

How do touchscreens work?

CS6456 and CS4470, Craig Tashman

Two kinds



Single Touch



Multitouch

<http://www.apple.com/iphone/>

http://articles.businessinsider.com/2009-10-21/wall_street/30101529_1_citi-lowcards-com-default-rates

OLD SCHOOL



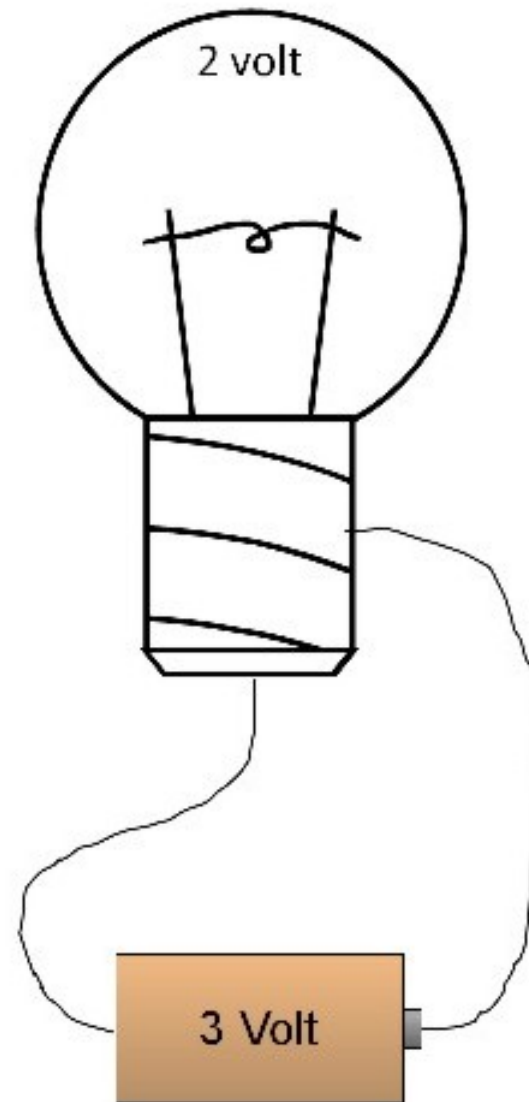
Single Touch

Resistive

Capacitive

Ultrasonic

IR Grid



Resistive

Capacitive

Ultrasonic

IR Grid

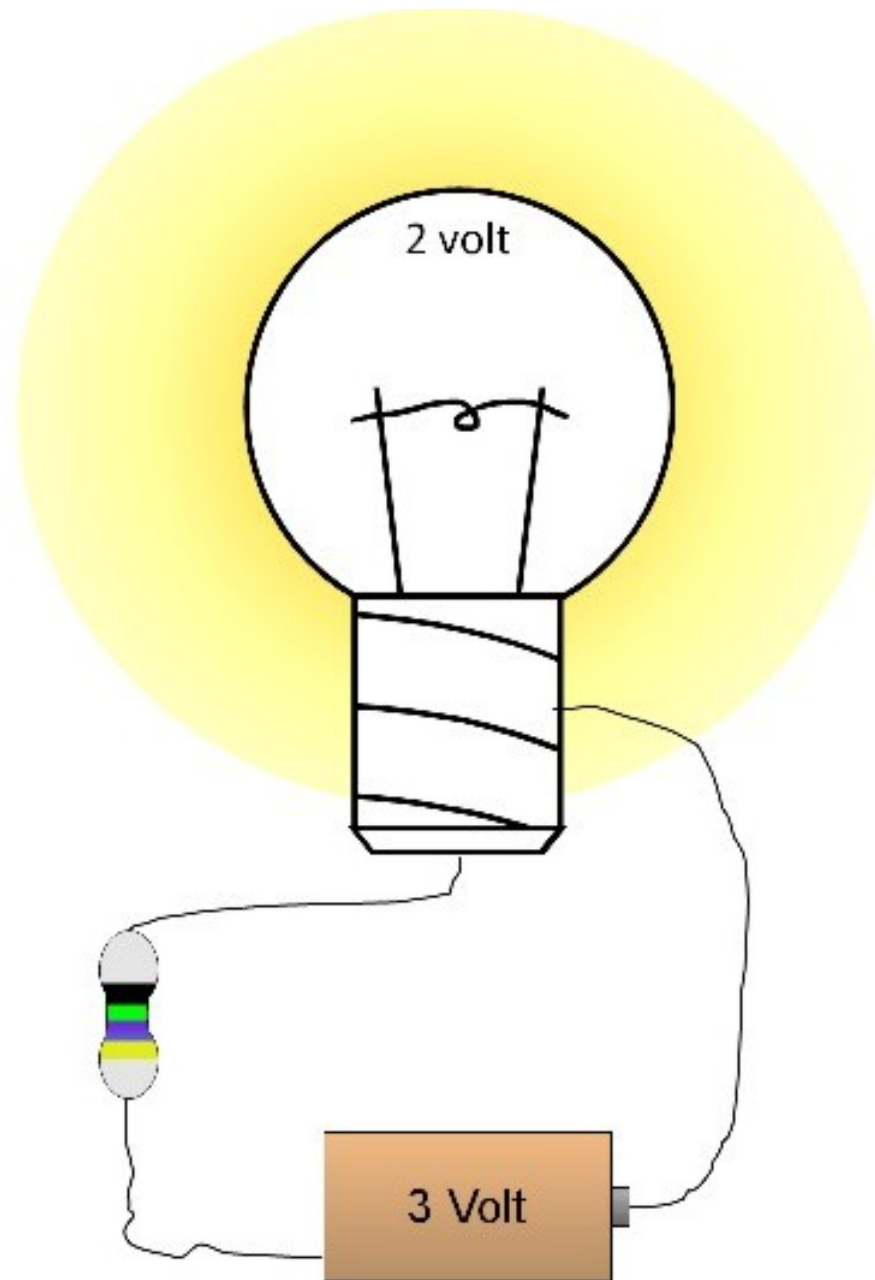


Resistive

Capacitive

Ultrasonic

IR Grid

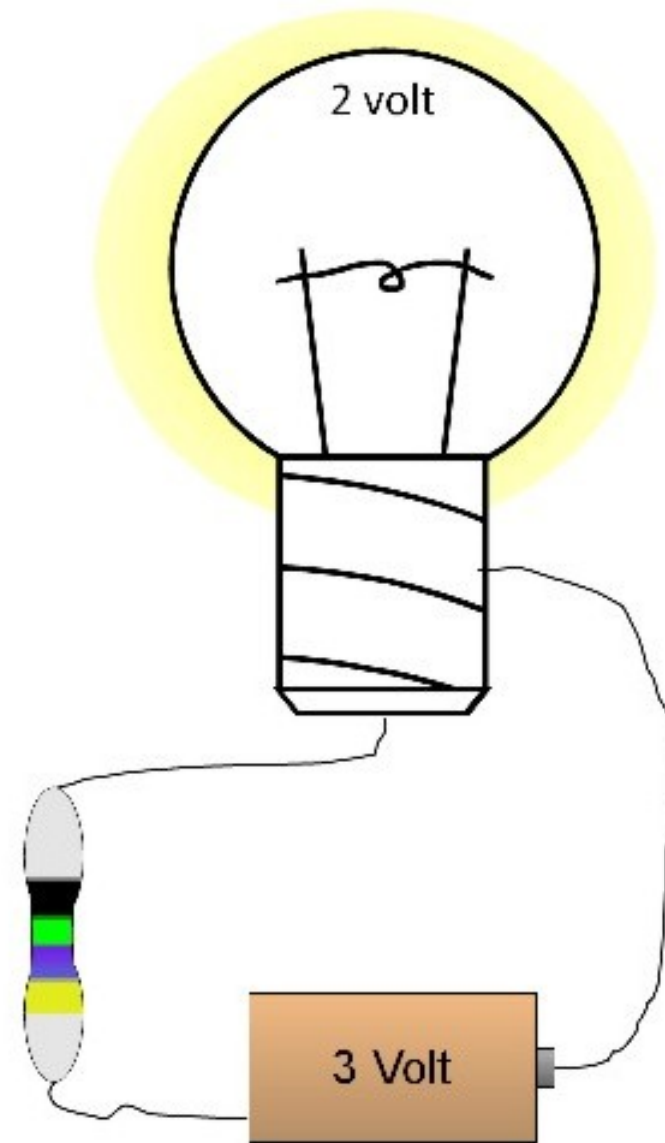


Resistive

Capacitive

Ultrasonic

IR Grid



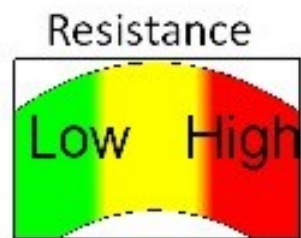
Resistive

1-D Touch Sensing

Capacitive

Ultrasonic

IR Grid



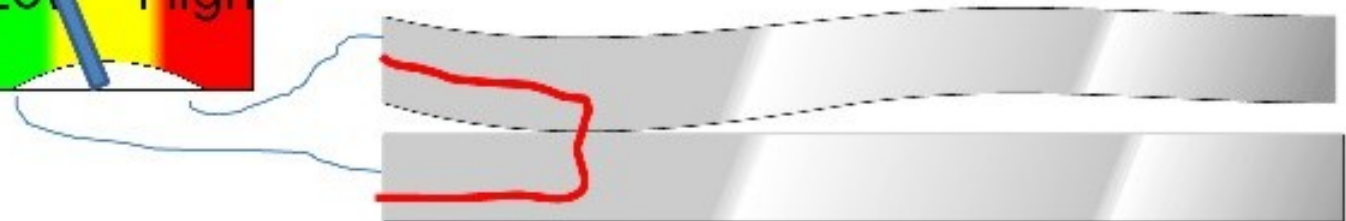
Resistive

1-D Touch Sensing

Capacitive

Ultrasonic

IR Grid



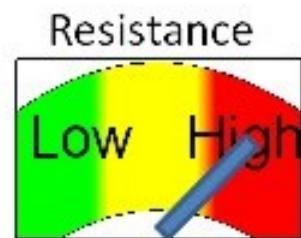
Resistive

1-D Touch Sensing

Capacitive

Ultrasonic

IR Grid



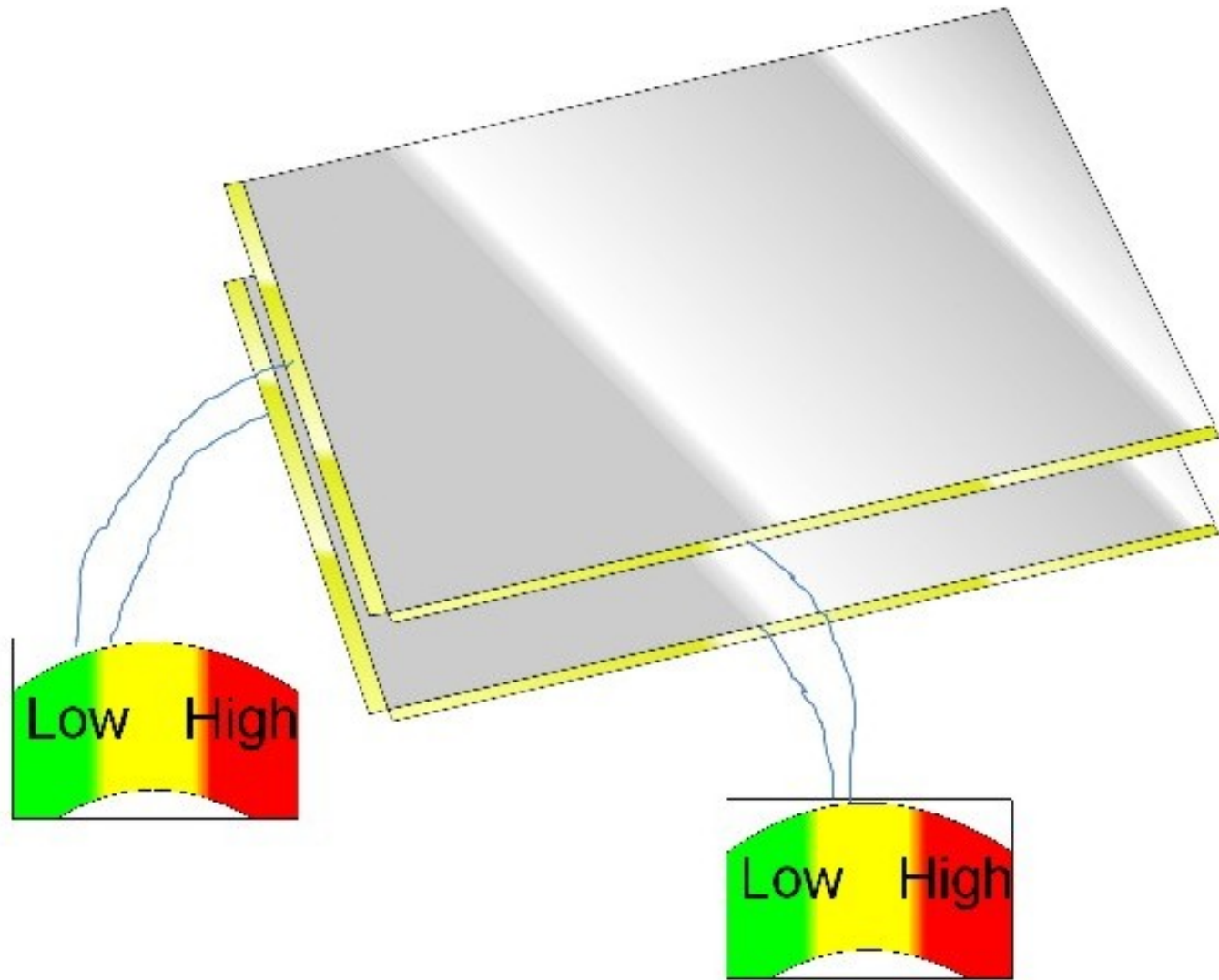
Resistive

2-D Touch Sensing

Capacitive

Ultrasonic

IR Grid



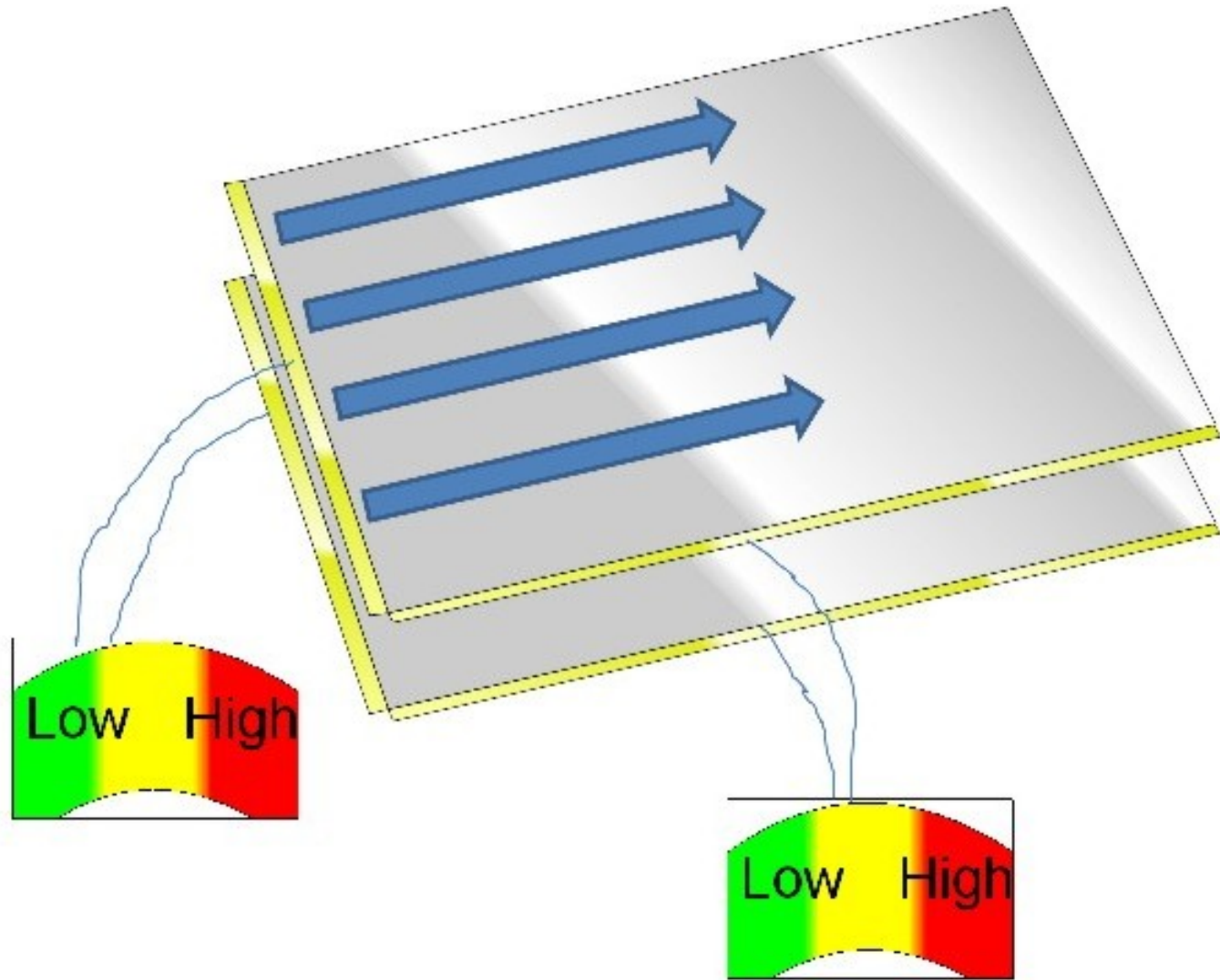
Resistive

2-D Touch Sensing

Capacitive

Ultrasonic

IR Grid



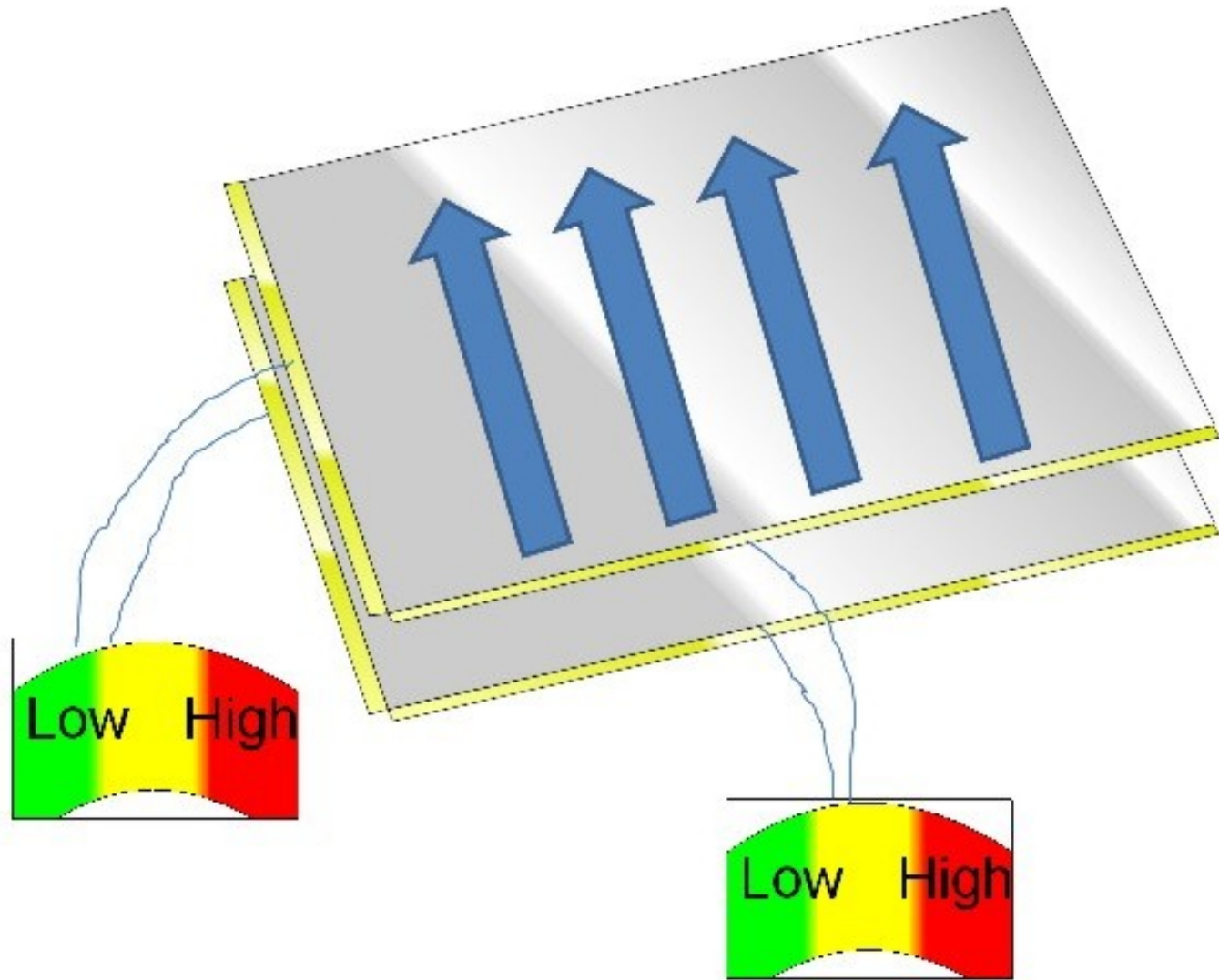
Resistive

2-D Touch Sensing

Capacitive

Ultrasonic

IR Grid



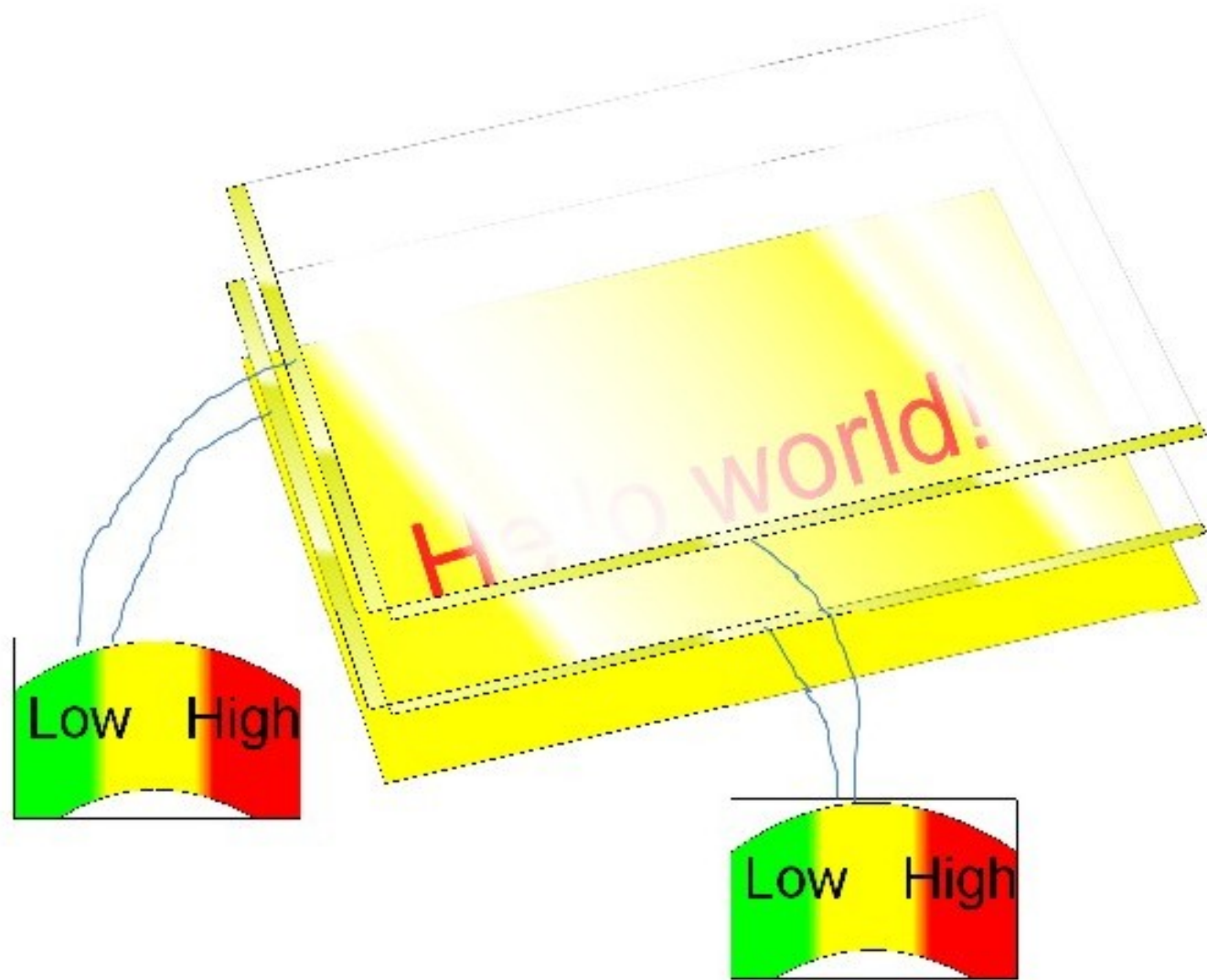
Resistive

2-D Touch Sensing

Capacitive

Ultrasonic

IR Grid



Resistive

Capacitive

Ultrasonic

IR Grid

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%)

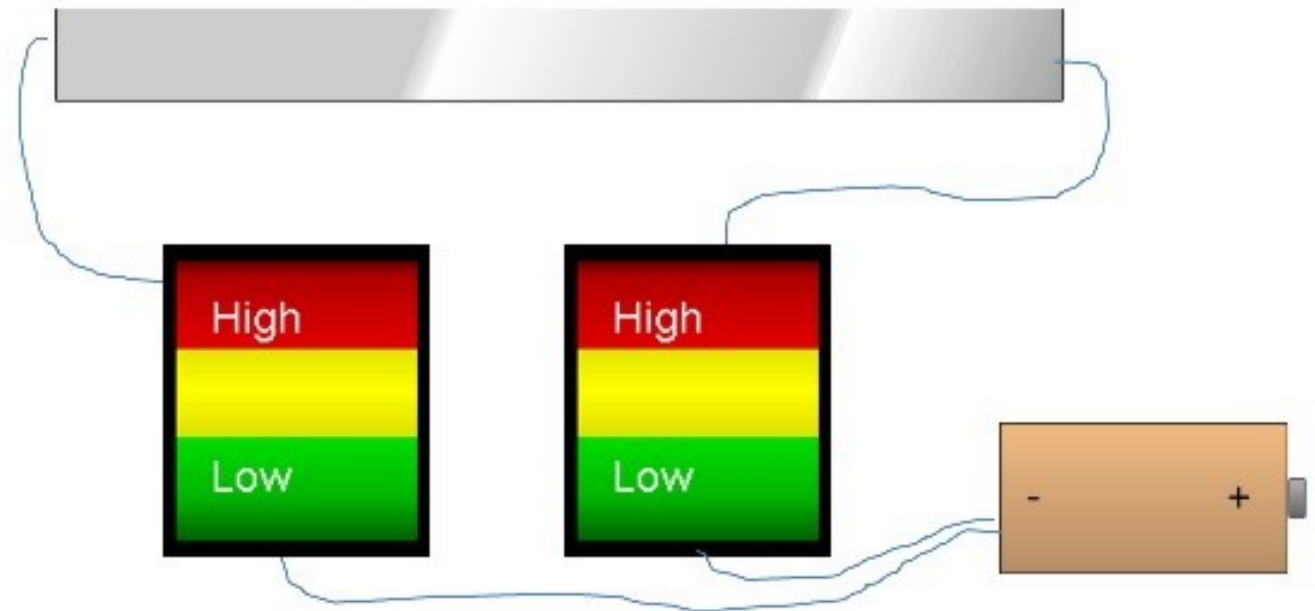
Resistive

Capacitive

Ultrasonic

IR Grid

Surface Capacitive



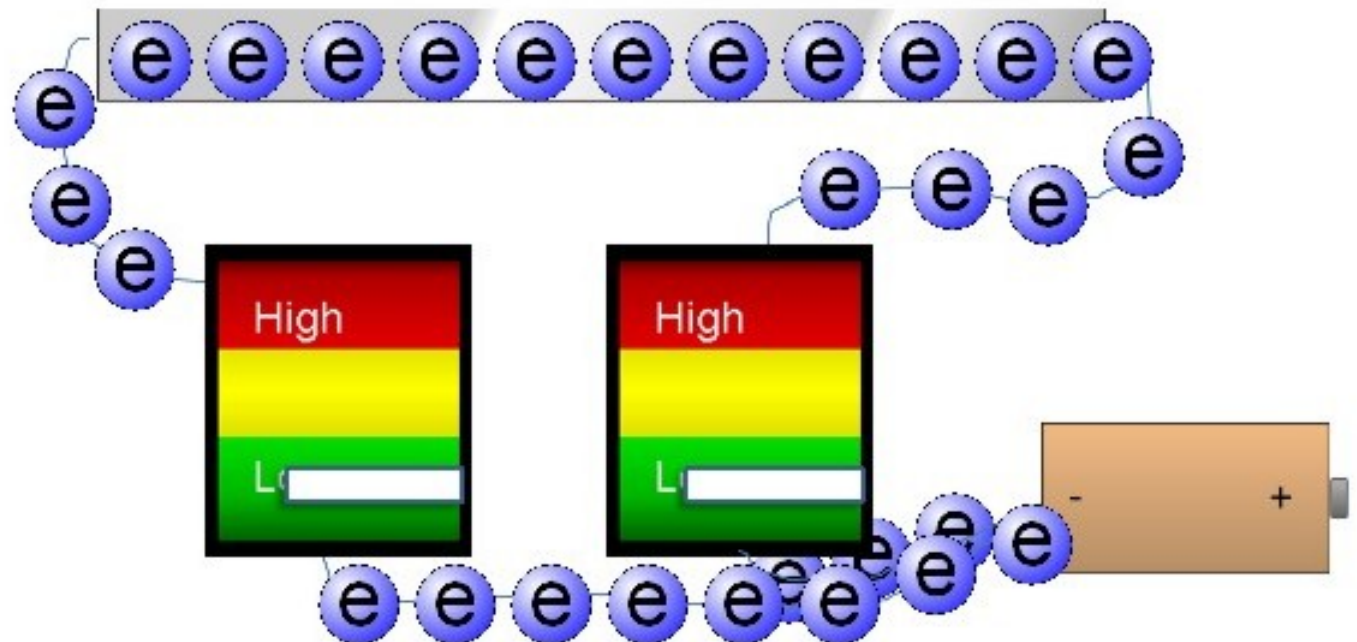
Resistive

Capacitive

Ultrasonic

IR Grid

Surface Capacitive



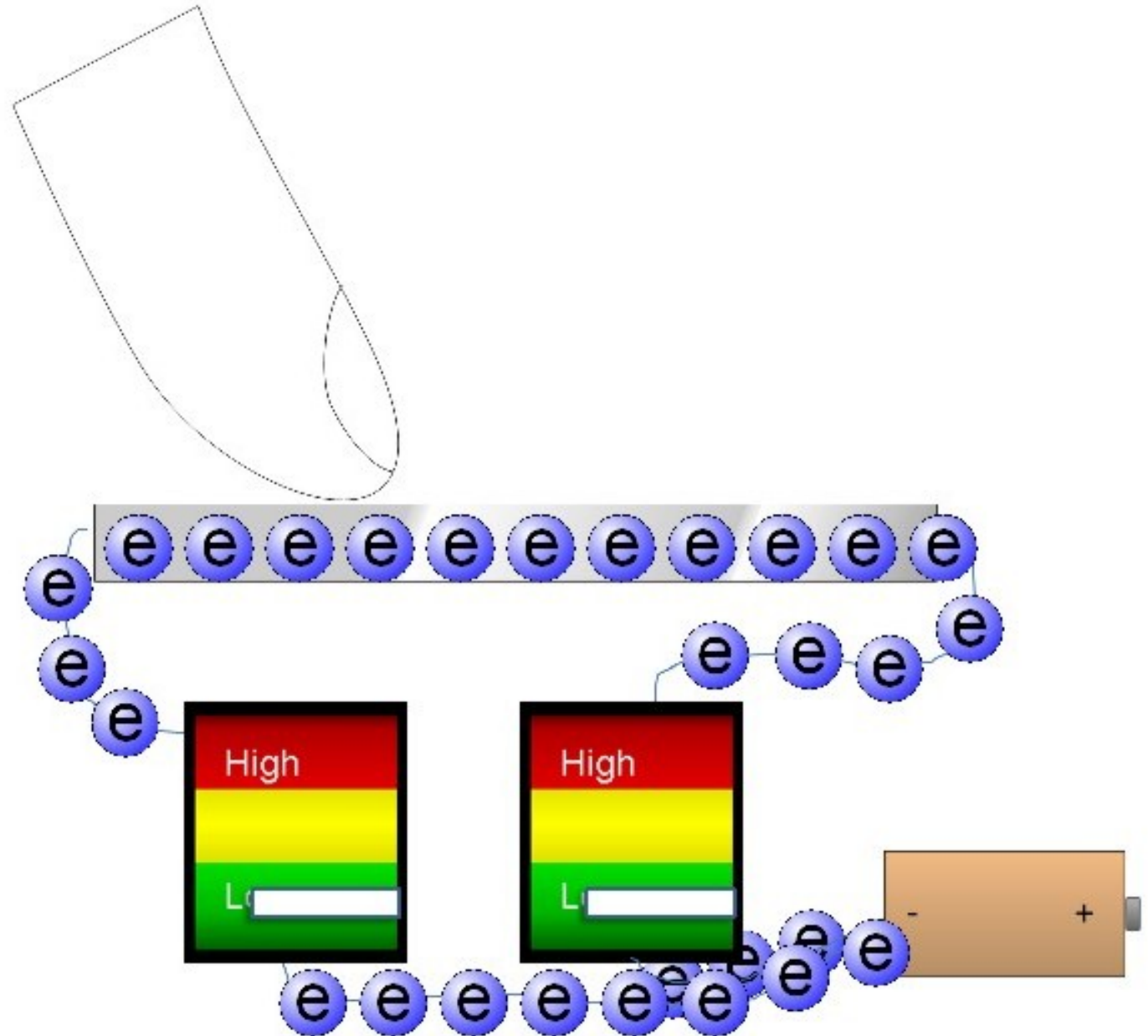
Resistive

Capacitive

Ultrasonic

IR Grid

Surface Capacitive



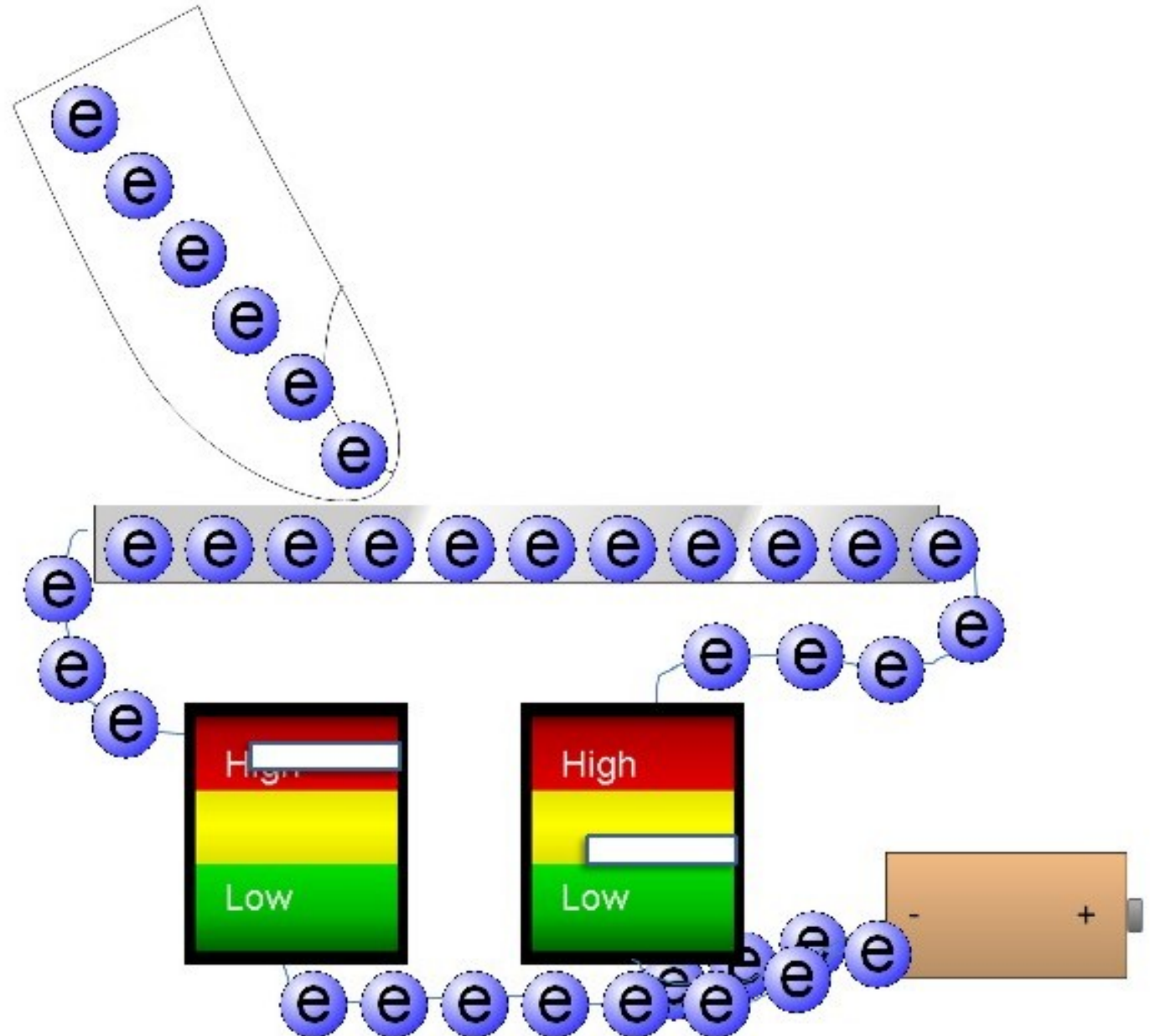
Resistive

Capacitive

Ultrasonic

IR Grid

Surface Capacitive



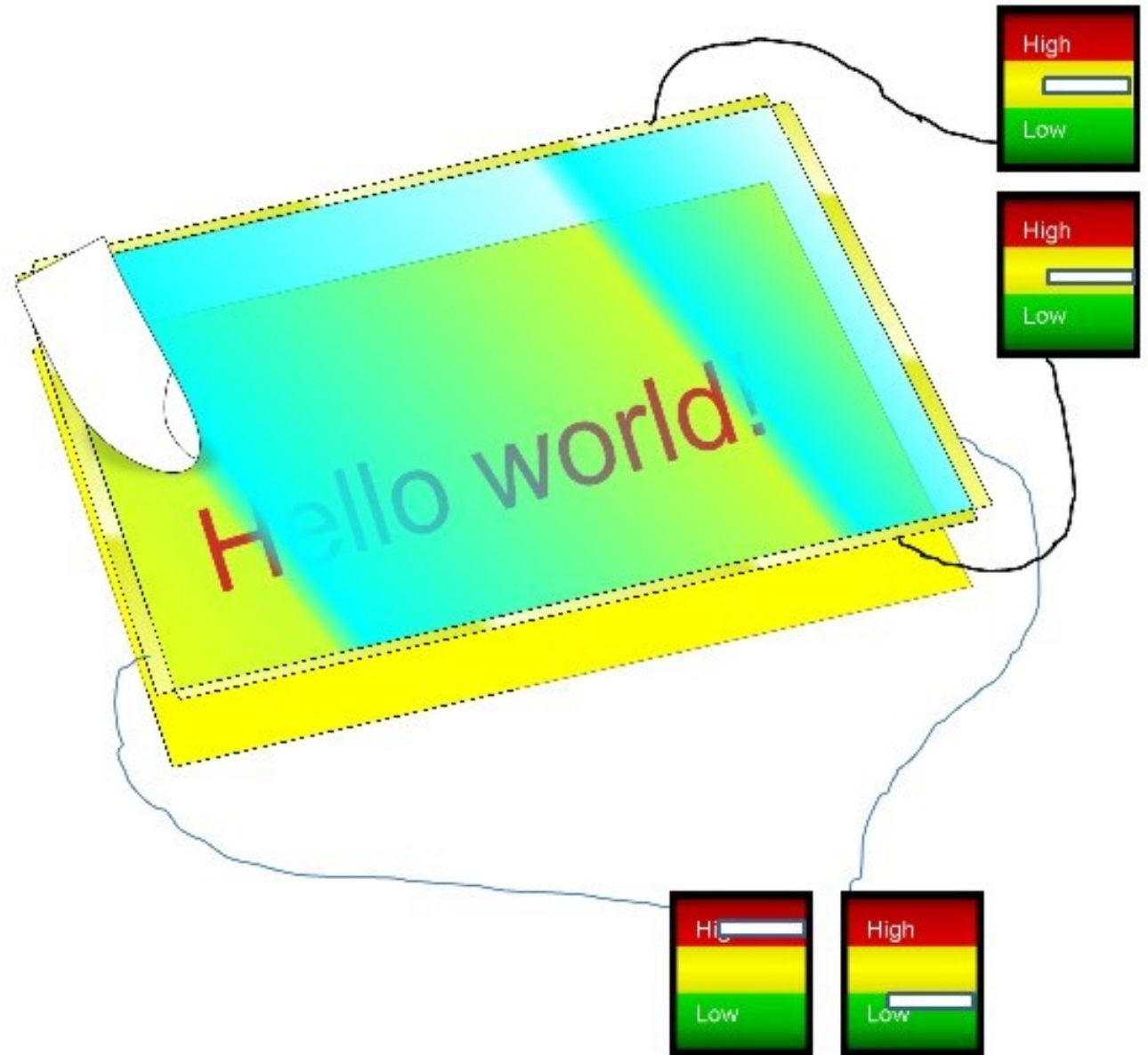
Resistive

Capacitive

Ultrasonic

IR Grid

Surface Capacitive



Resistive

Capacitive

Ultrasonic

IR Grid

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.

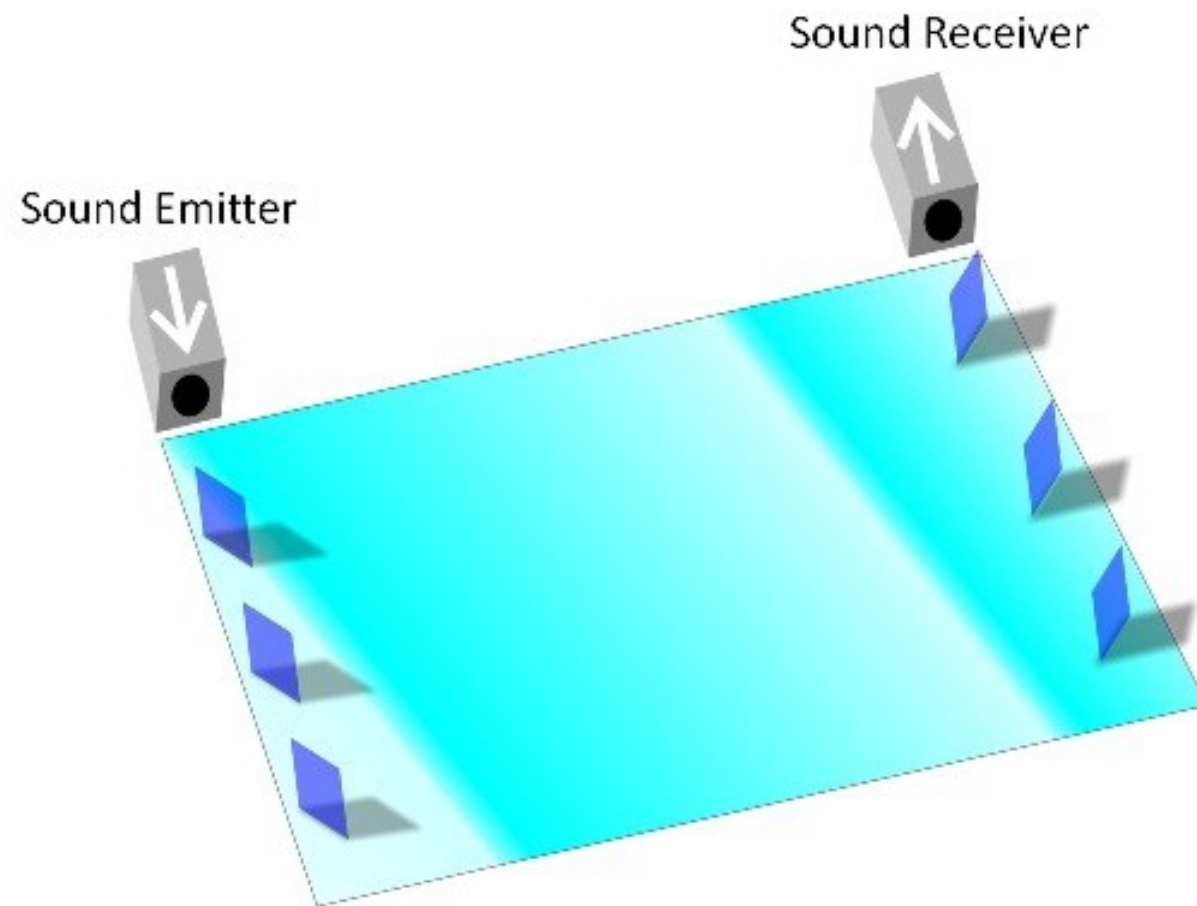
Resistive

Capacitive

Ultrasonic

IR Grid

Surface Acoustic Wave



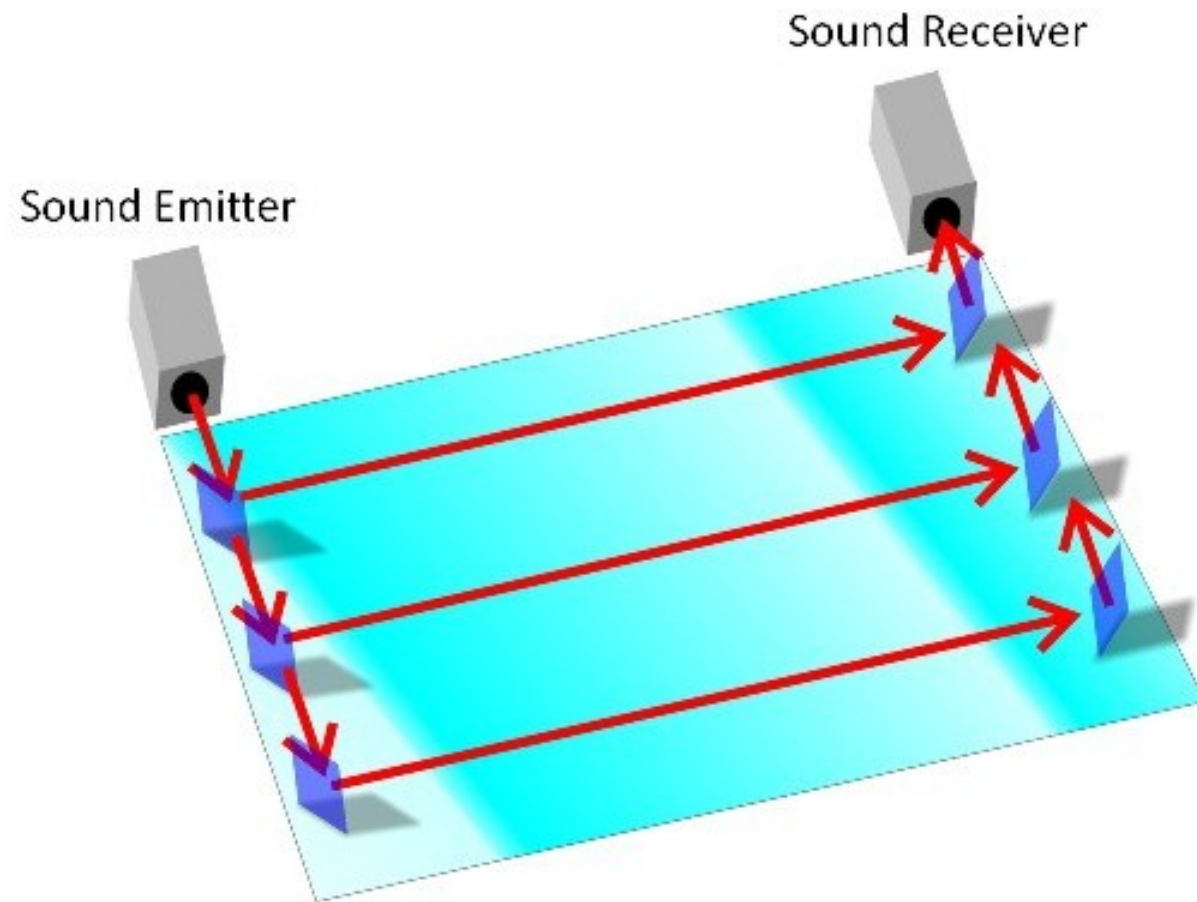
Resistive

Capacitive

Ultrasonic

IR Grid

Surface Acoustic Wave



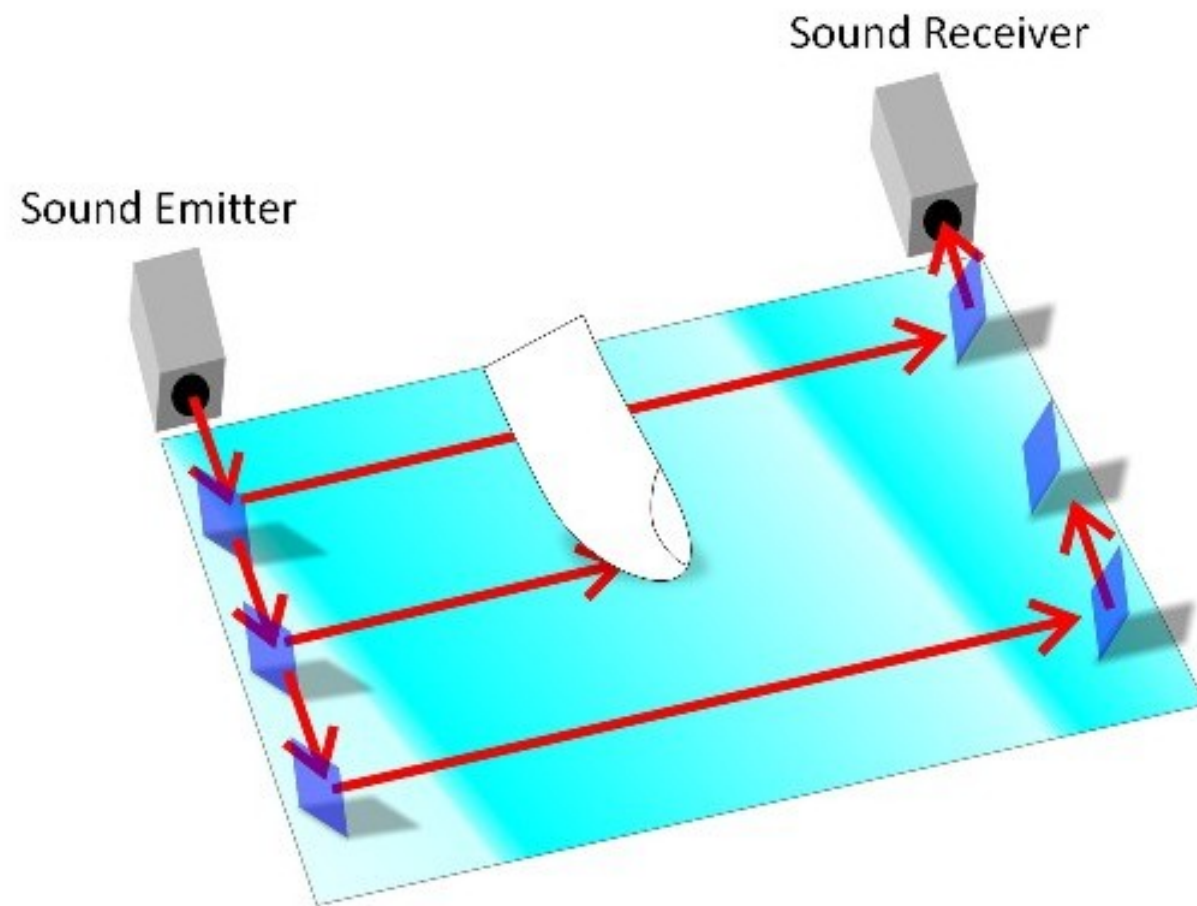
Resistive

Capacitive

Ultrasonic

IR Grid

Surface Acoustic Wave



Resistive

Capacitive

Ultrasonic

IR Grid

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.

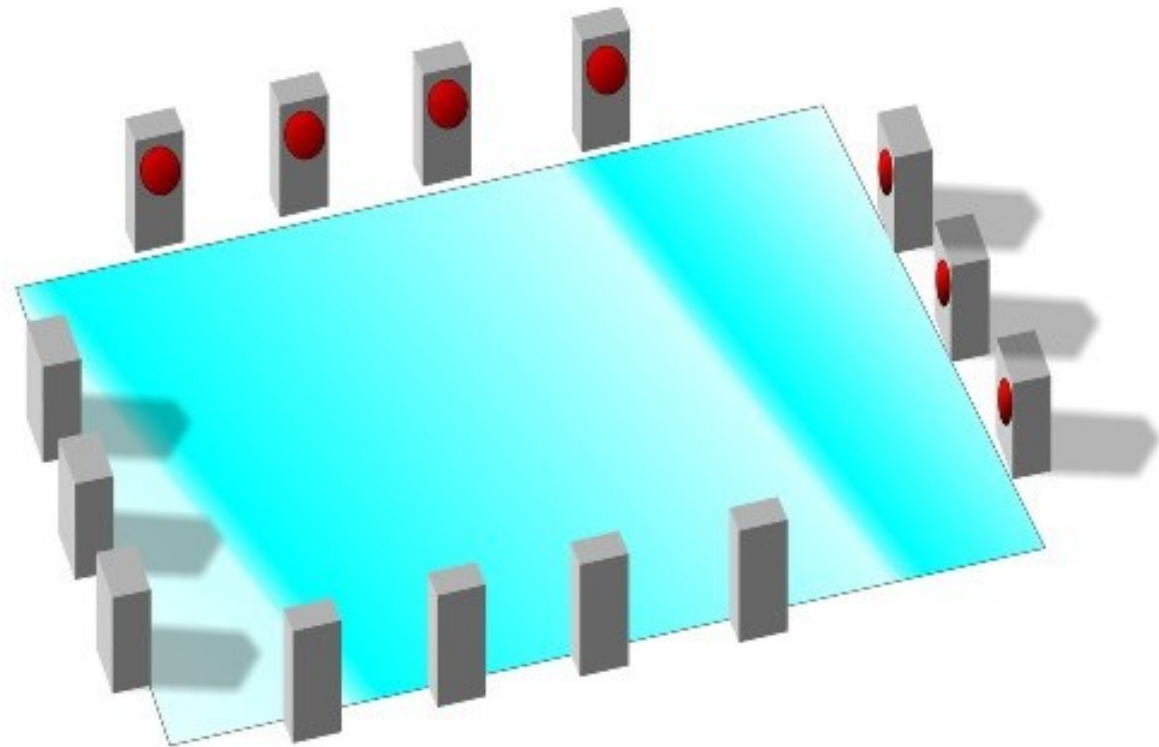
The Bad: Dirt on screen can confuse it.
Can be hard to seal.
Mediocre accuracy (~1%).
Doesn't detect contact per se.

Resistive

Capacitive

Ultrasonic

IR Grid



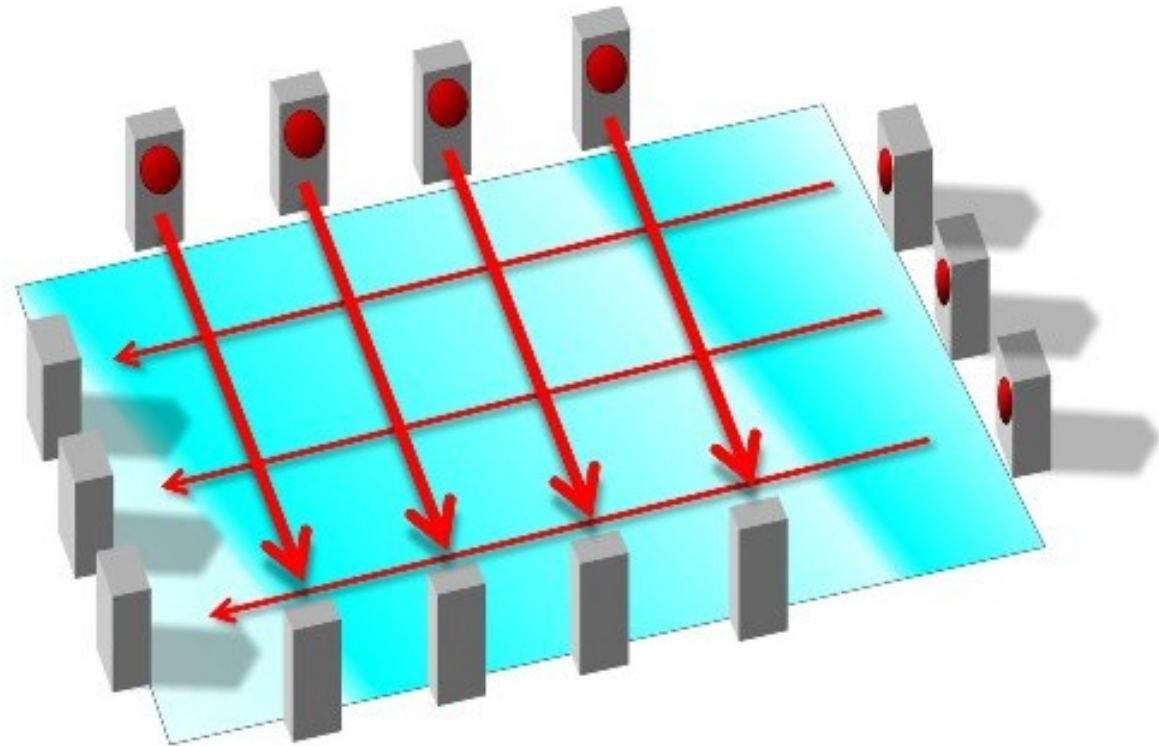
IR emitters on top and right, receivers on bottom and left

Resistive

Capacitive

Ultrasonic

IR Grid



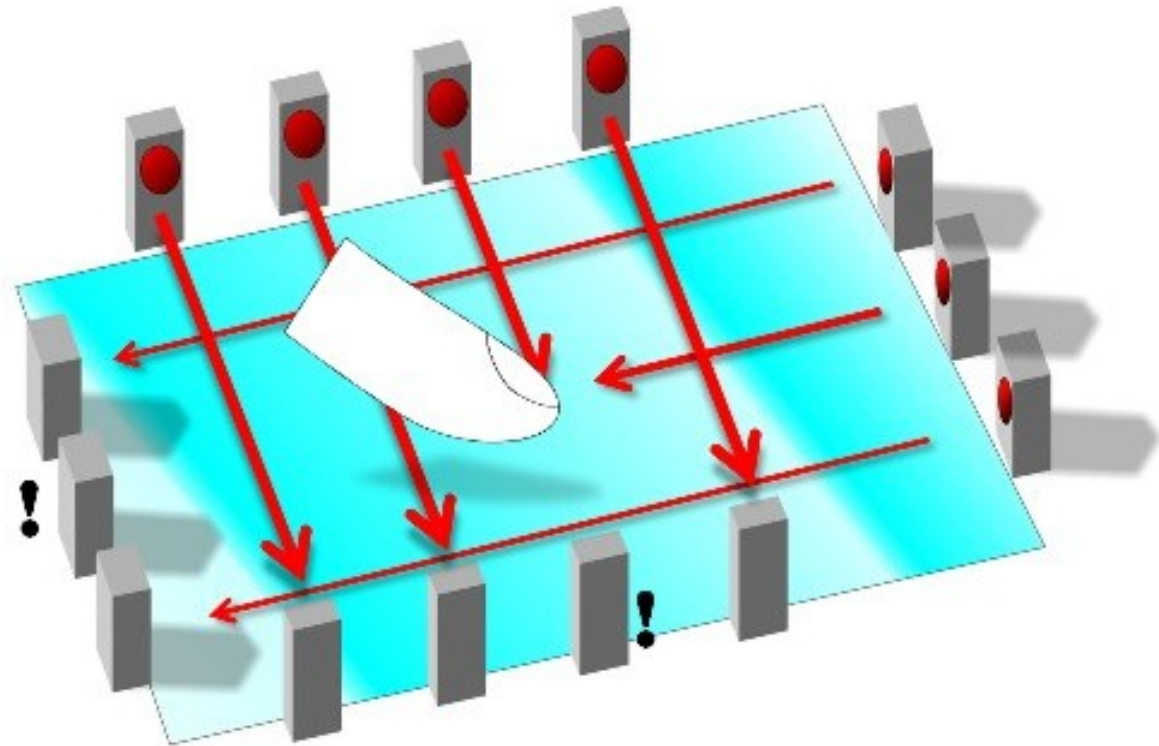
IR emitters on top and right, receivers on bottom and left

Resistive

Capacitive

Ultrasonic

IR Grid



IR emitters on top and right, receivers on bottom and left

Resistive

Capacitive

Ultrasonic

IR Grid

Corner IR

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.

Resistive

Capacitive

Ultrasonic

IR Grid

Corner IR



IR Emitters along the sides

Resistive

Capacitive

Ultrasonic

IR Grid

Corner IR



IR Emitters along the sides

IR cameras at the corners

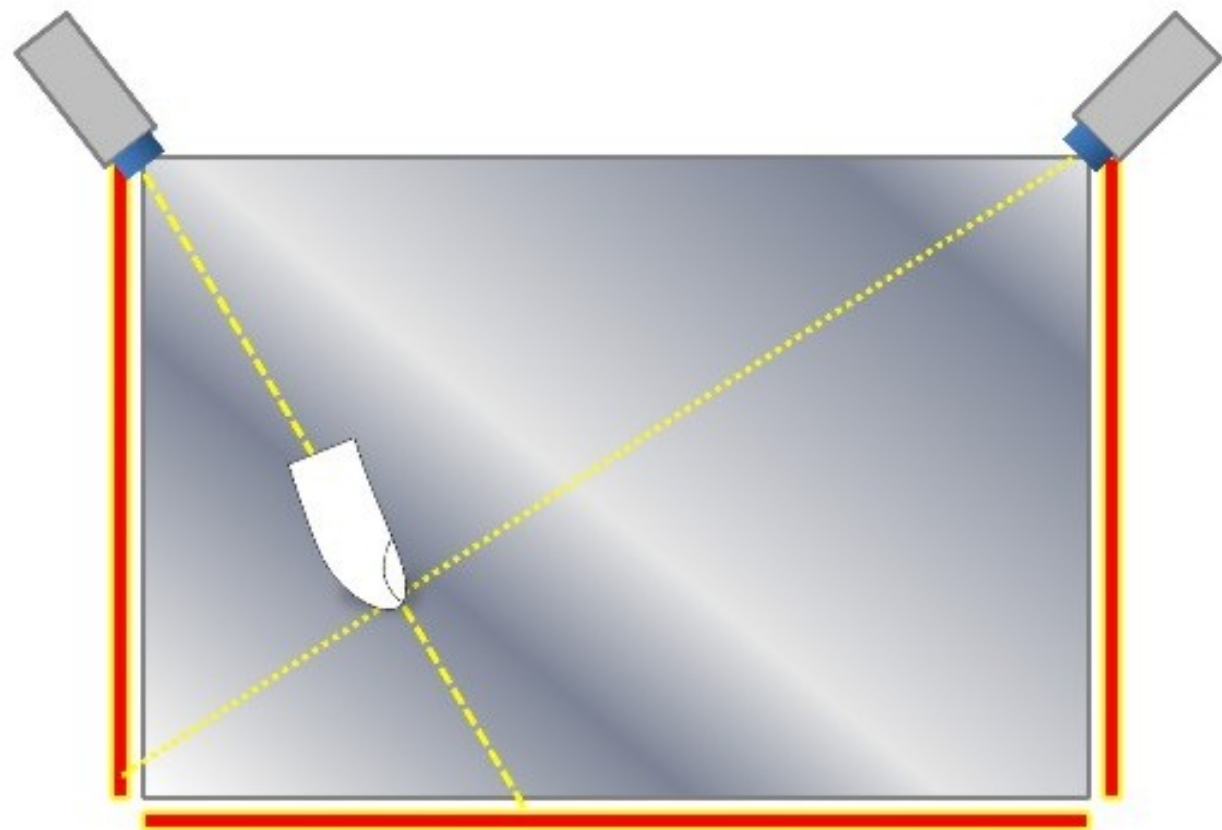
Resistive

Capacitive

Ultrasonic

IR Grid

Corner IR



IR Emitters along the sides

IR cameras at the corners

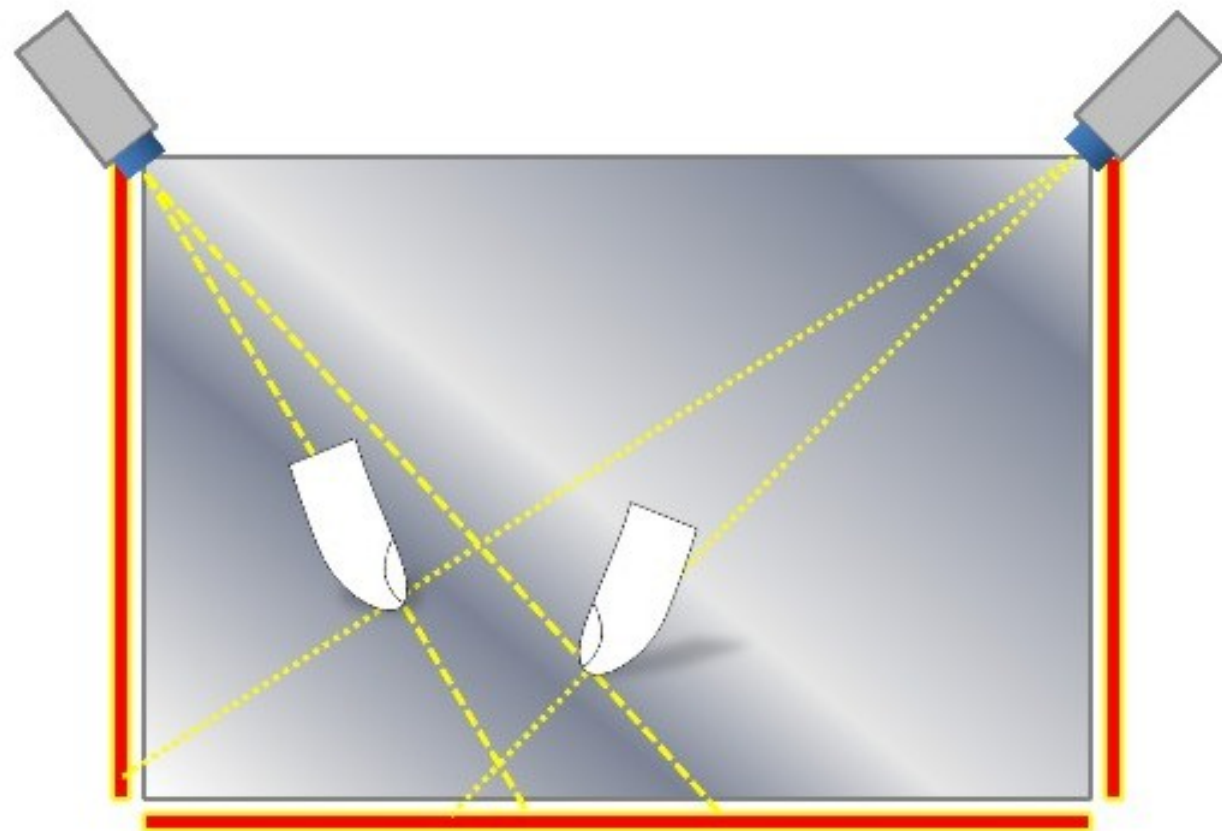
Resistive

Capacitive

Ultrasonic

IR Grid

Corner IR



IR Emitters along the sides

IR cameras at the corners

Supports multitouch, sort of.

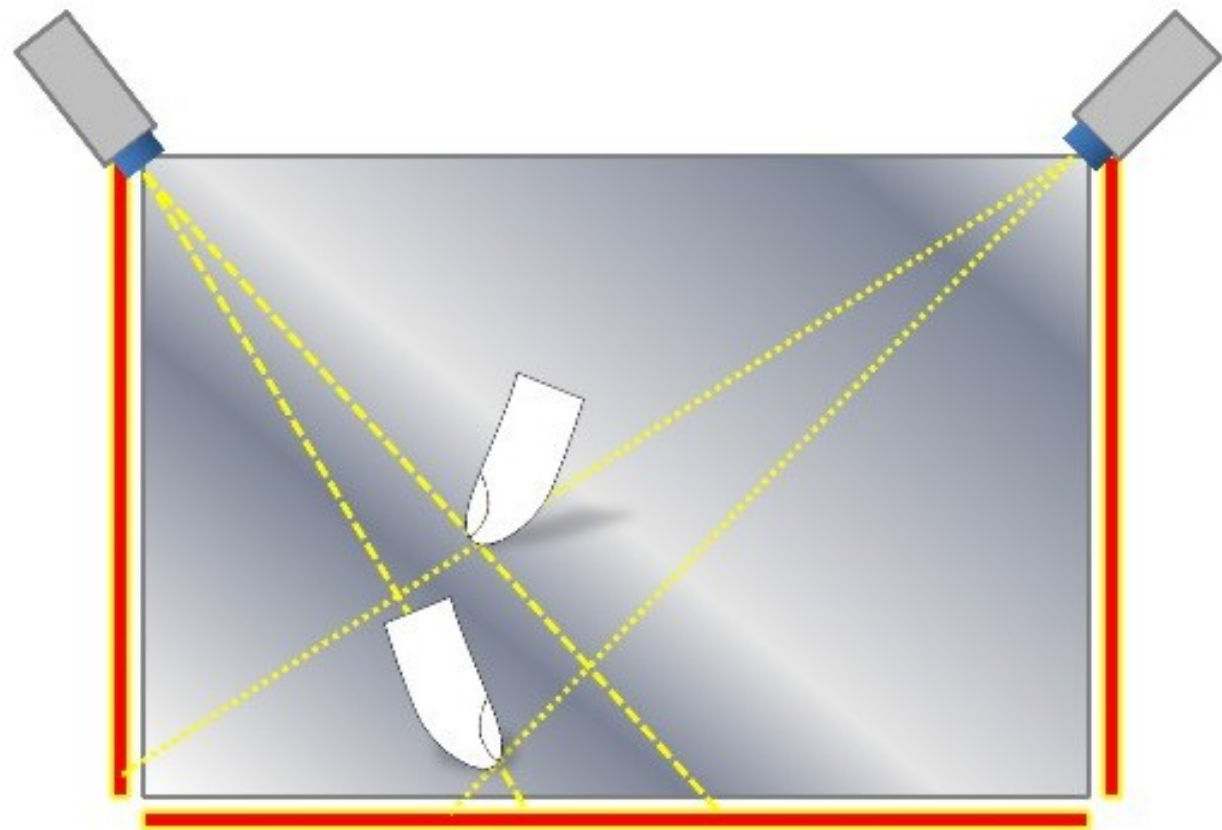
Resistive

Capacitive

Ultrasonic

IR Grid

Corner IR



IR Emitters along the sides

IR cameras at the corners

Supports multitouch, sort of.

Resistive

Capacitive

Ultrasonic

IR Grid

Corner IR

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!

Capacitive

FTIR Optical

Diffuse Optical

Digital Resistive

Surface Capacitive

(what we talked about earlier)

vs

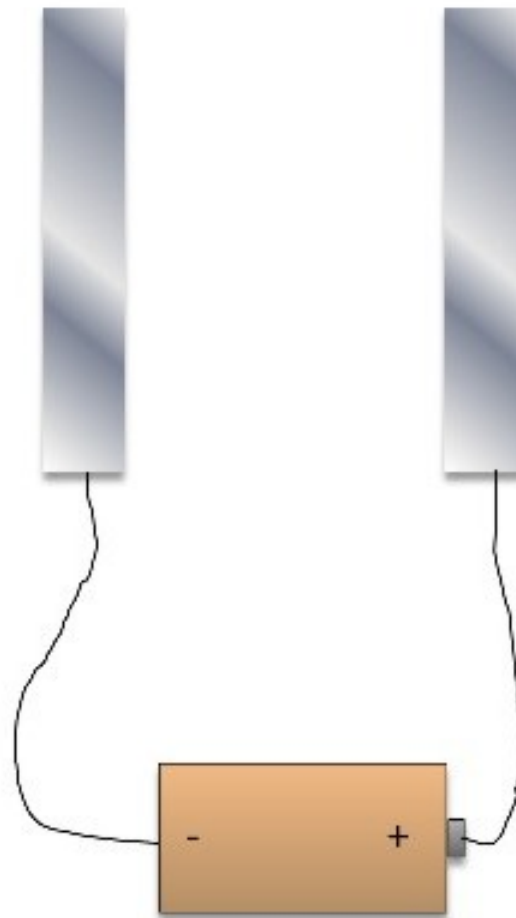
PROJECTED CAPACITIVE
PROJECTED CAPACITIVE

Capacitive

FTIR Optical

Diffuse Optical

Digital Resistive

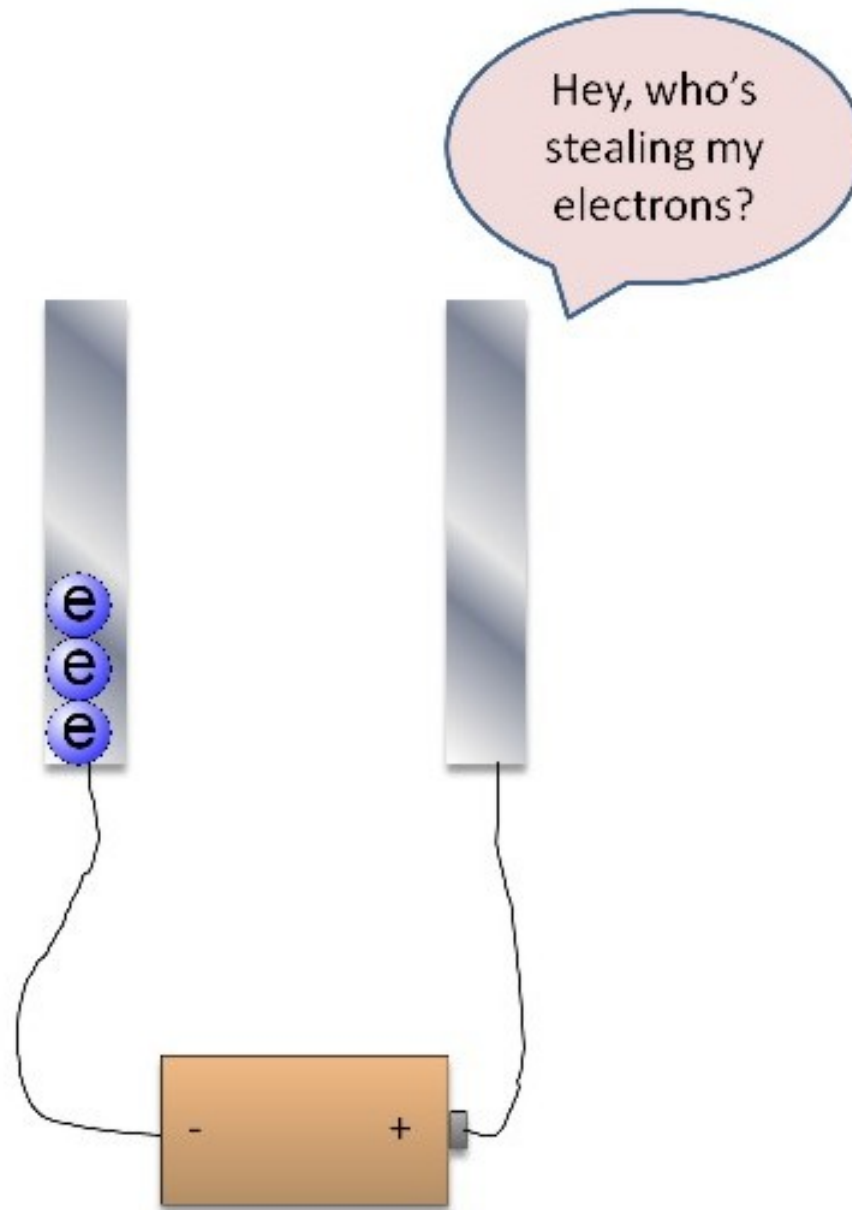


Capacitive

FTIR Optical

Diffuse Optical

Digital Resistive



Capacitive

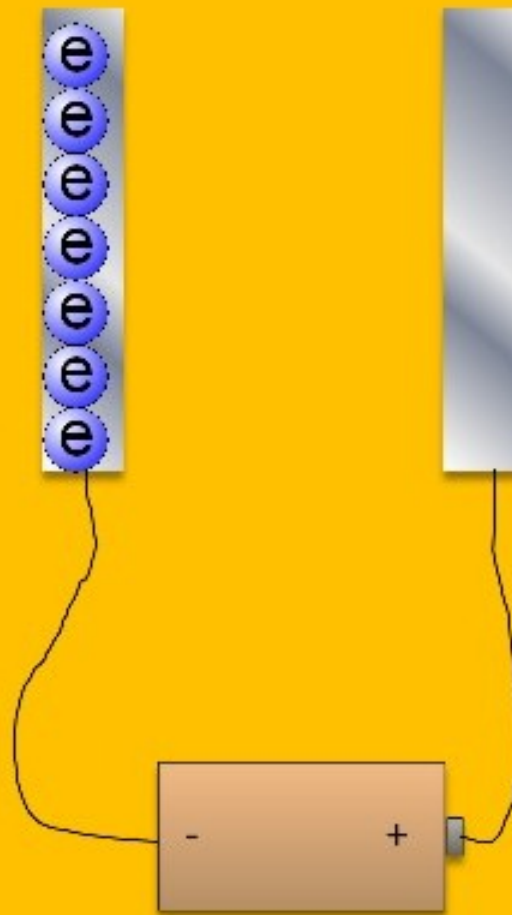
FTIR Optical

Diffuse Optical

Digital Resistive

Chicken soup.

HEY!!!
Who's
stealing my
electrons?



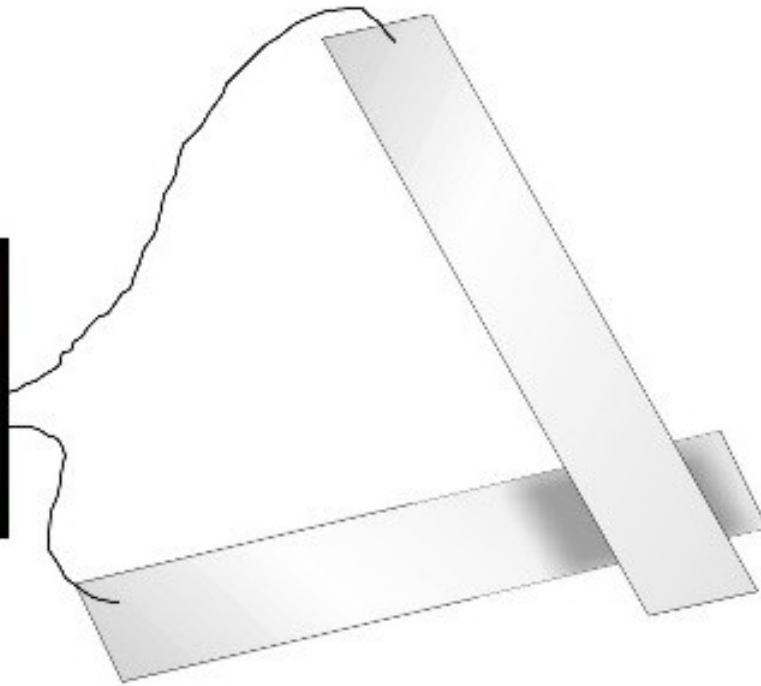
Capacitive

FTIR Optical

Diffuse Optical

Digital Resistive

Capacitance



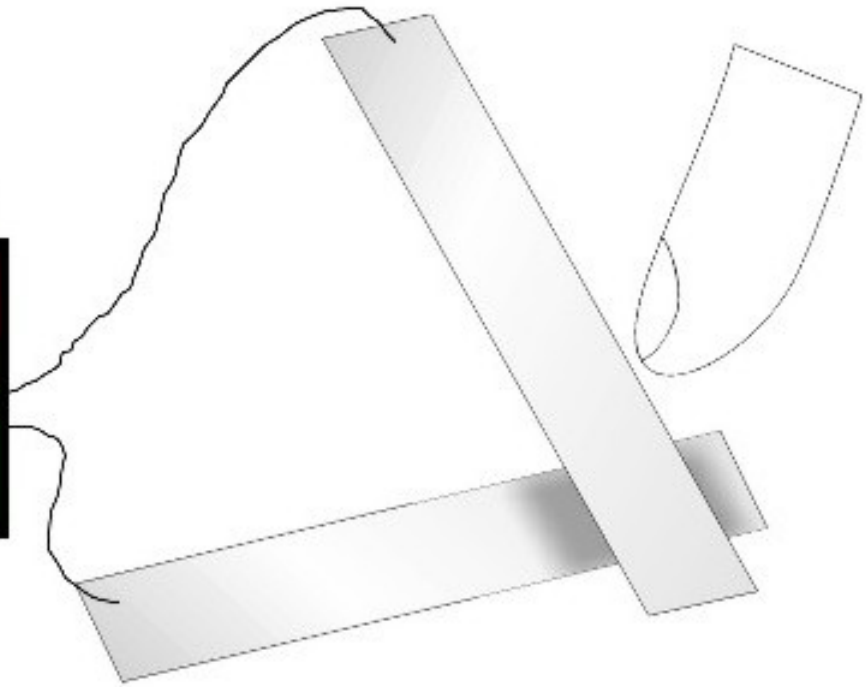
Capacitive

FTIR Optical

Diffuse Optical

Digital Resistive

Capacitance

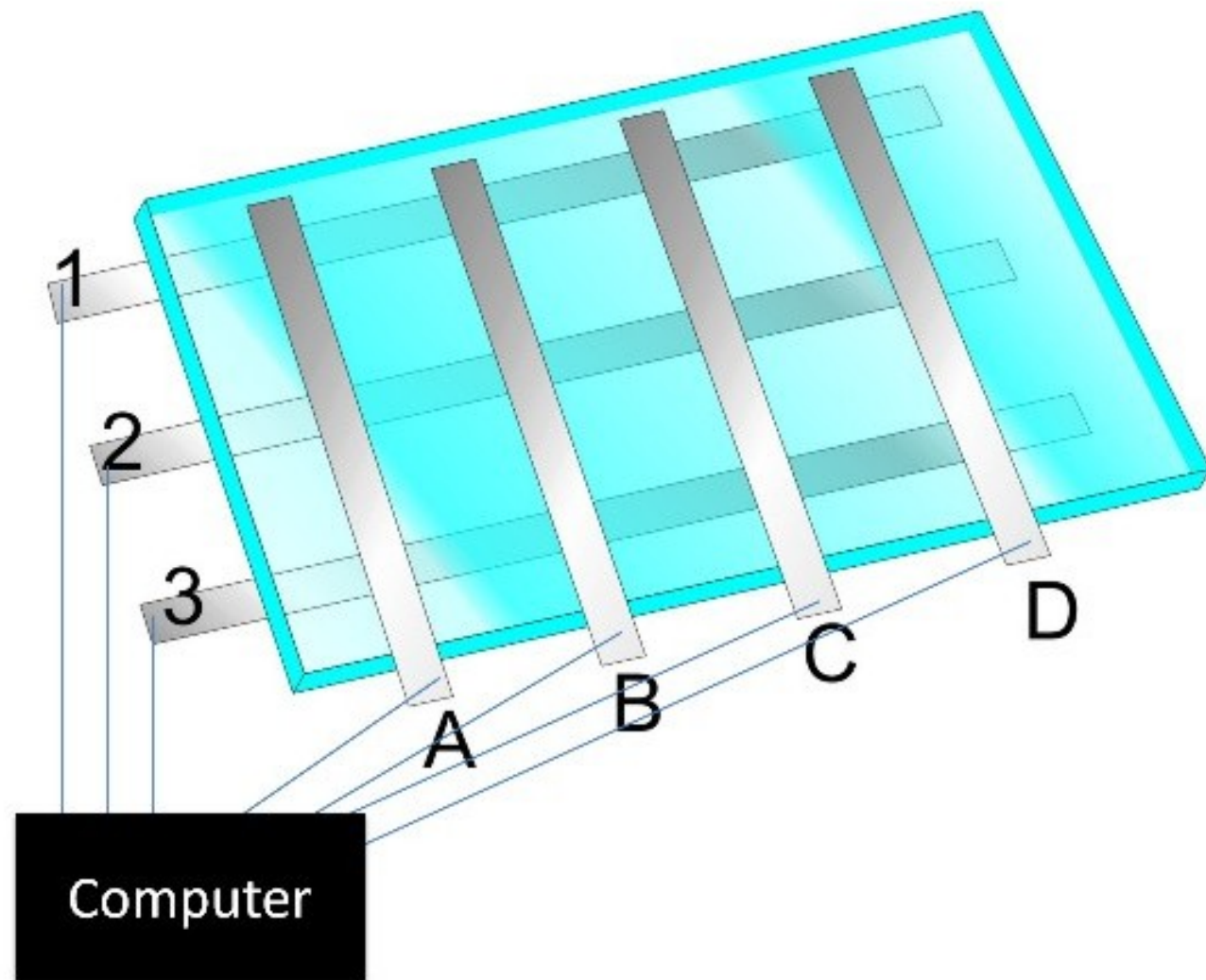


Capacitive

FTIR Optical

Diffuse Optical

Digital Resistive

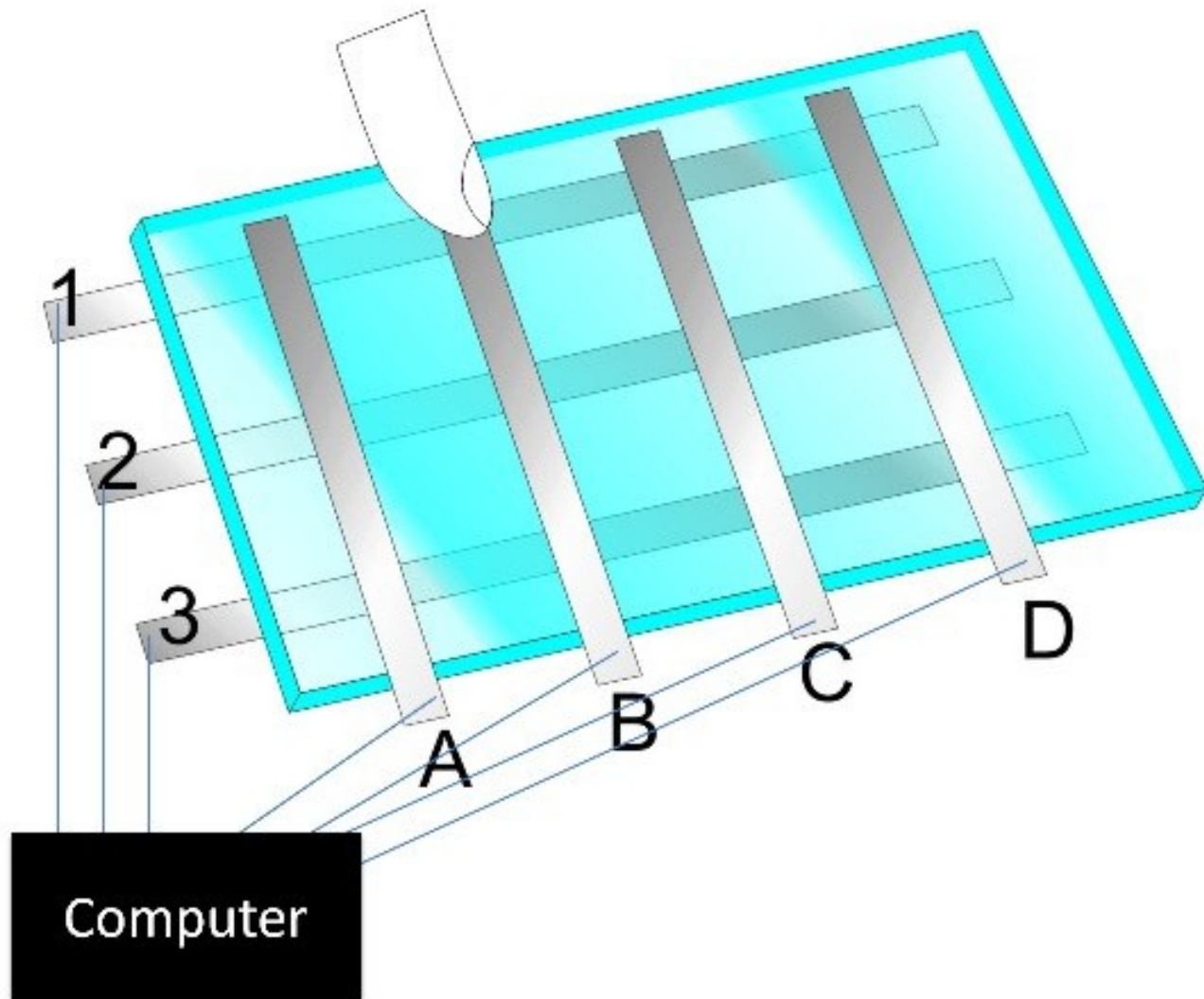


Capacitive

FTIR Optical

Diffuse Optical

Digital Resistive



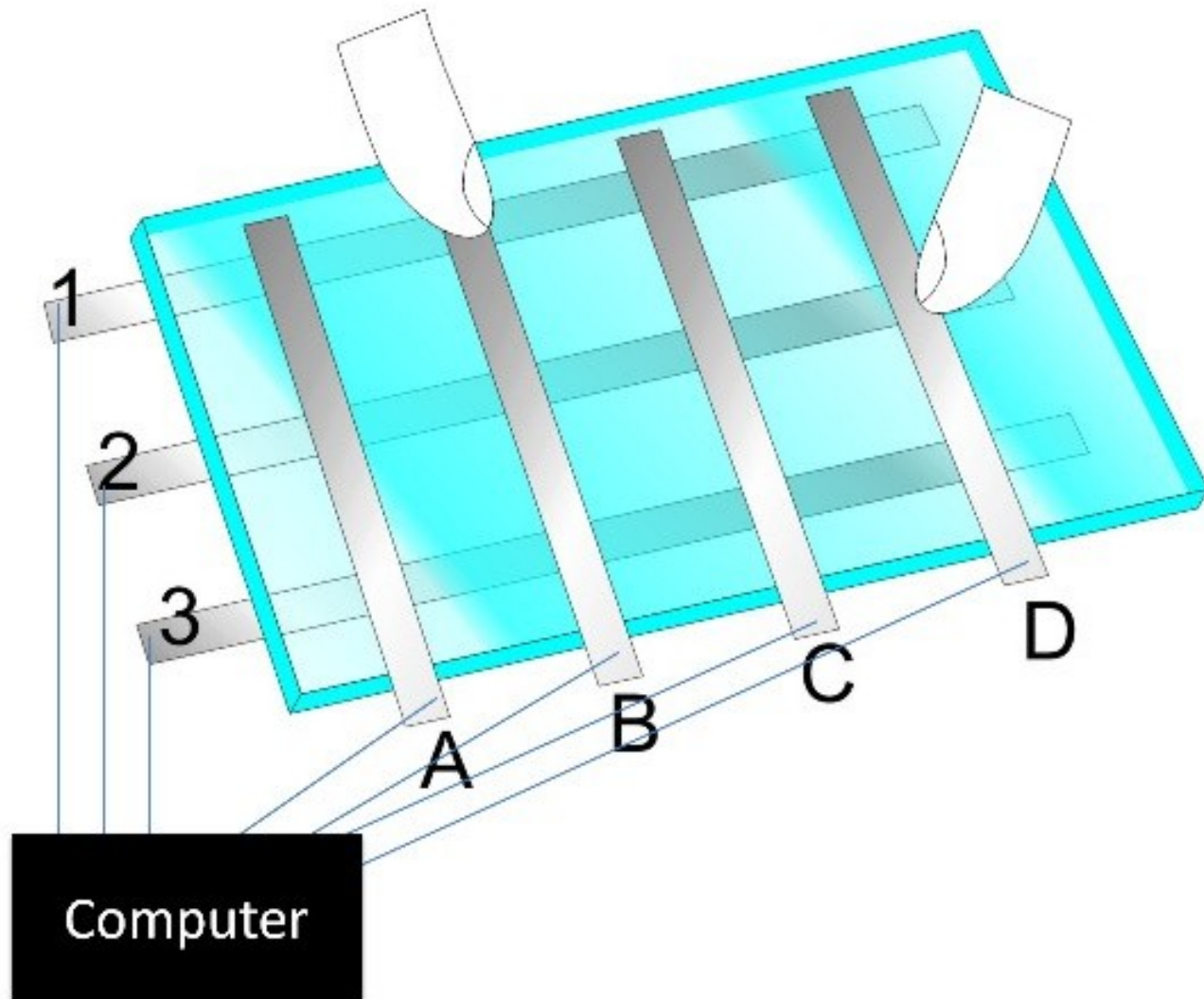
Higher capacitance at intersection of 1 & B

Capacitive

FTIR Optical

Diffuse Optical

Digital Resistive



Higher capacitance at intersection of 1 & B

Higher capacitance at intersection of 2 & D

Capacitive

FTIR Optical

Diffuse Optical

Digital Resistive

The Good:

Actually very good resolution.
Small, thin.
Doesn't need much energy.
Fairly transparent.

The Bad:

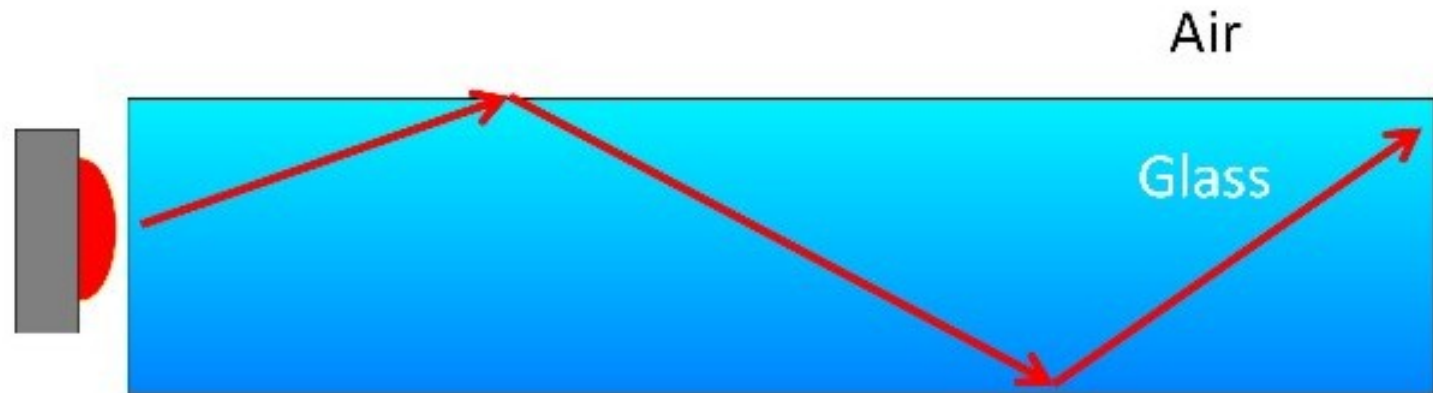
VERY sensitive to electrical noise.
Easily confused by water on the sensor.
Does block a bit of light.
Scales very badly.
Usually works with finite number of touches.

Capacitive

FTIR Optical

Diffuse Optical

Digital Resistive



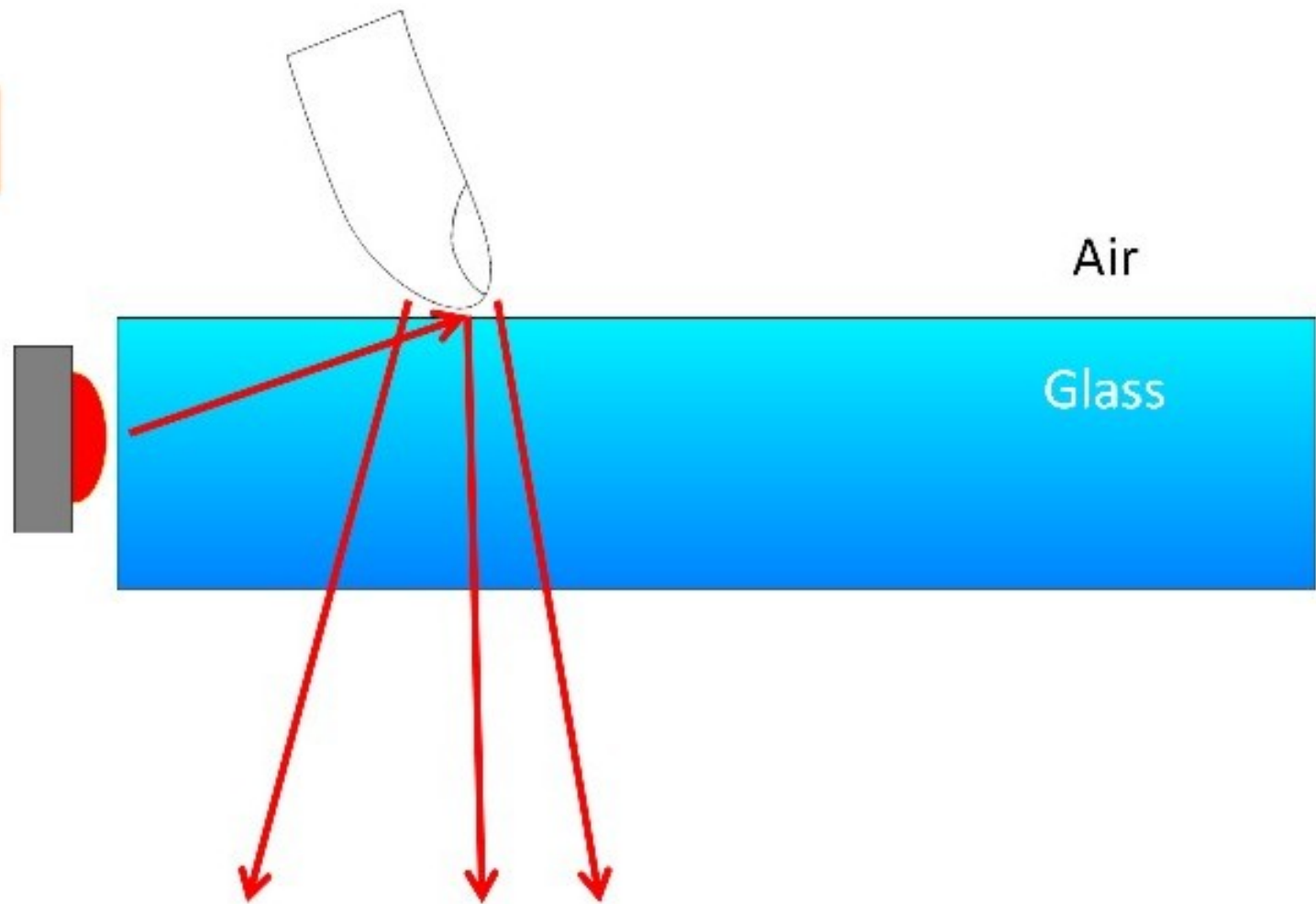
“Total Internal Reflection”

Capacitive

FTIR Optical

Diffuse Optical

Digital Resistive



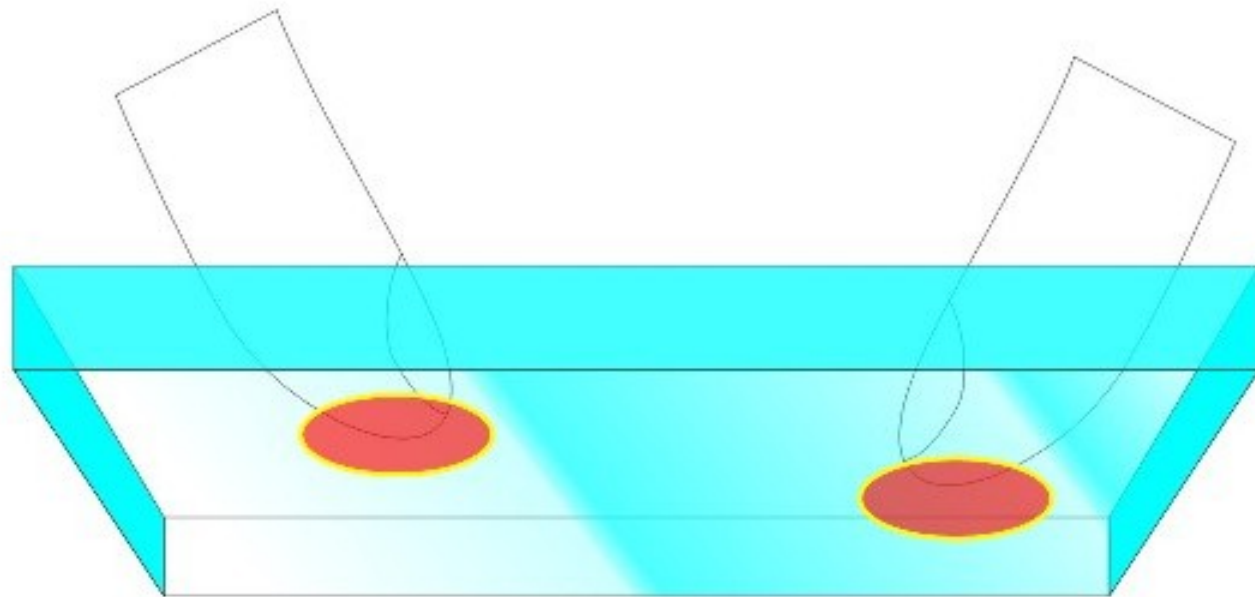
“Frustrated Total Internal Reflection”

Capacitive

FTIR Optical

Diffuse Optical

Digital Resistive



Capacitive

FTIR Optical

Diffuse Optical

Digital Resistive



Camera



Projector



Capacitive

FTIR Optical

Diffuse Optical

Digital Resistive

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.

Capacitive

FTIR Optical

Diffuse Optical

Digital Resistive



Often uses multiple cameras to calculate depth

Capacitive

FTIR Optical

Diffuse Optical

Digital Resistive

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.

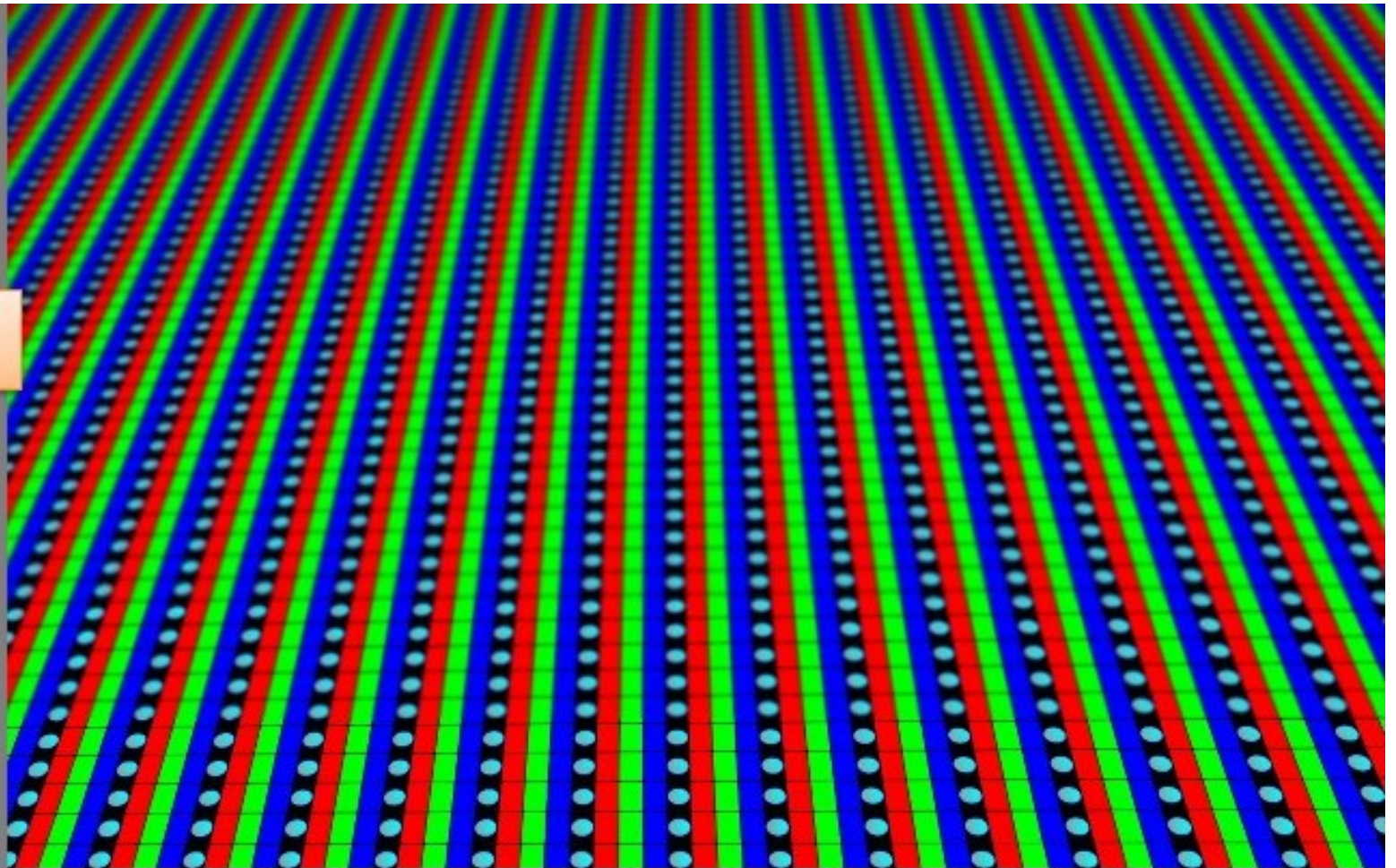
Sensitive to ambient lighting.

Capacitive

FTIR Optical

Diffuse Optical

Digital Resistive



Diffuse optical may be the future:

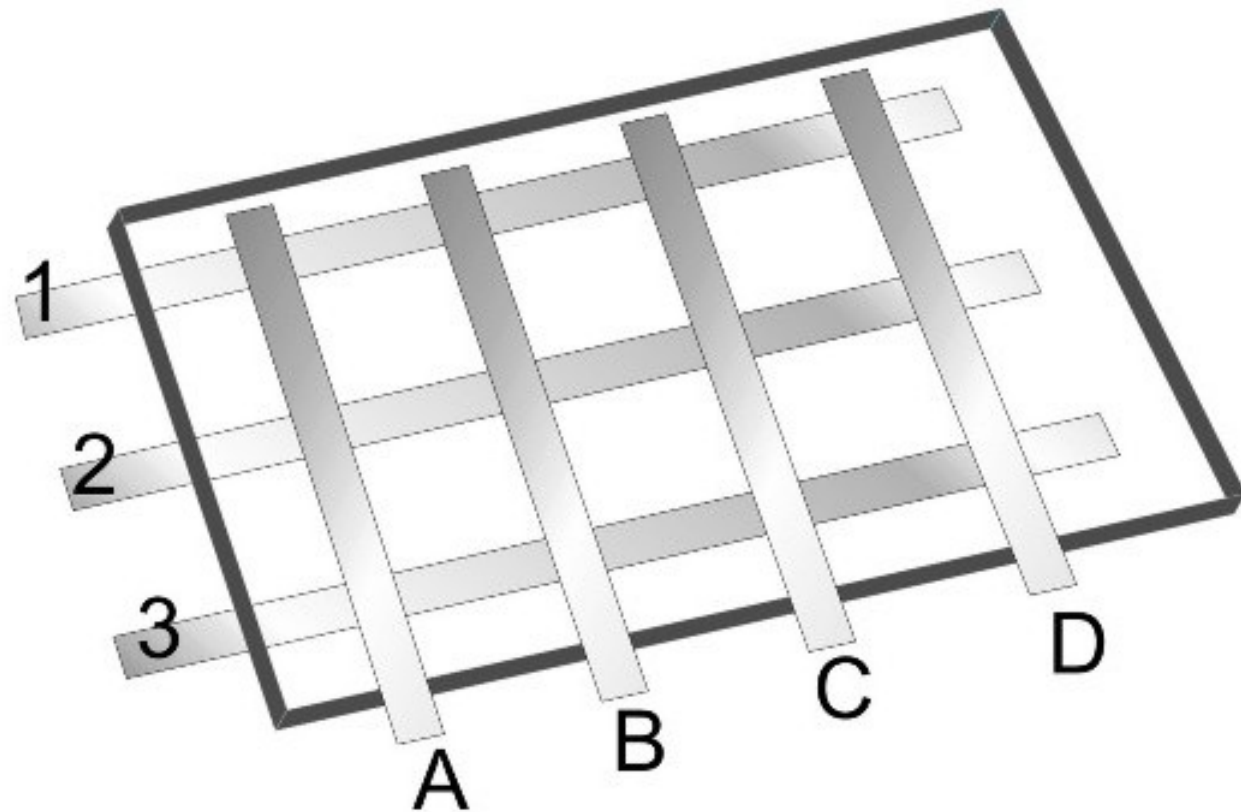
Companies are already integrating optical sensors into LCD's

Capacitive

FTIR Optical

Diffuse Optical

Digital Resistive



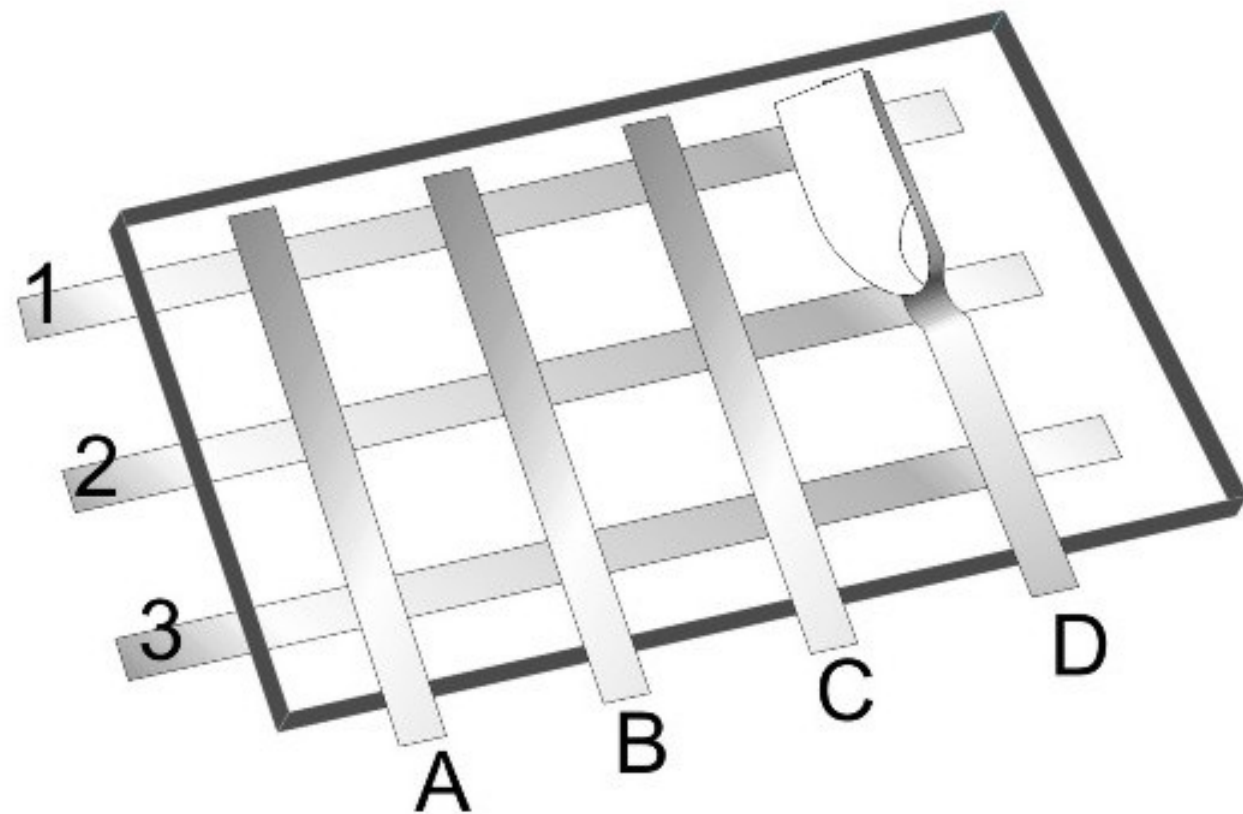
Remember the Projected Capacitive approach?
Well, just take away the glass!

Capacitive

FTIR Optical

Diffuse Optical

Digital Resistive



Remember the Projected Capacitive approach?

Well, just take away the glass!

Only problem seems to be making those wires **clear**.

Capacitive

FTIR Optical

Diffuse Optical

Digital Resistive

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?