How do touchscreens work?

CS6456 and CS4470, Craig Tashman
Two kinds

Single Touch

Multitouch

http://www.apple.com/iphone/
OLD SCHOOL

Single Touch
Resistive

Capacitive

Ultrasonic

IR Grid

2 volt

3 Volt
1-D Touch Sensing

- Resistive
- Capacitive
- Ultrasonic
- IR Grid
1-D Touch Sensing
1-D Touch Sensing
2-D Touch Sensing
2-D Touch Sensing

Resistive
Capacitive
Ultrasonic
IR Grid

Low High

Low High
2-D Touch Sensing

- Resistive
- Capacitive
- Ultrasonic
- IR Grid
2-D Touch Sensing

Hello world!

Low High

Low High
The Good:
- Reasonable precision.
- Can sense any object!

The Bad:
- Can sense any object!
- Mechanical wear.
- Drift.
- Easy to scratch.
- Blocks a lot of light (~25%)
Surface Capacitive
Surface Capacitive
Surface Capacitive
Surface Capacitive

Hello world!
Surface Capacitive

The Good: Transmits lots of light (85%-90%). Very durable.

The Bad: Can only sense certain (relatively conductive) objects. Mediocre accuracy (~1.5%). Must be really well shielded.
Surface Acoustic Wave

Sound Emitter

Sound Receiver

Resistive

Capacitive

Ultrasonic

IR Grid
Surface Acoustic Wave

Sound Emitter

Sound Receiver
Surface Acoustic Wave
Surface Acoustic Wave

The Good:  
Need not absorb any light!  
Very durable—just a piece of glass!  
Can sense any object!  
Not sensitive to electrical noise.

The Bad:  
Dirt on screen can confuse it.  
Can be hard to seal.  
Mediocre accuracy (~1%).  
Doesn’t detect contact per se.
IR emitters on top and right, receivers on bottom and left
IR emitters on top and right, receivers on bottom and left
IR emitters on top and right, receivers on bottom and left
The Good: Need not absorb any light!
Very durable—just a piece of glass!
Can sense any object!
Not sensitive to electrical noise.
Simple.

The Bad: Very limited resolution.
Again, senses any object.
Doesn’t sense contact per se.
IR Emitters along the sides
IR Emitters along the sides
IR cameras at the corners
IR Emitters along the sides
IR cameras at the corners
IR Emitters along the sides
IR cameras at the corners
Supports multitouch, sort of.
IR Emitters along the sides
IR cameras at the corners
Supports multitouch, sort of.
The Good: Need not absorb any light!
Very durable—just a piece of glass!
Can sense any object!
Not sensitive to electrical noise.
Good resolution.
Almost multitouch?

The Bad: Again, senses any object.
Resolution varies over the display surface.
Doesn’t detect contact per se.
Multitouch!
Surface Capacitive
(what we talked about earlier)

vs

Projected Capacitive
Capacitive

FTIR Optical

Diffuse Optical

Digital Resistive
Hey, who’s stealing my electrons?
Capacitive

FTIR Optical

Diffuse Optical

Digital Resistive

Chicken soup.

Hey!!!
Who's stealing my electrons?
Capacitive

FTIR Optical

Diffuse Optical

Digital Resistive
Higher capacitance at intersection of 1 & B
Higher capacitance at intersection of 1 & B
Higher capacitance at intersection of 2 & D
The Good:  Actually very good resolution.
          Small, thin.
          Doesn’t need much energy.
          Fairly transparent.

The Bad:   VERY sensitive to electrical noise.
          Easily confused by water on the sensor.
          Does block a bit of light.
          Scales very badly.
          Usually works with finite number of touches.
“Frustrated Total Internal Reflection”
FTIR Optical

The Good: Sense any number of objects! Detects exact contact shape! No parallax error in display.

The Bad: Huge beast of a device. Needs a lot of power (for projector). Limited to projector display resolutions. Can’t sense anything not touching the surface. Sensitive to ambient lighting.
Often uses multiple cameras to calculate depth
The Good:
- Sense any number of objects!
- Detects exact contact shape!
- No parallax error in display.
- Can sense objects BEFORE they touch screen!
- Can see through screen to tell WHAT is contacting.

The Bad:
- Detects objects before they touch screen.
- Usually a huge beast of a device.
- Needs a lot of power (for projector).
- Limited to projector display resolutions.
- Sensitive to ambient lighting.
Diffuse optical may be the future:
Companies are already integrating optical sensors into LCD’s
Remember the Projected Capacitive approach?
Well, just take away the glass!
Remember the Projected Capacitive approach?
Well, just take away the glass!
Only problem seems to be making those wires clear.
The Good:

- Very high precision pressure calculation.
- Not sensitive to electrical noise.
- Very small and thin.

The Bad:

- Not yet commercial—just in the R&D phase.
- Haven’t figured out how to get the wires clear!
Next time, we’ll talk software

Any questions?