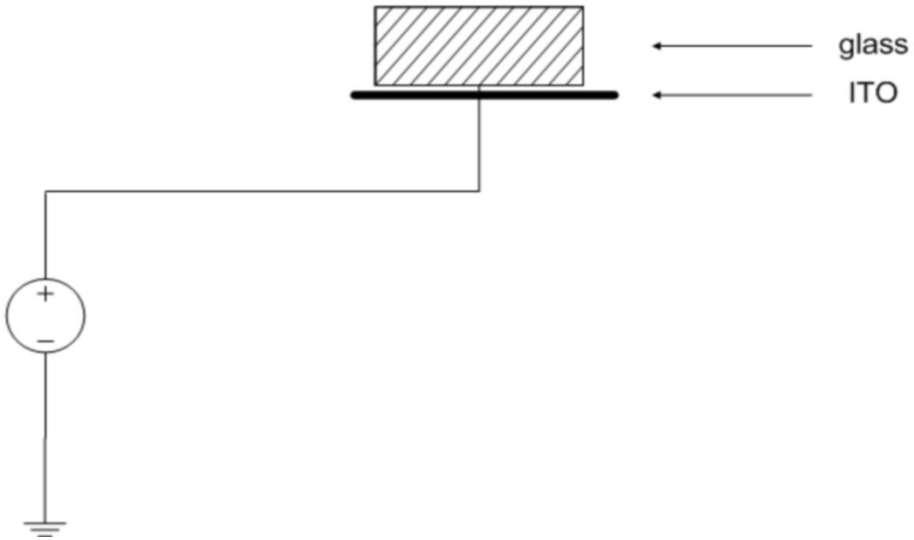
Surface Capacitance

- Only one side is coated
- Electrodes at the edges
  - Distribute voltage



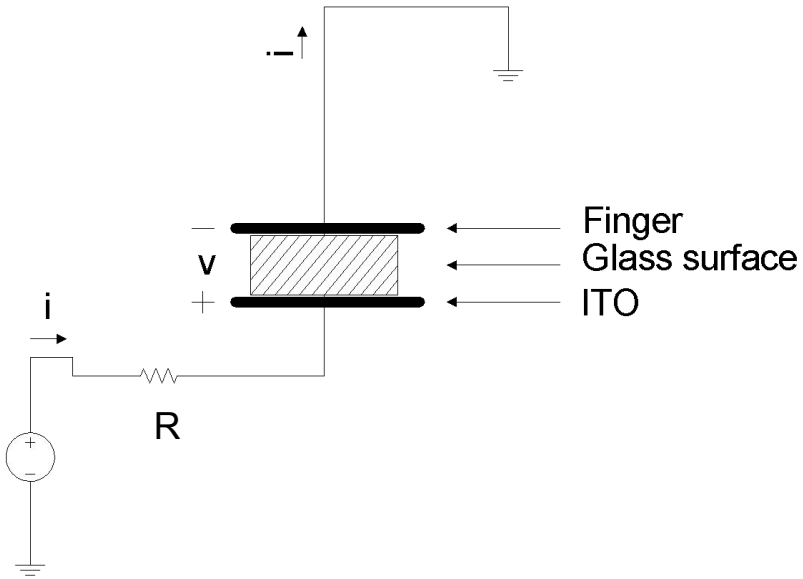
Surface Capacitance Cont.

Before



After

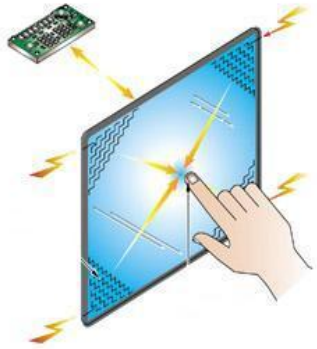
- Capacitor forms
- Current flows



- Determine location
  - Controller
  - Ratio of currents

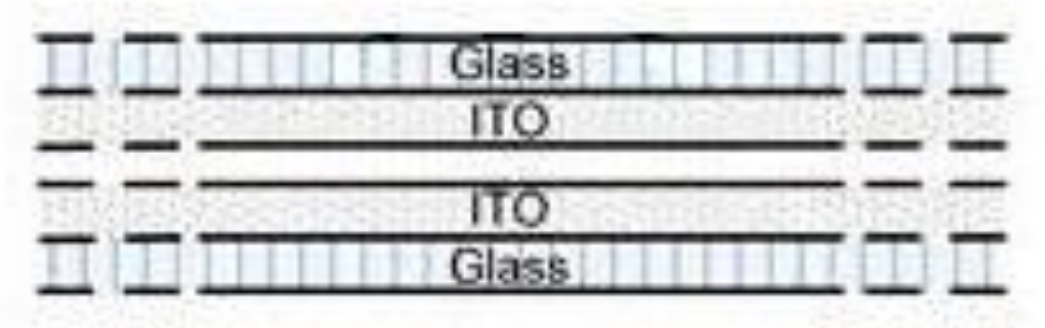
$$R = \frac{\square \times \rho}{A} \quad , \quad i \alpha \frac{1}{\square}$$

  - XY coordinates



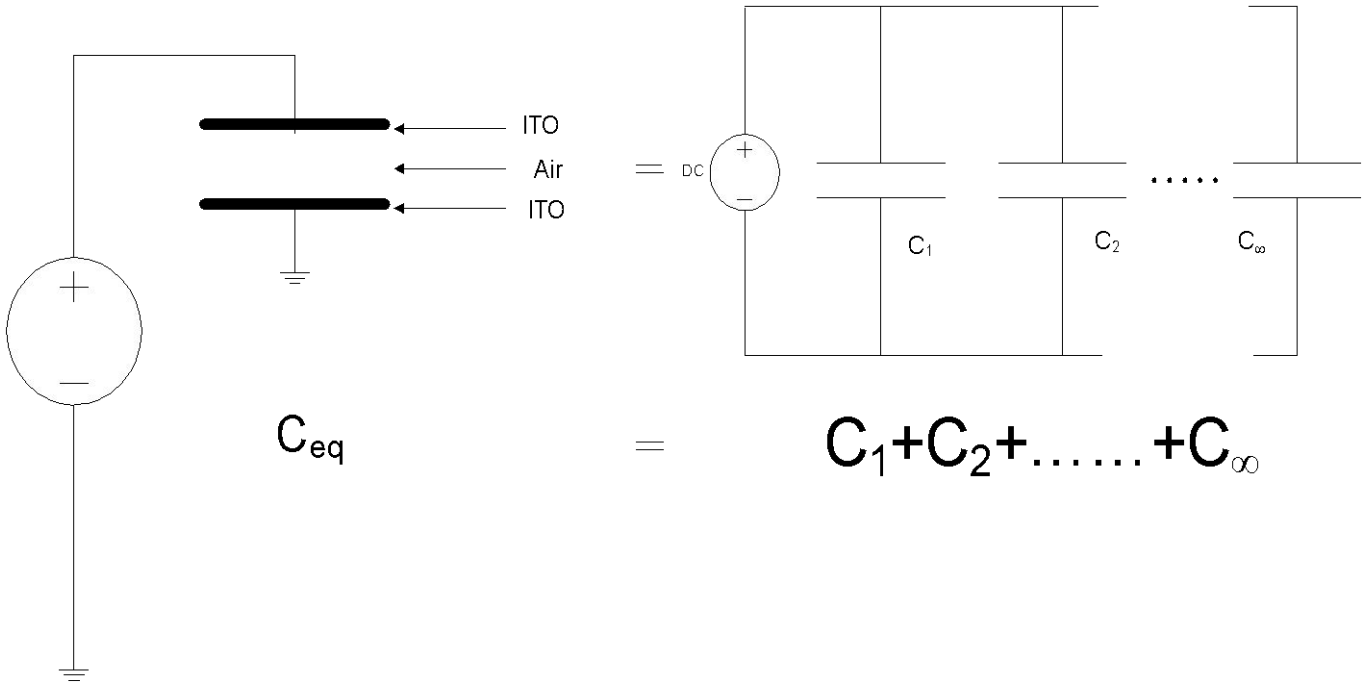
Projected Capacitance

- Two parallel ITO layers
- Two sheets of glass



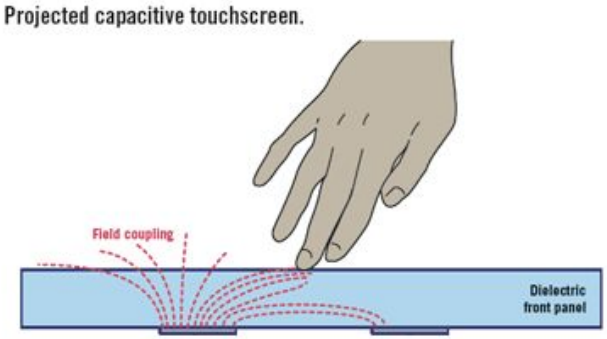
Projected Capacitance

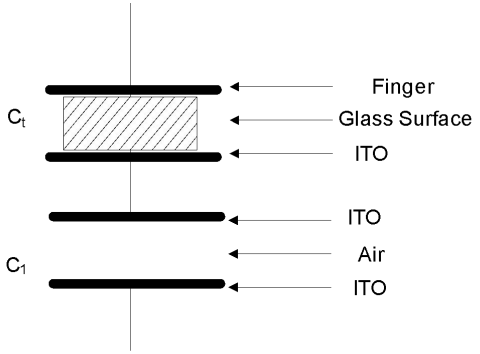
- Capacitor at each point on the surface



Projected Capacitance Cont.

- E Field is projected through glass
- Finger couples with E field
- Capacitance changes





$$C_{new}=(C_1*C_t) / (C_1+C_t)$$

Surface vs. Projected

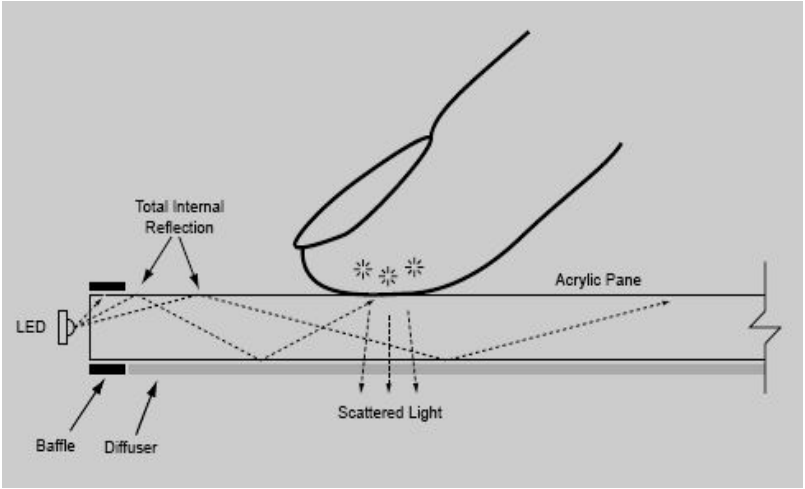
- Limited resolution
- Single touch
- Operation with direct contact

- High resolution
- Multi touch
- Operation with indirect contact

Multi-Touch Using Infrared

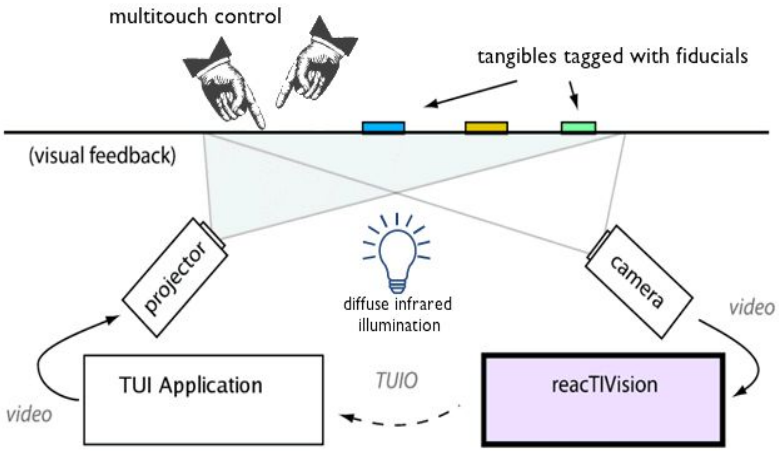
Frustrated Total Internal Reflection

A process by which light is trapped within a medium and can be interrupted by a third medium of higher reflective index to cause light to escape.



http://cs.nyu.edu/~jhan/ftirsense/ftirschematic.gif

Rear Projection

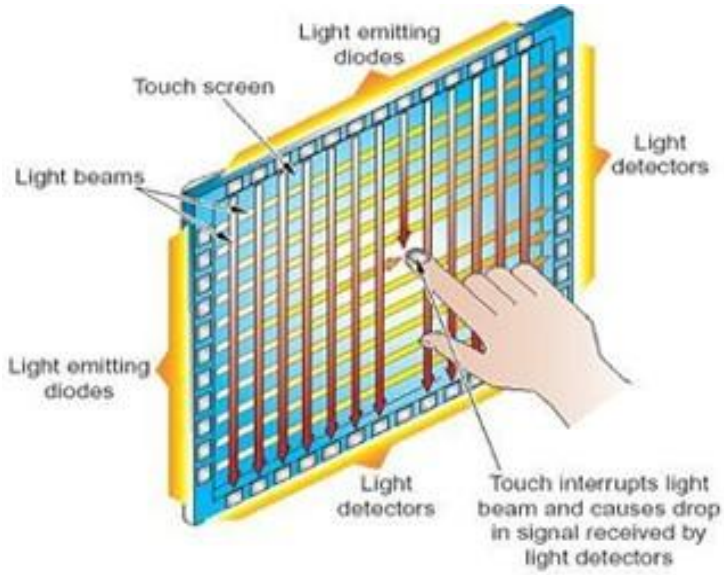


http://reactivision.sourceforge.net/images/reactivision03.png

- Hardware
  - Infrared LED's or lasers with line generator for optical dispersion
  - Glass surface or plexi-glass
  - Infrared Camera
  - Projector
- Cost
- Scalability

Alternative Single-Unit Design

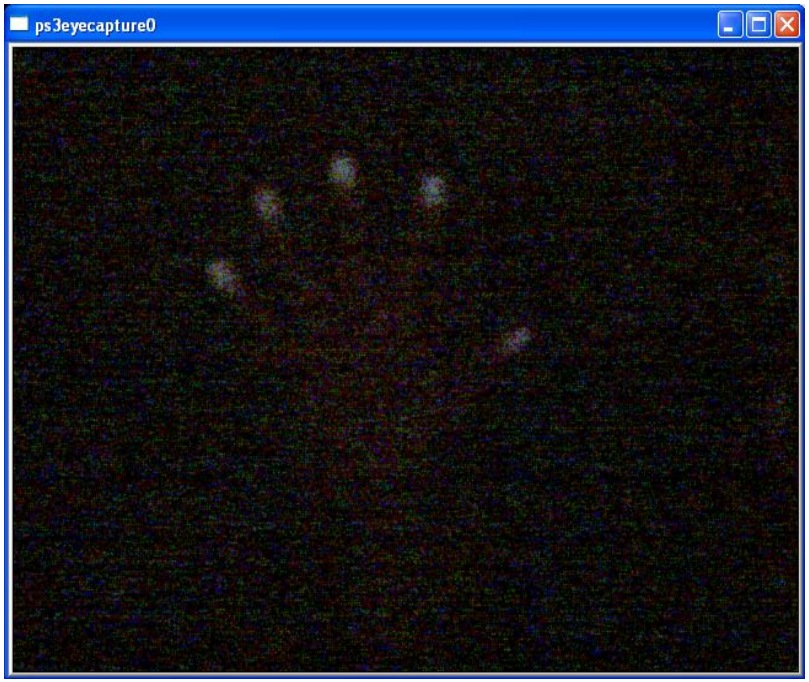
- Eliminates rear projection
- Expensive
- Robustness



http://wiki.fluidproject.org/display/fluid/Benchmarking+-+Touch+Screen+Options

Software

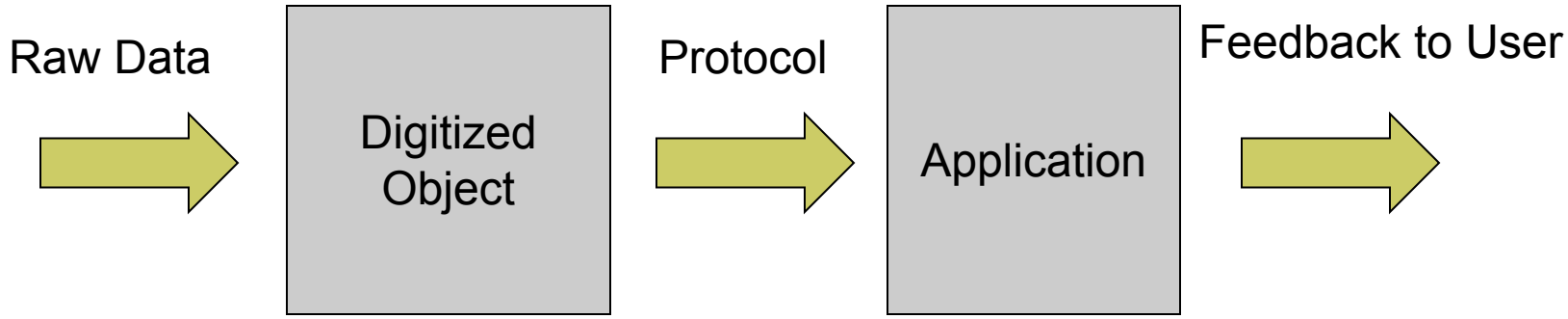
Surface Capture via Detector



Digitized View

Software Cont.

- Interpret and Relay Information
  - Assign Objects or gestures with Unique ID# and location
  - Compare and Execute

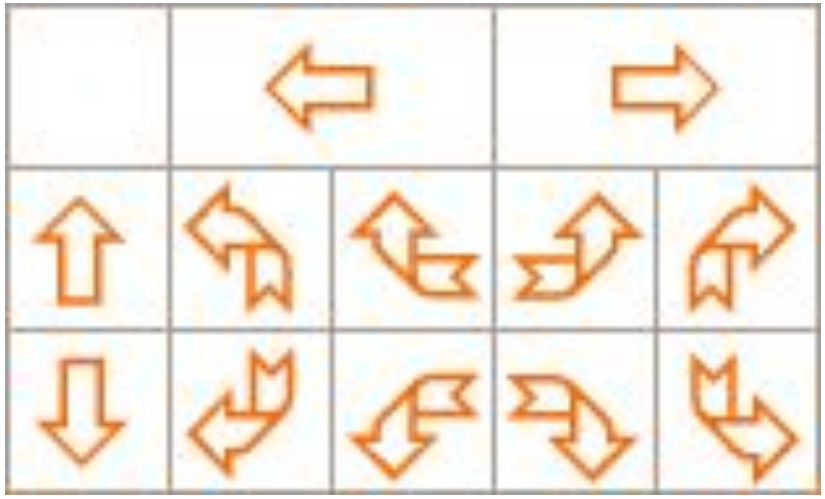


Improving Accessibility?

- Universal Design Principles
  - Utility for all users
  - Simple and intuitive
- Touchscreens depend on visual feedback in order to use

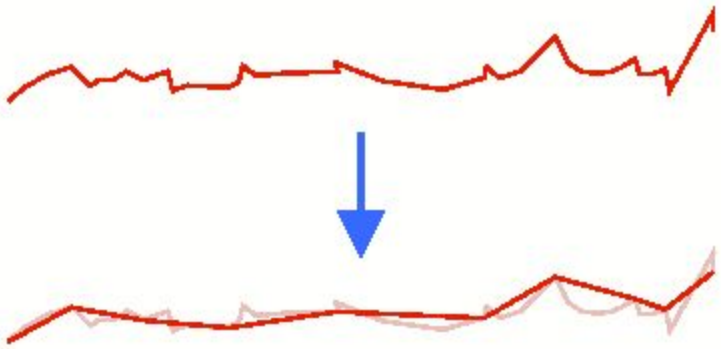
Pointing Device Gestures

- Cursor movements as command shortcuts
- Takes place of keyboard shortcuts
- Useful in applications where keyboard use is less prominent or undesirable



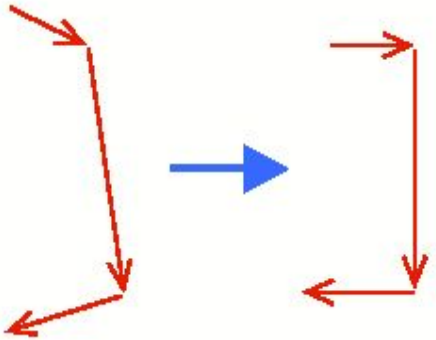
Above: Some possible cursor movement patterns for use in gesture support.

Implementation: Step 1



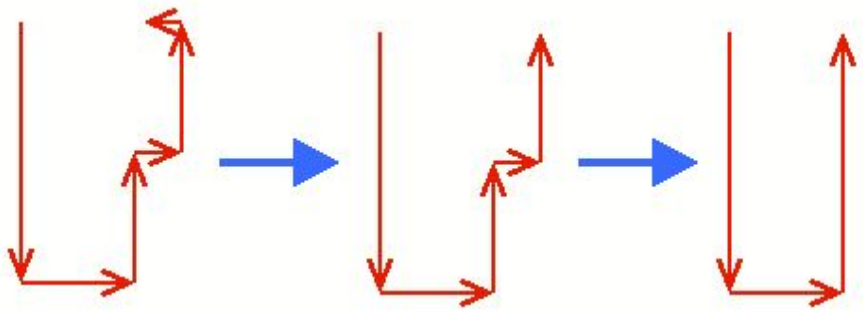
- Filter Input
  - Sampling rate
  - Smooth out input data, get rid of unnecessary “noise”
  - Simplify data analysis

Implementation: Step 2



- Vectorize
  - Separate x- and y-component
  - Compute dominant component and ignore smaller one
  - Store in array

Implementation: Step 3



- Matching
  - Match captured vector array to pre-defined gesture library
  - If no match, pop smallest vector from array and repeat matching process

Example

Fig. 1 – User input

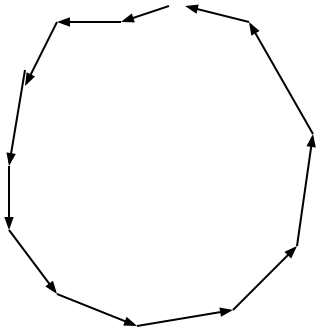


Fig. 2 – Captured/filtered pointer data

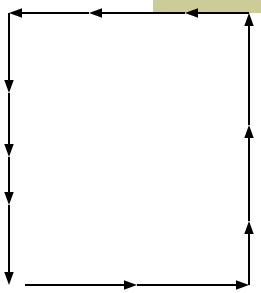


Fig. 3 – After vectorization

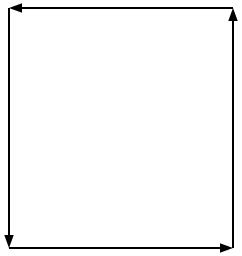


Fig. 4 – Final matching result

Goal

- Allows for a quicker and more efficient UI
- Universal Design
  - Enhances usability for visually-impaired as well as non-impaired
- Easily added to existing touchscreen devices, no additional hardware required

Questions?