Chapter 3: Interactive Tabletops and Surfaces

Vorlesung „Mensch-Maschine-Interaktion II”

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(slides today partly courtesy of Dr. Otmar Hilliges)

Chapter 3: Interactive Tabletops and Surfaces

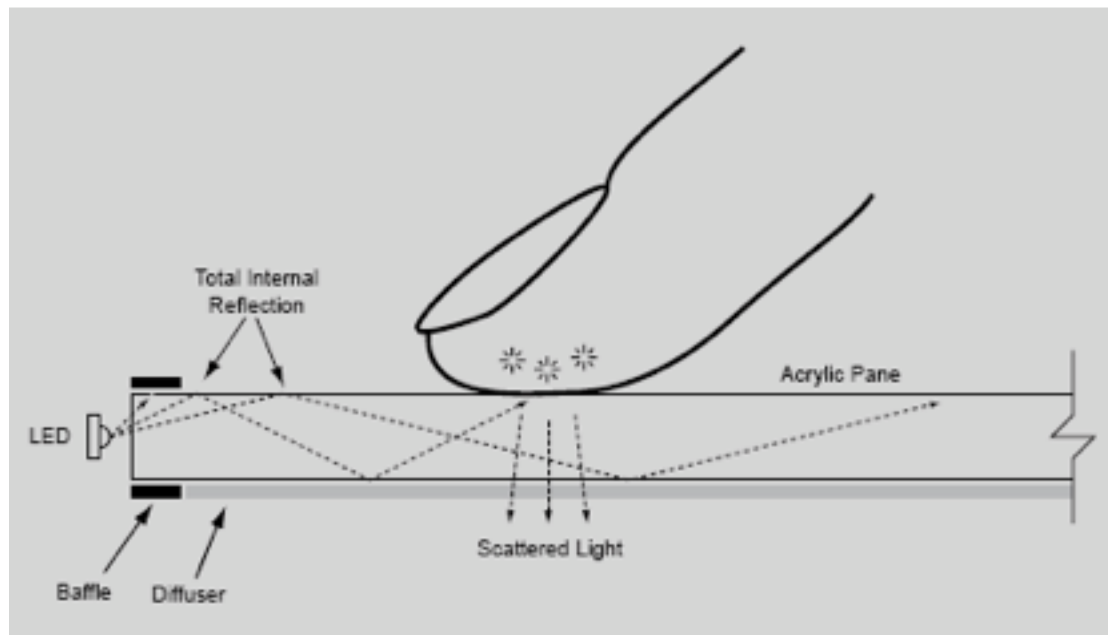
- Motivation, Vision
  - the FTIR hype
  - the SUN Starfire Video
- Early Research
  - The MIT MetaDesk
  - Pierre Wellner‘s Digital Desk
- Hardware for Interactive Surfaces
  - displays
  - input sensing

Interactive Surfaces before the FTIR hype

- Interactive Tabletops in research since early 1990ies
  - cumbersome setups, expensive technology
  - commercial prototypes early 2000s
    - e.g., „Roomware“ 2001, photo below from Fraunhofer IPSI
  - did not really catch on at a large scale
- Interactive walls also in the 90ies
  - became commercial products as interactive whiteboards
  - front or back projection
  - sensing of one or multiple pens
  - affordable and widespread today
  - use for presentation, teaching, ...

Jeff Han and the FTIR Hype

- Jefferson Y. Han (NYU): work on a cheap multi touch sensing scheme (http://cs.nyu.edu/~jhan/ftirtouch/)
- Spin-off company „perceptive pixels“
- „FTIR Hype“ started probably with a TED talk, Feb. 2006
- many refinements and DIY projects followed



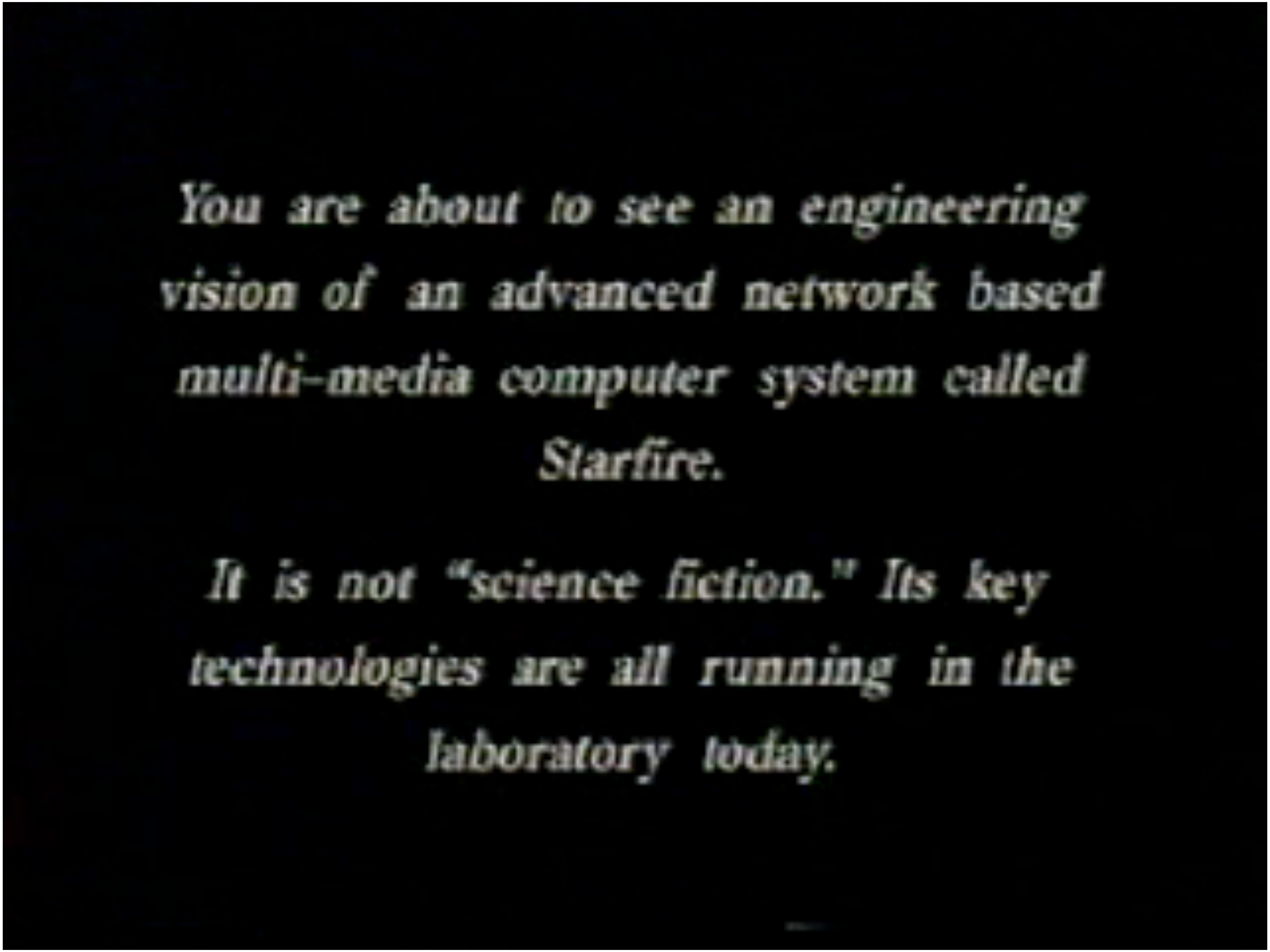
Interactive Tabletops and Surfaces Today

- Rapidly growing research field
- conference ITS 2009 in Banff, Canada:
  - started in 2006 as IEEE tabletop workshop
  - ~150 participants, 30 papers, conference status
  - 2010 will be in Germany (more submissions in 2009 from Germany than from USA)

- Commercial interest since „Perceptive Pixels“ and the Microsoft Surface
- Multi Touch also popularized by the iPhone

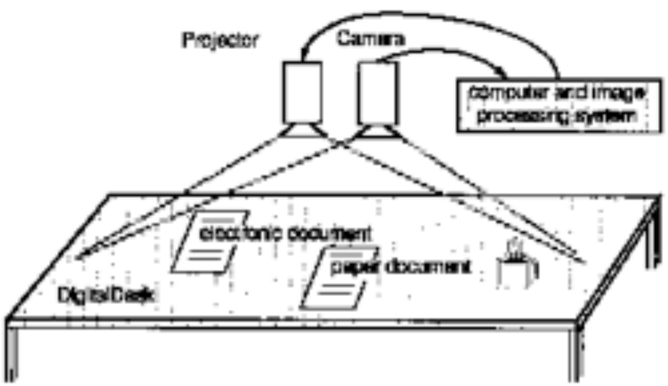
SUN Starfire - an early vision

- concept video produced in 1992
- only shows existing or almost existing technology
- features a curved high resolution interactive surface
- multimodal interaction with the system
- http://www.asktog.com/starfire/


You are about to see an engineering vision of an advanced network based multi-media computer system called Starfire.
It is not "science fiction." Its key technologies are all running in the laboratory today.

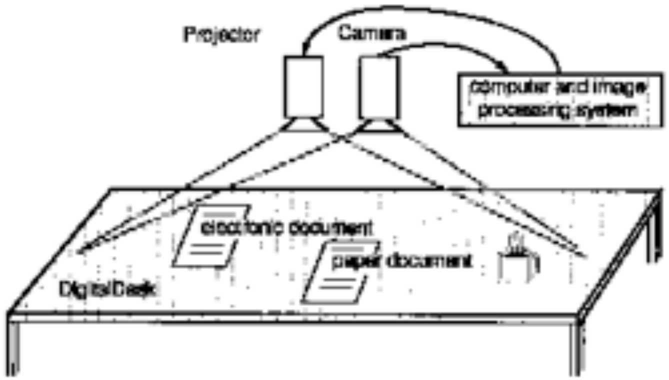
Historic Interactive Surfaces

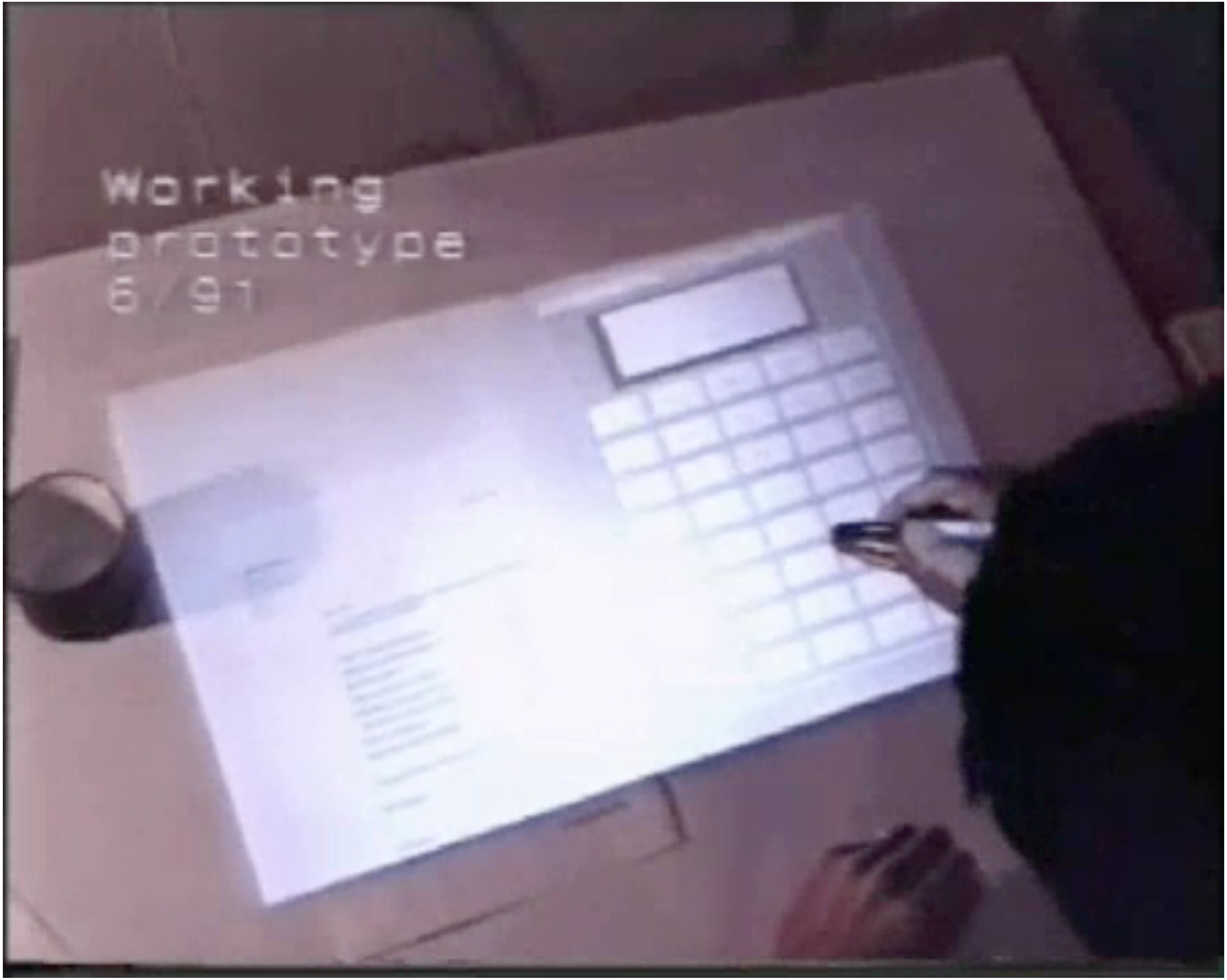
- read http://www.billbuxton.com/multitouchOverview.html !
- early experiments with multi touch in the 1980ies
- For this lecture: 2 prominent historic examples:
  - Pierre Wellner‘s Digital Desk
  - MIT MetaDesk



Pierre Wellner‘s Digital Desk

- Working prototype in 1991
- Regular table with top projection
- Overhead camera to detect fingers
- Camera can also scan paper on the desk
- Interaction with printed paper and digital applications on the same surface




Working
prototype
6/91

The MIT MetaDESK

- Platform for exploring Tangible UIs (Ullmer & Ishii, 1997)
- Also uses top projection
- Various projects built on top of it

Interactive Surface Hardware

- (Visual) output: Display
  - quite well understood
  - simple solution: projection: front or back (or side ;-)
  - screens built into tables
  - modification of screen hardware
- Input: Sensing
  - much less well understood
  - many concurrent approaches, each with its drawbacks
  - categories: resistive, capacitive, optical, ...
  - wide field of ongoing research

Display: Front Projection

- what we are doing here in class
- simplest way to produce visual output on any surface
- pro:
  - cheap, simple
  - even light distribution
  - no additional space needed
  - space for legs under the table
- contra
  - interacting hand and person cast a shadow
  - only feasible for tabletops when firmly mounted

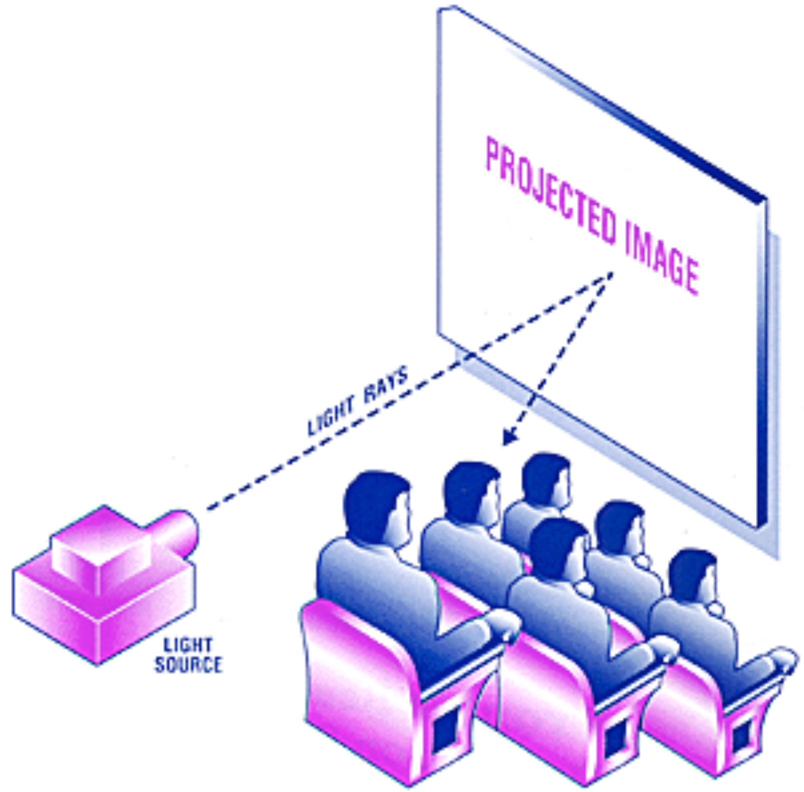
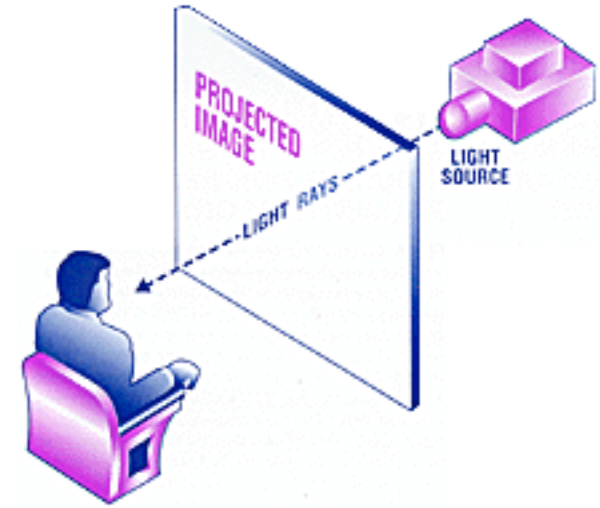


image source: http://www.rosco.com/

Display: Rear Projection

- Pro:
  - projector is hidden, space in front empty
  - no shadowing of the surface
- Contra:
  - Can only be done with space behind
  - complex mirror construction for tabletops
  - can create „hot spot“ with cheap screen



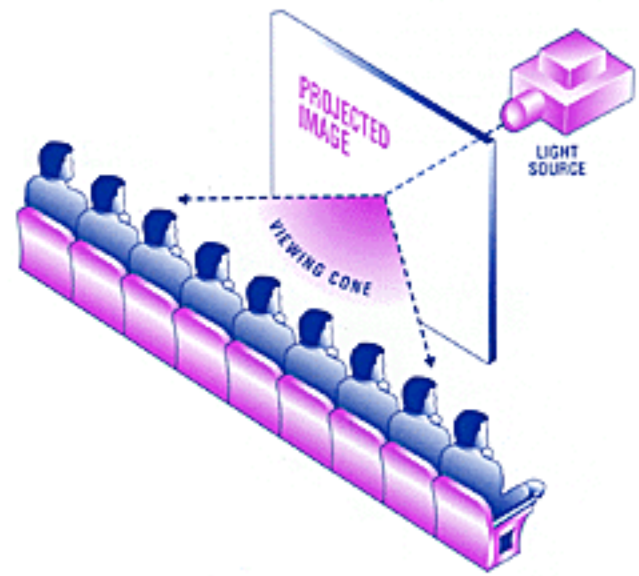
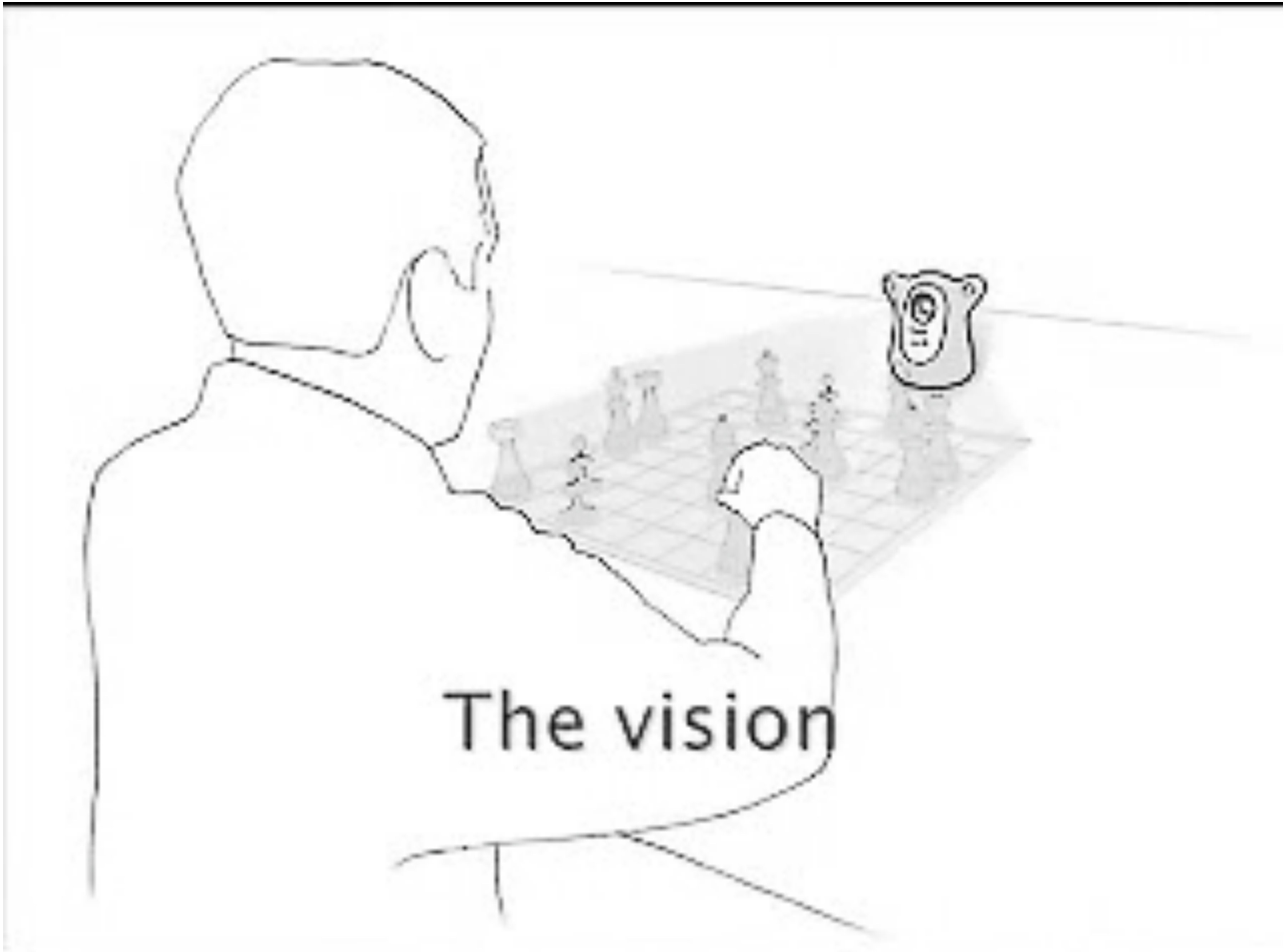


image source: http://www.rosco.com/

Display: Projection from the side ;-)

- PlayAnywhere, Andy Wilson (Microsoft Research), 2005
- Uses commercial short throw projector for front projection at an angle of 40 degrees
- Uses cameras for sensing
  - mounted off axis from the projection
  - can see shadows caused by front projection
  - can recognize fingers and markers
- Turns any flat surface (e.g., table) into an interactive surface

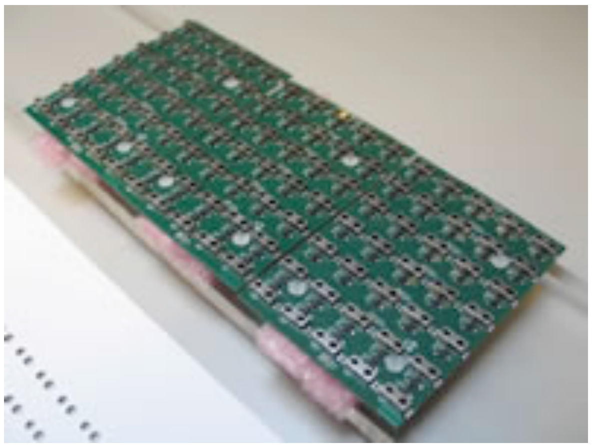

The vision

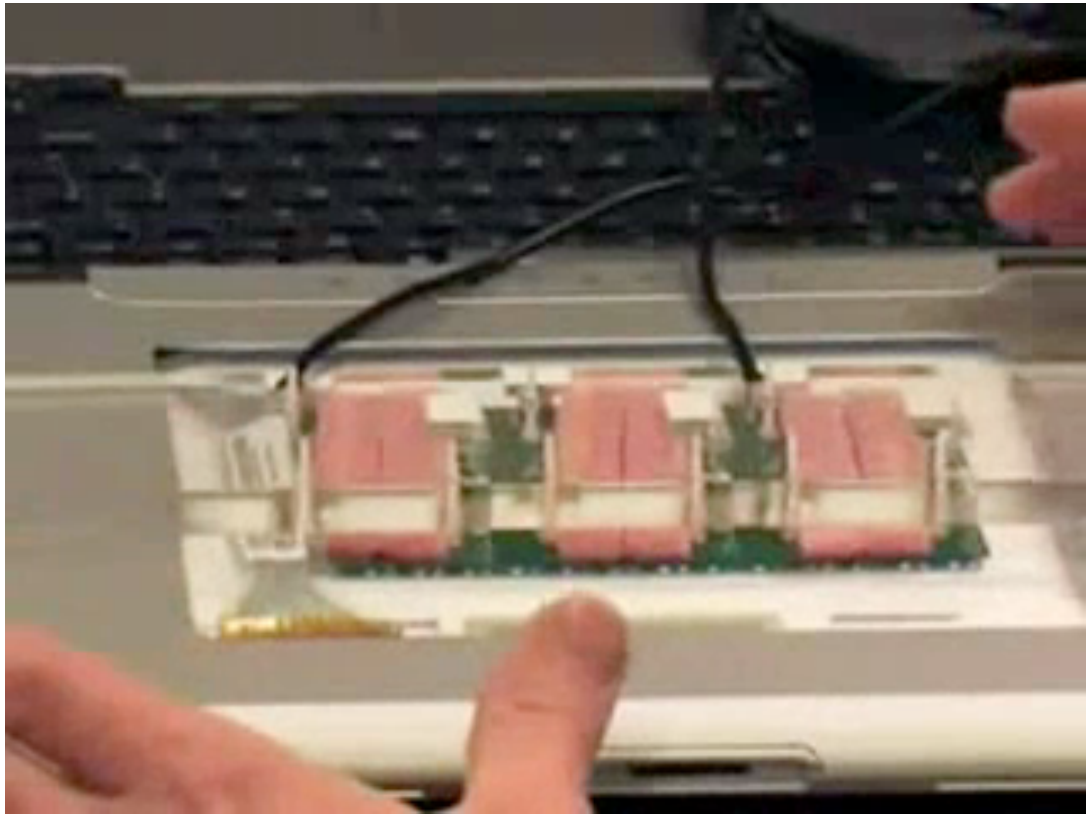
Display: Screens

- What we initially used in our tabletop research @LMU
  - High resolution and contrast + great color
  - Insensitive to ambient light
  - Can be bought with touch overlay for sensing

Screen with integrated sensing: ThinSight

- Izadi (Microsoft Research), 2007
- Shines IR light through LCD from the back
- Mesures Reflection from objects or fingers
- low resolution prototype
- senses simple gestures
- could turn display into a scanner/camera

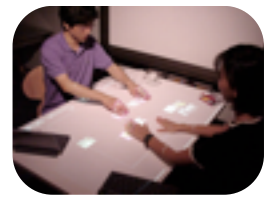


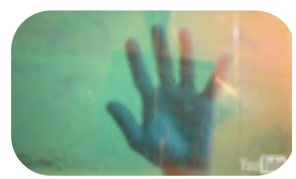
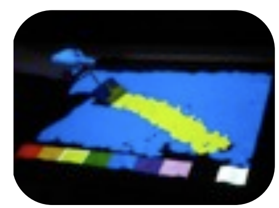


Sensing

- Embedded sensors
  - Capacitive
  - Resistive
  - Optical
- Camera Infrared
  - FTIR
  - Diffuse Illumination
- Others

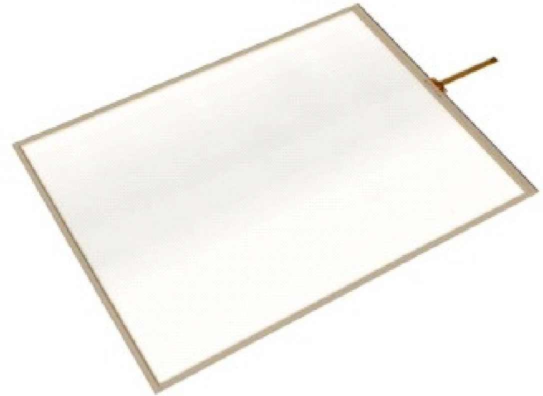


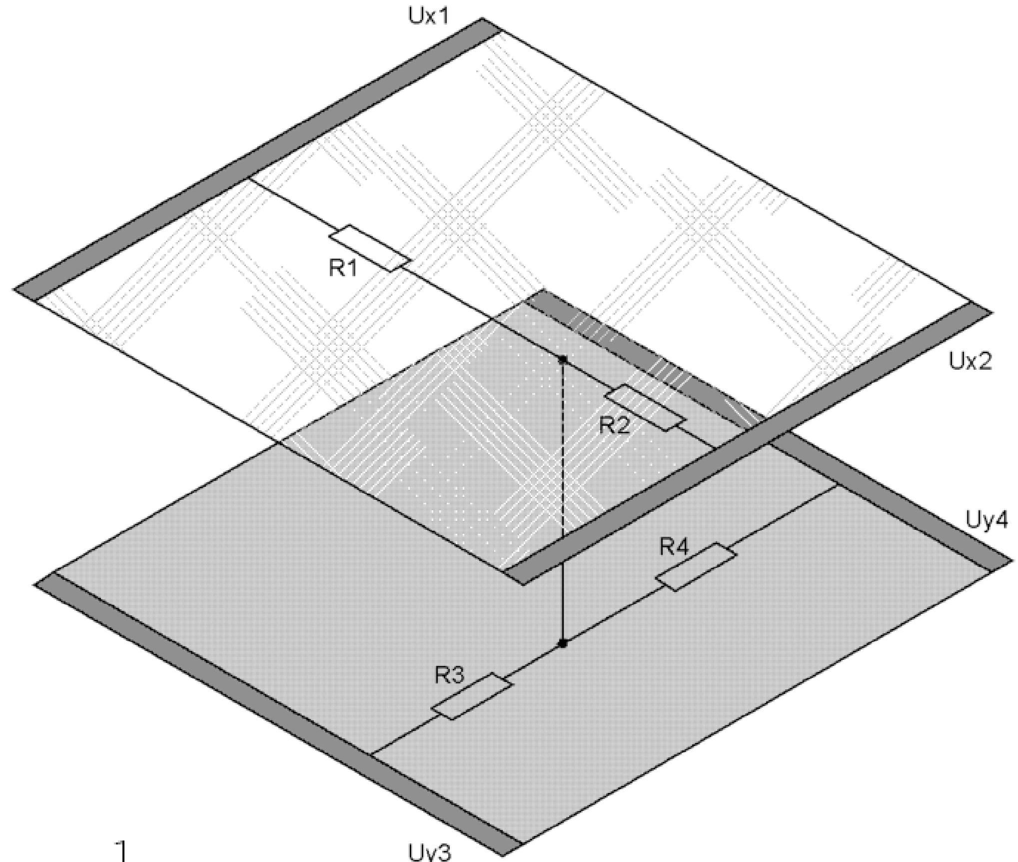




Classical touch screen

[http://de.wikipedia.org/wiki/Touchscreen]



- Two sheets of conductive, transparent material
- Connected by finger or pen pressure
- Resistance measurements
  - Between X electrodes
  - Between Y electrodes



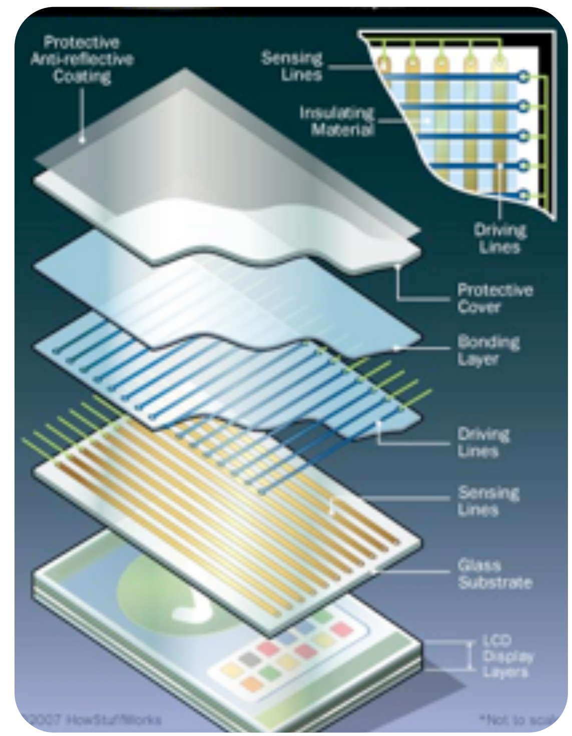
$$Uy_3 = Uy_4 = Ux_2 + \frac{(Ux_1 - Ux_2) * R_2}{R_1 + R_2} = 0V + 5V * \frac{1}{3} = 1,66V$$

Capacitive Sensing

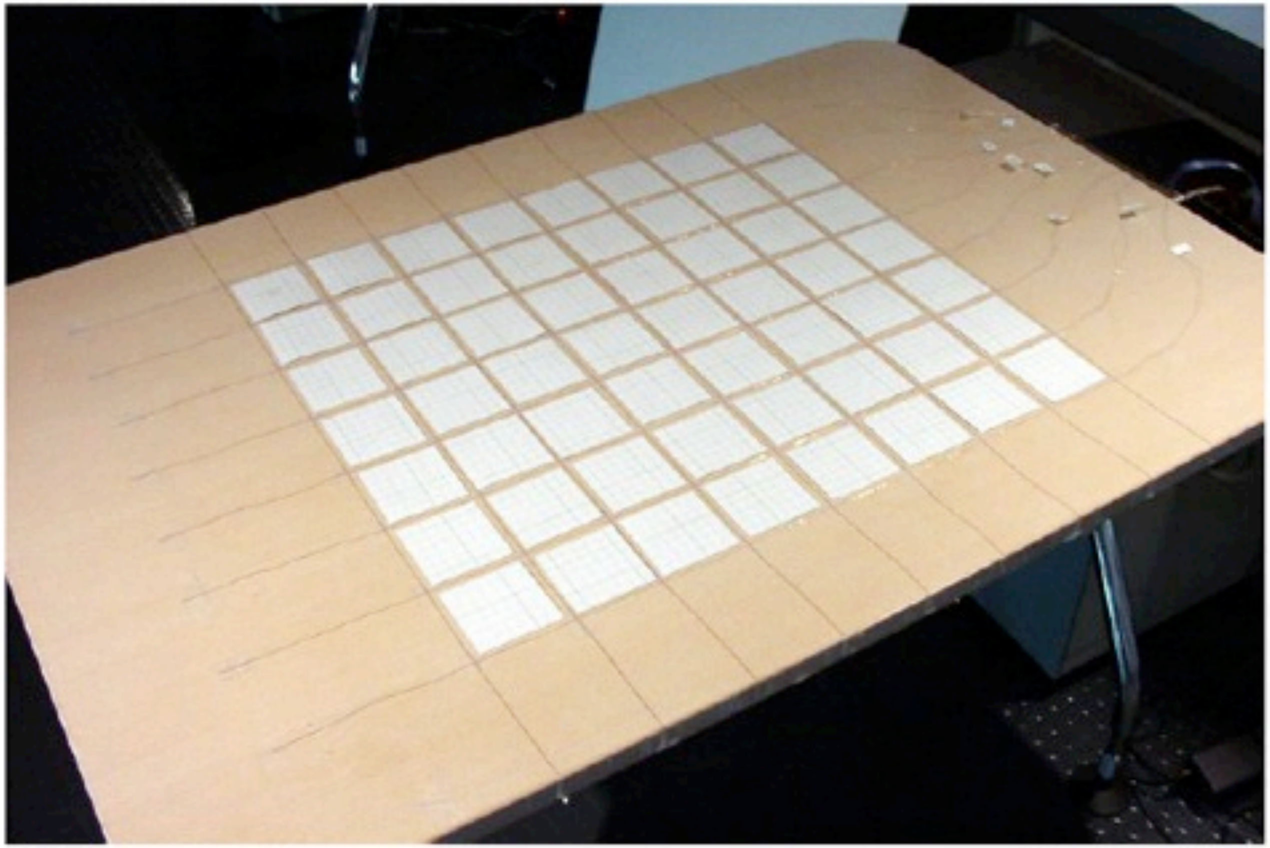
- Layer of conductive material holds charge
- Finger approaching the surface changes the amount of charge
- requires grid of driving and sensing lanes
- OR individual electrodes embedded in one layer

[Dietz Leigh'01]

[Rekimoto'02]



Capacitive Sensing: Sony SmartSkin



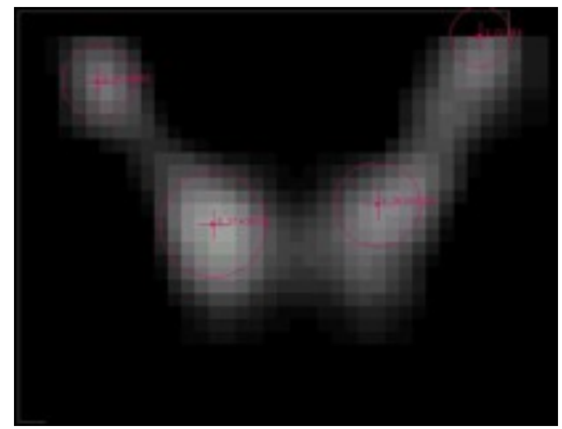


Figure 3: Interactive table with an 8 × 9 SmartSkin sensor: A sheet of plywood covers the antennas. The white squares are spacers to protect the wires from the weight of the plywood cover.

Capacitive Sensing: Sony SmartSkin

- finger only changes capacitive coupling in grid

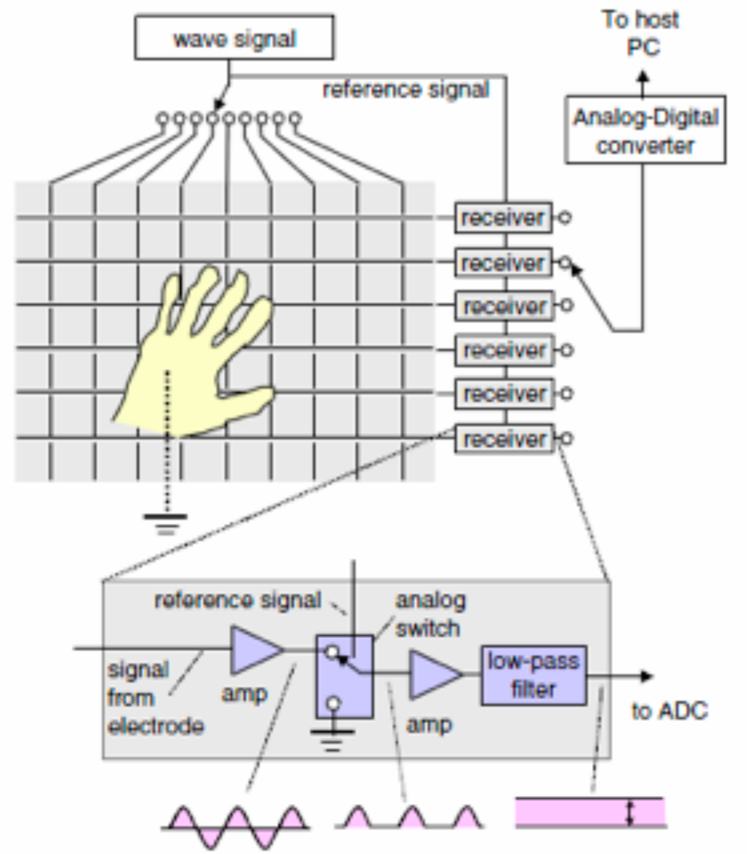


Figure 2: The SmartSkin sensor configuration: A mesh-shaped sensor grid is used to determine the hand's position and shape.

Capacitive Sensing: MERL DiamondTouch

- finger acts as one electrode of the capacitor
- connection e.g., through the chair
- different users send different signals
- finger identification solved!!

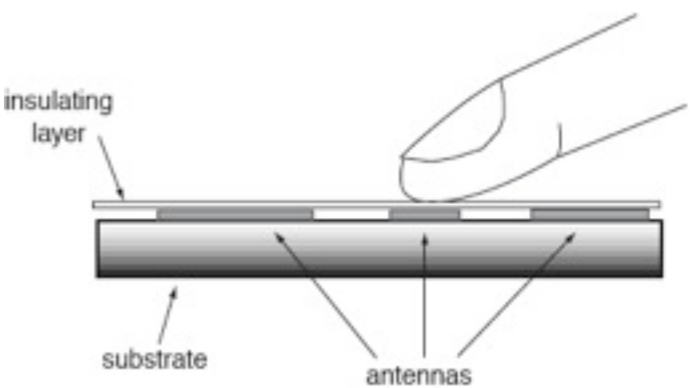
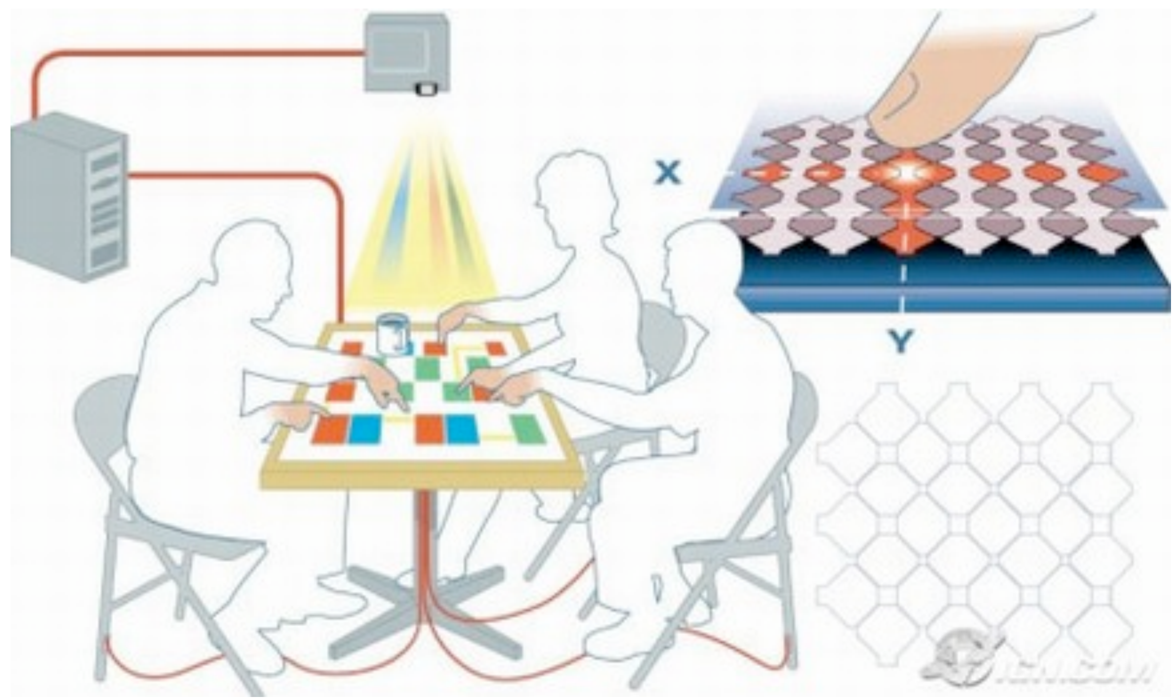
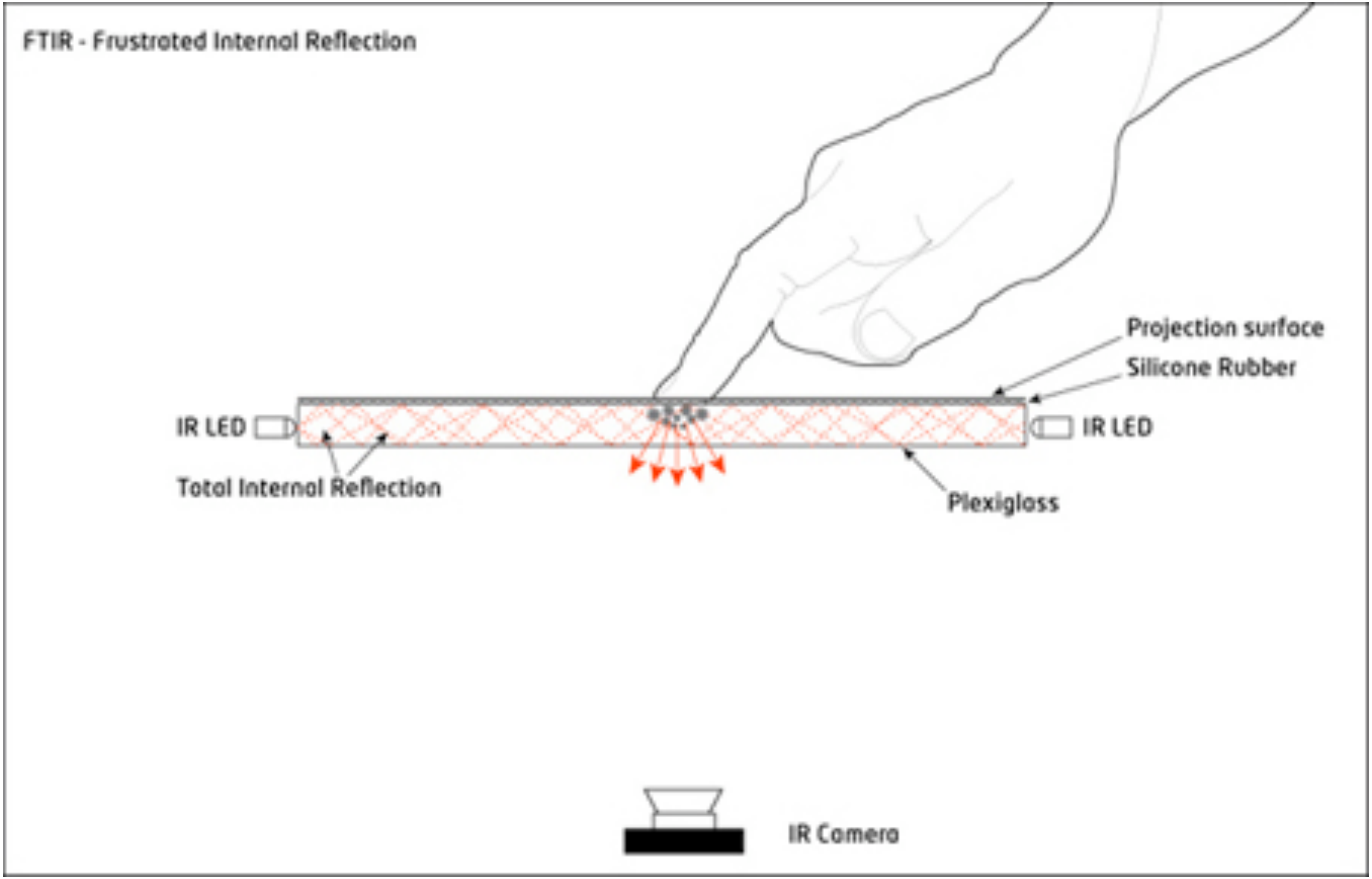


Figure 3: A set of antennas is embedded in the table-top. The antennas are insulated from each other and from the users.

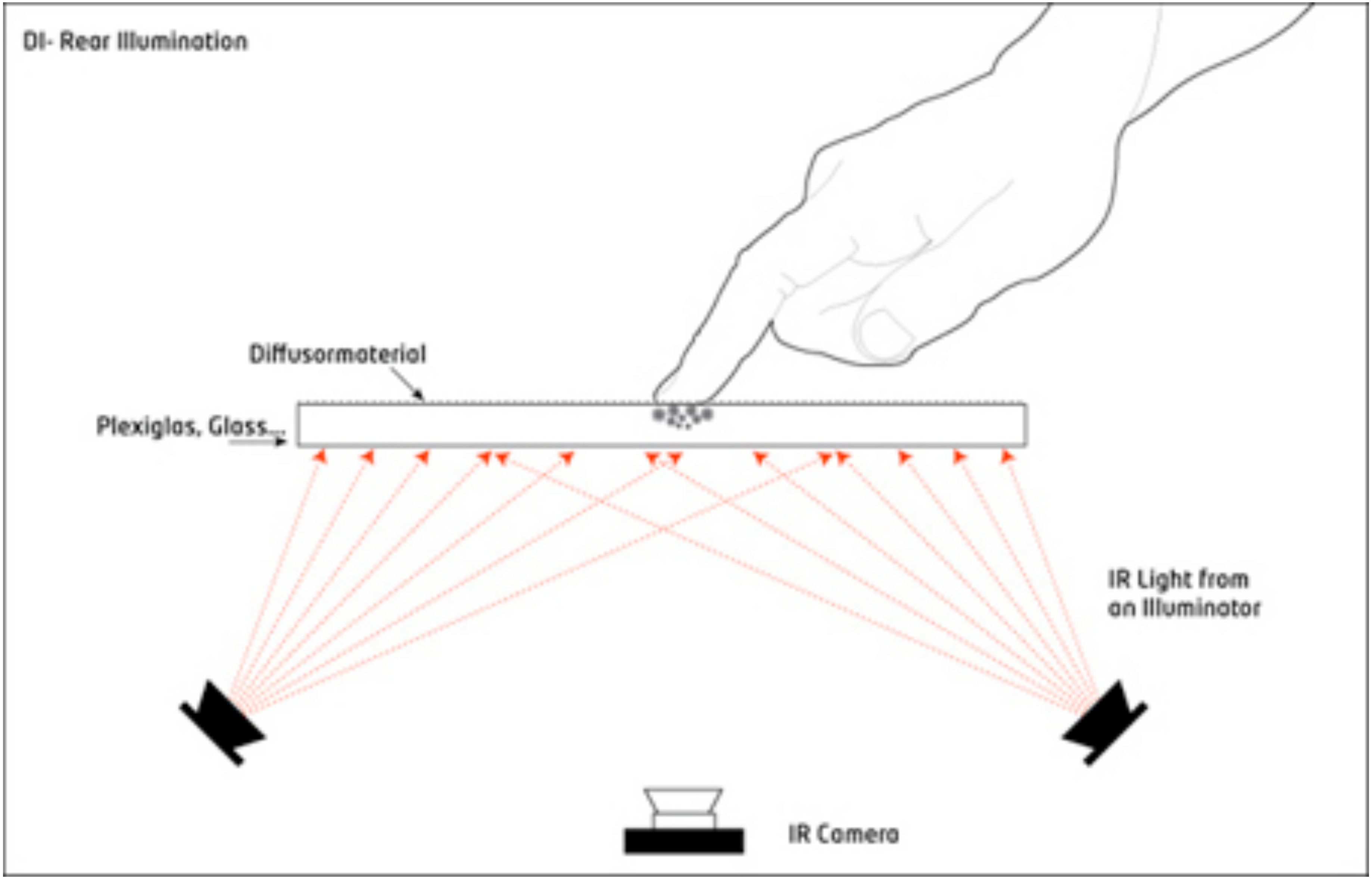


Optical Sensing - FTIR



http://iad.projects.zhdk.ch/multitouch/

Optical Sensing - DI



http://iad.projects.zhdk.ch/multitouch/

TouchLight

- Andy Wilson, ICMI 2004
- Projection onto Holofilm (transparent projection screen)
- imaging through the screen ==> funny effects possible

Optical tracking from the side: SmartTech SmartBoard DViT

Figure 1: DViT Technology Camera

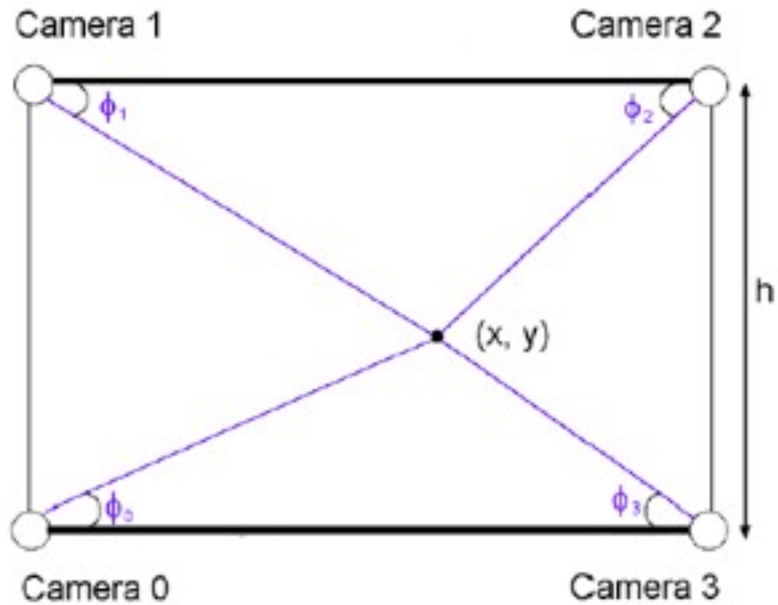
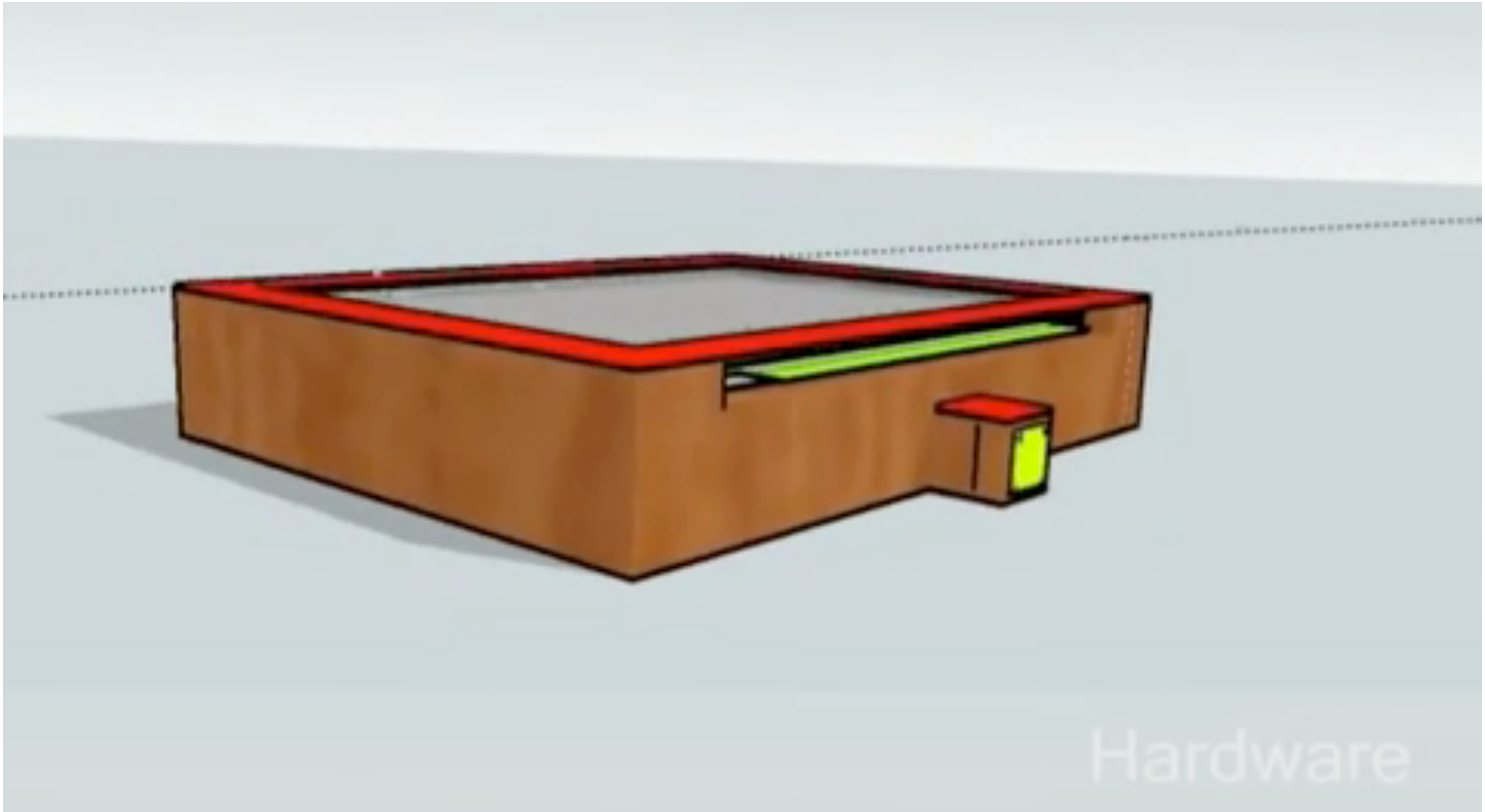


Figure 2: Camera Identification of a Contact Point

- 4 cameras, 100FPS
- can be overlaid to screens, projection surfaces etc..
- theoretically 4, practically 2 (narrow) contact points
- http://www.smarttech.com/dvit/index.asp

Optical Tracking twisted: Fiberboard



Multitouch DIY project for the weekend!