

# Mensch-Maschine-Interaktion 2

## Interactive Environments

Prof. Dr. Andreas Butz, Dr. Julie Wagner



# Interactive Environments

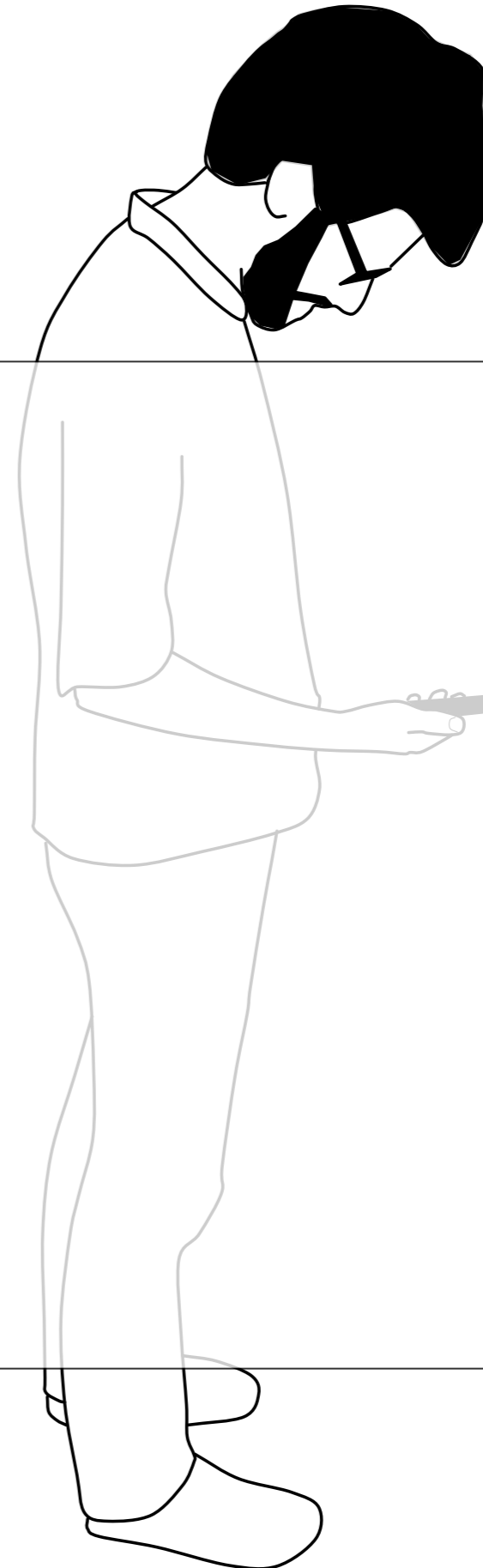
context and task

challenges

**input technologies**

challenges in interaction  
design

output technologies



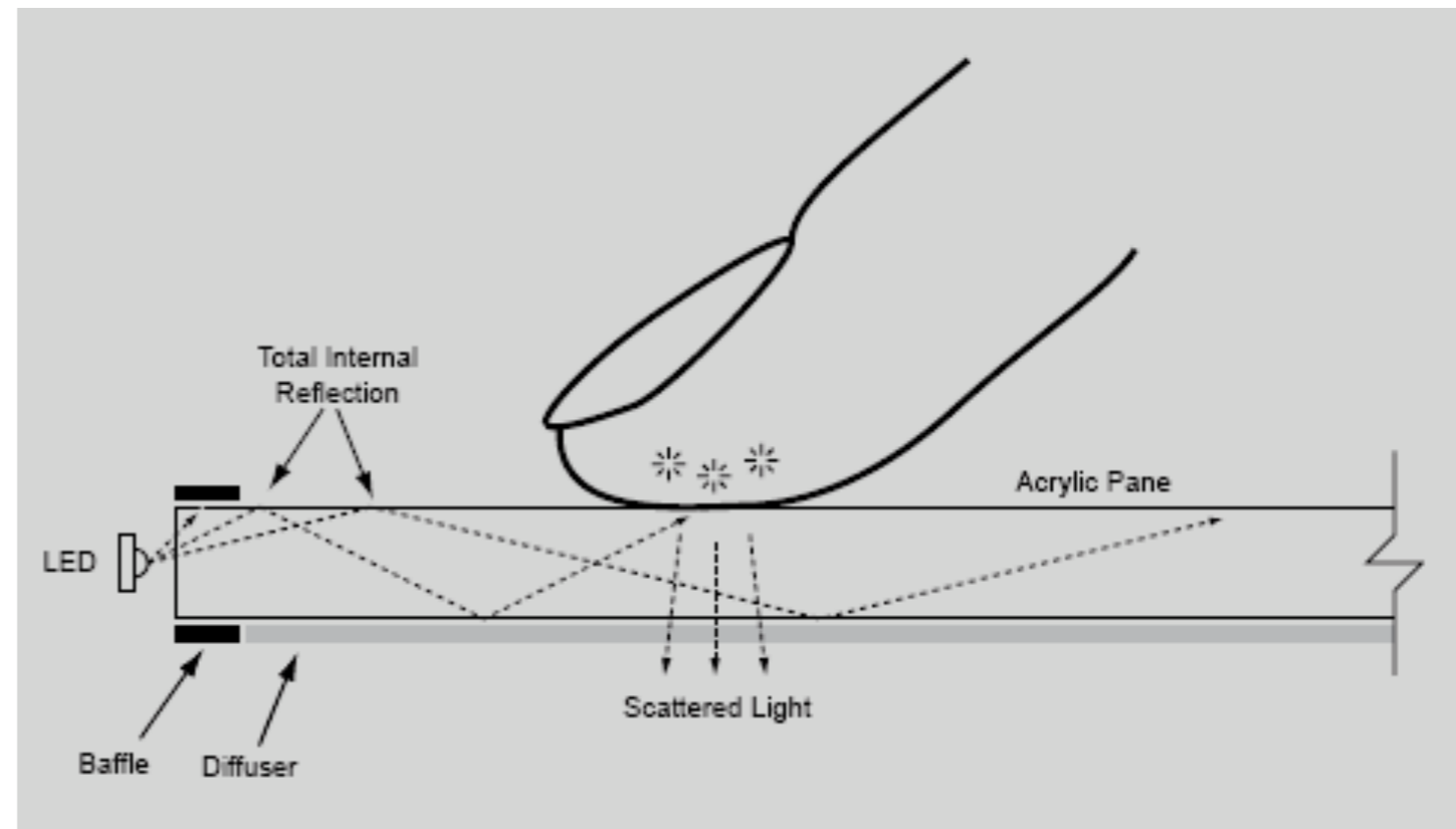
# Interactive Surfaces before the FTIR hype

- 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
  - started in 2006 as IEEE tabletop workshop
  - 2009 in Banff, Canada: ~150 participants, 30 papers, conference status, more submissions from Germany than from USA ;-)
  - 2012: next week in Cambridge/MA, submission by D. Baur (ex-LMU) nominated for best paper award
- Commercial interest since „Perceptive Pixels“ and the Microsoft Surface
- Multi Touch also popularized by the iPhone / iPad etc...

# 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.*

# Discussion about the Starfire video

- What ironic side remarks on society did you catch?
- What of the technology shown has become...
  - reality long since?
  - a technological failure?
  - a current topic of research?
- How long does it take for technologies to catch on?



context and task

challenges

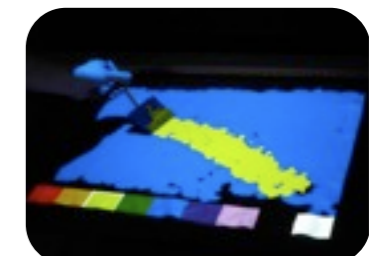
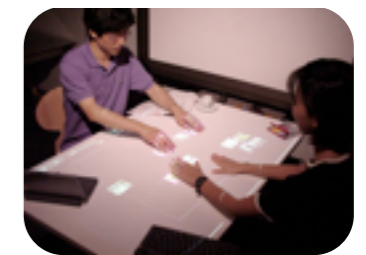
input technologies

challenges in interaction design

output technologies

# Sensing

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



# Capacitive Sensing

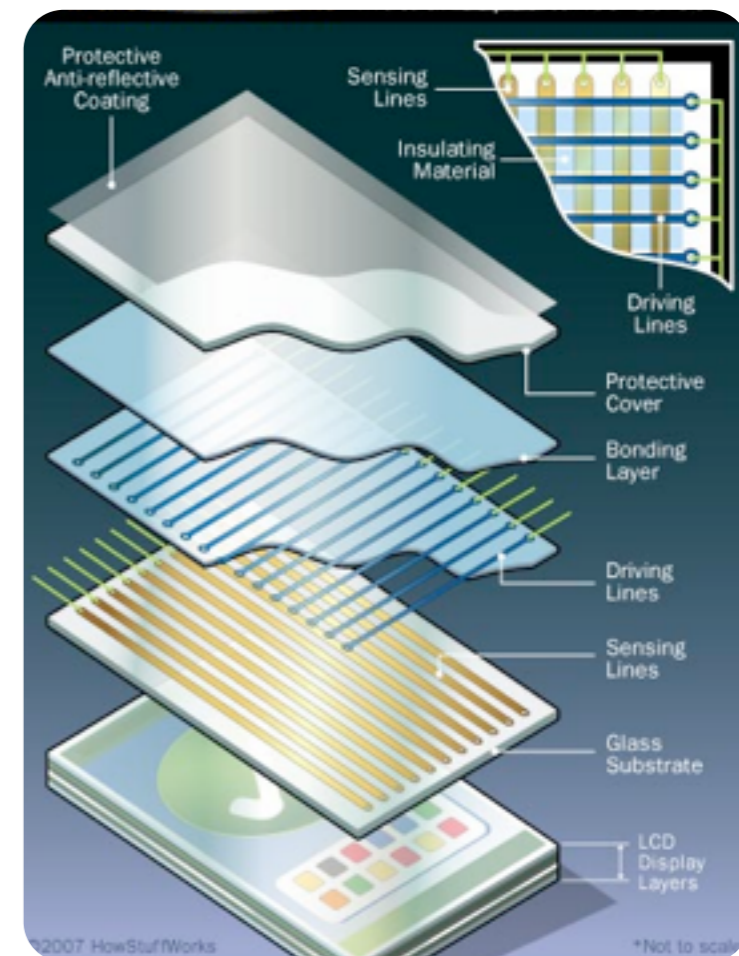
- Layer of conductive material holds charge
- Finger approaching the surface changes the amount of charge
- requires grid of driving and sensing lanes
- OR individual electrodes embedded in one layer



[Dietz Leigh'01]



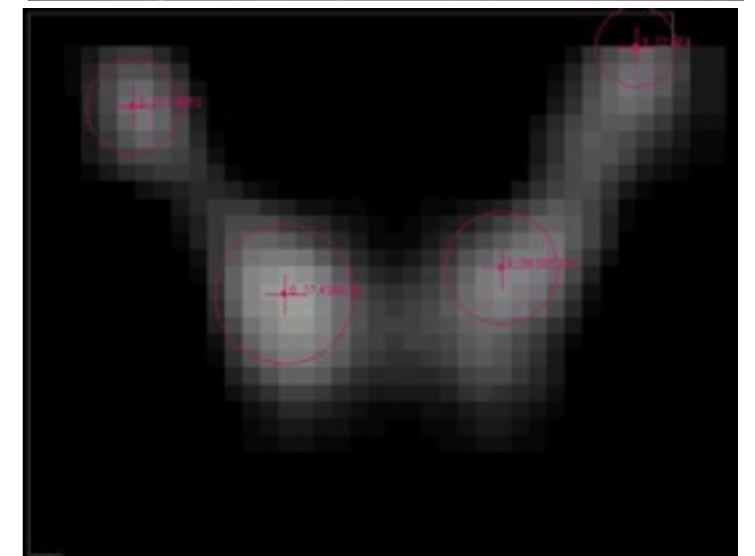
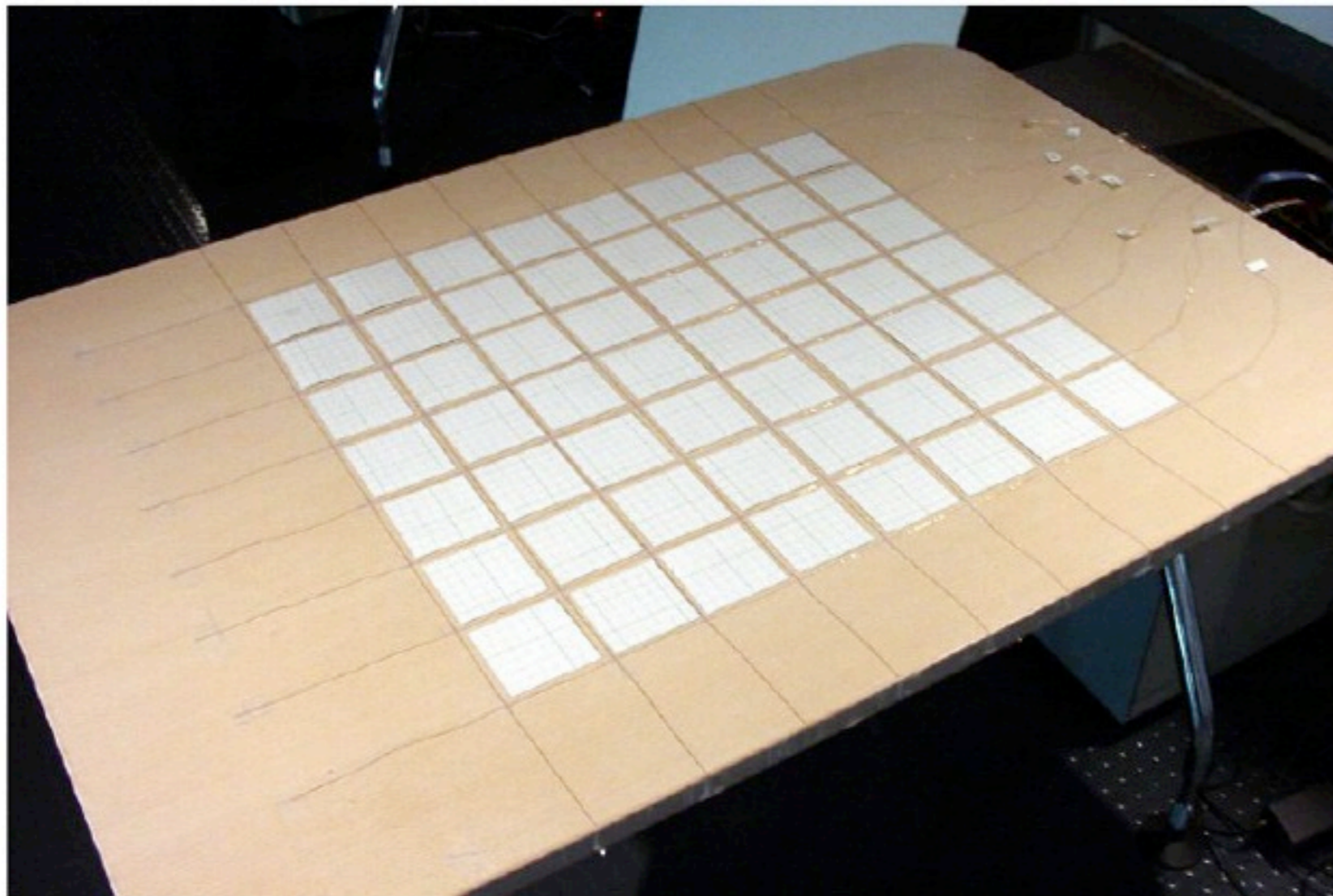
[Rekimoto'02]





# Capacitive Sensing: Sony SmartSkin

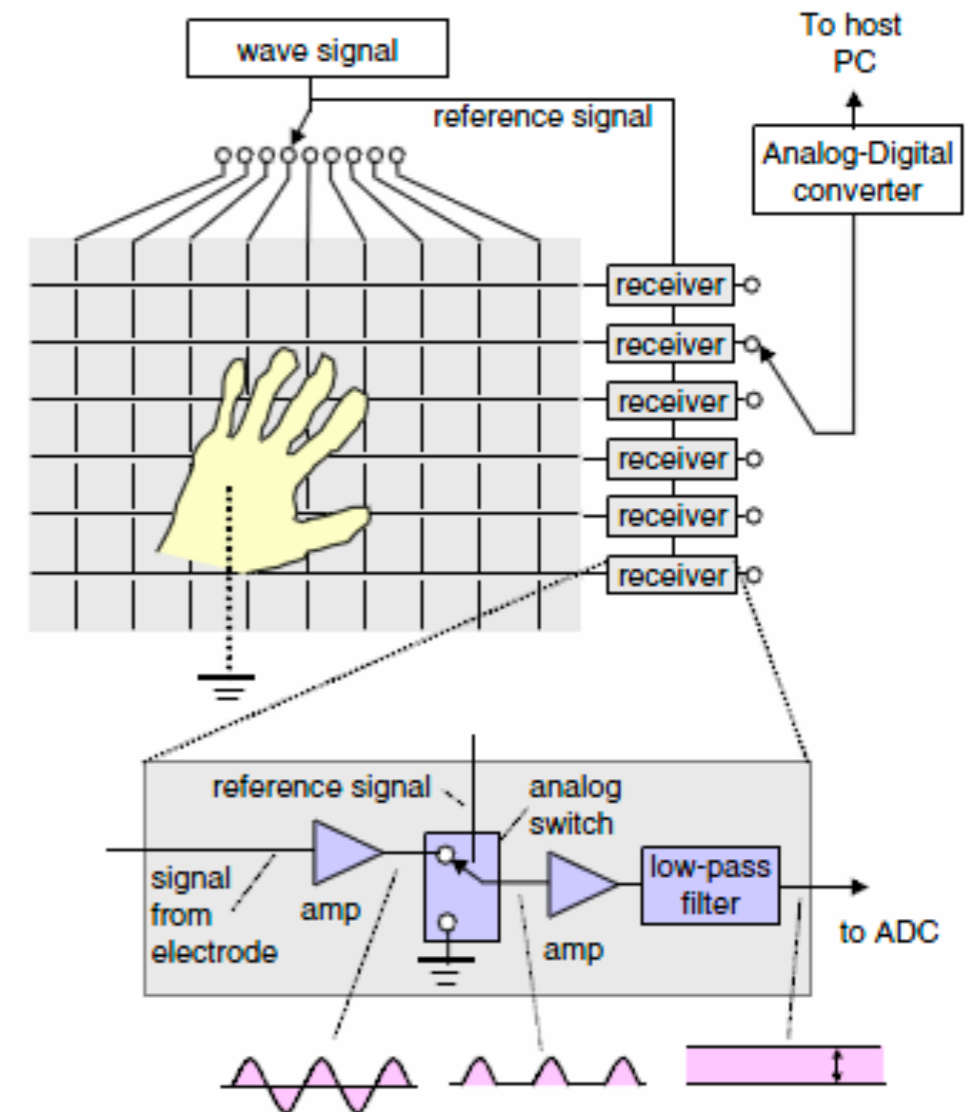
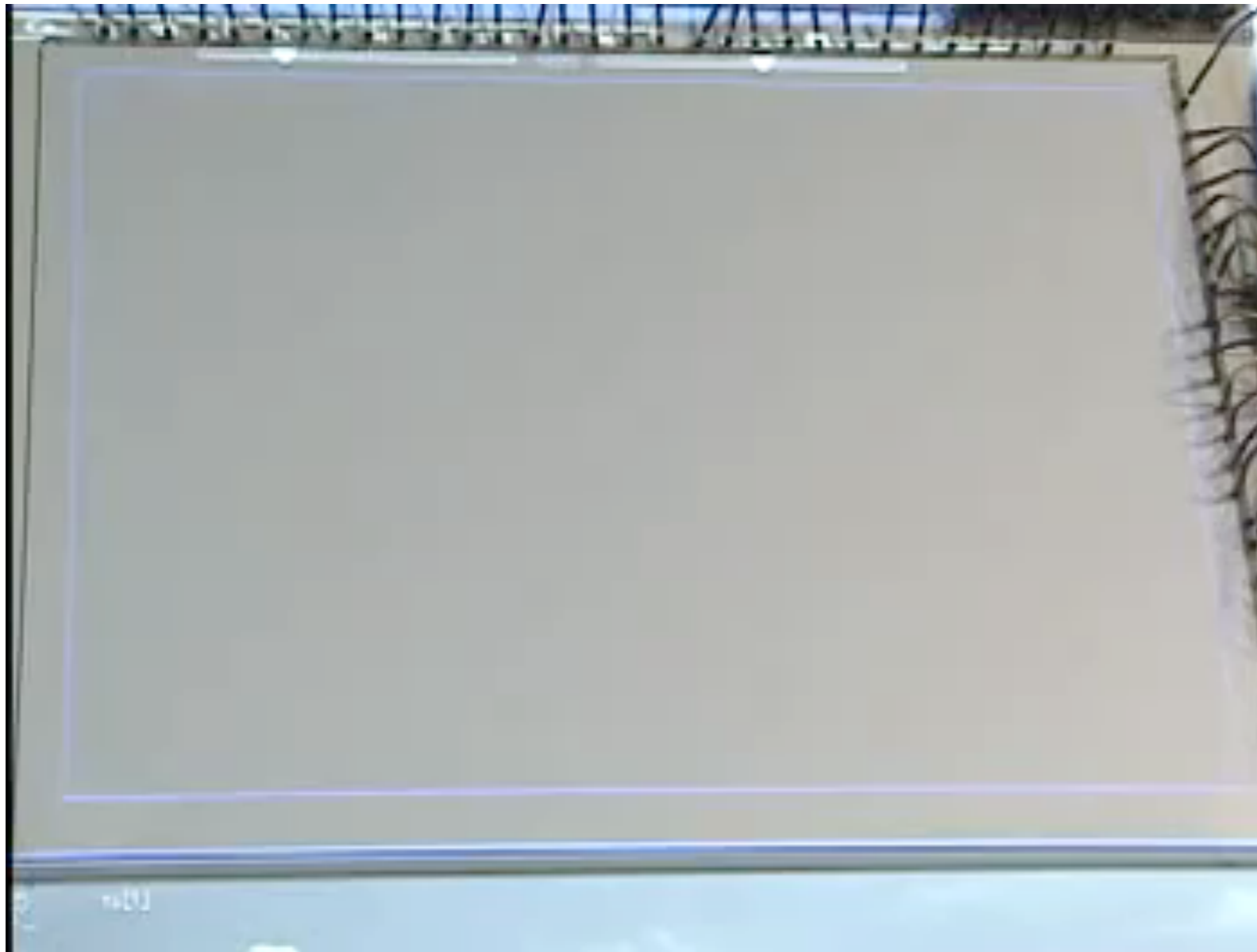
Jun Rekimoto, SmartSkin: An Infrastructure for Freehand Manipulation on Interactive Surfaces, CHI2002



**Figure 3: Interactive table with an  $8 \times 9$  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.**

<http://www.sonycsi.co.jp/person/rekimoto/smartskin/>



# Capacitive Sensing: MERL DiamondTouch

Dietz, P.; Leigh, D. "DiamondTouch: A Multi-User Touch Technology". UIST 2001

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

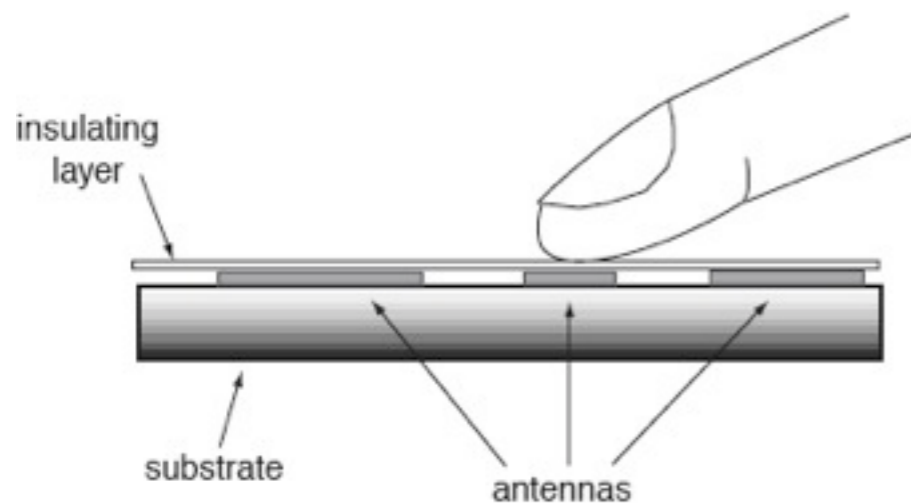
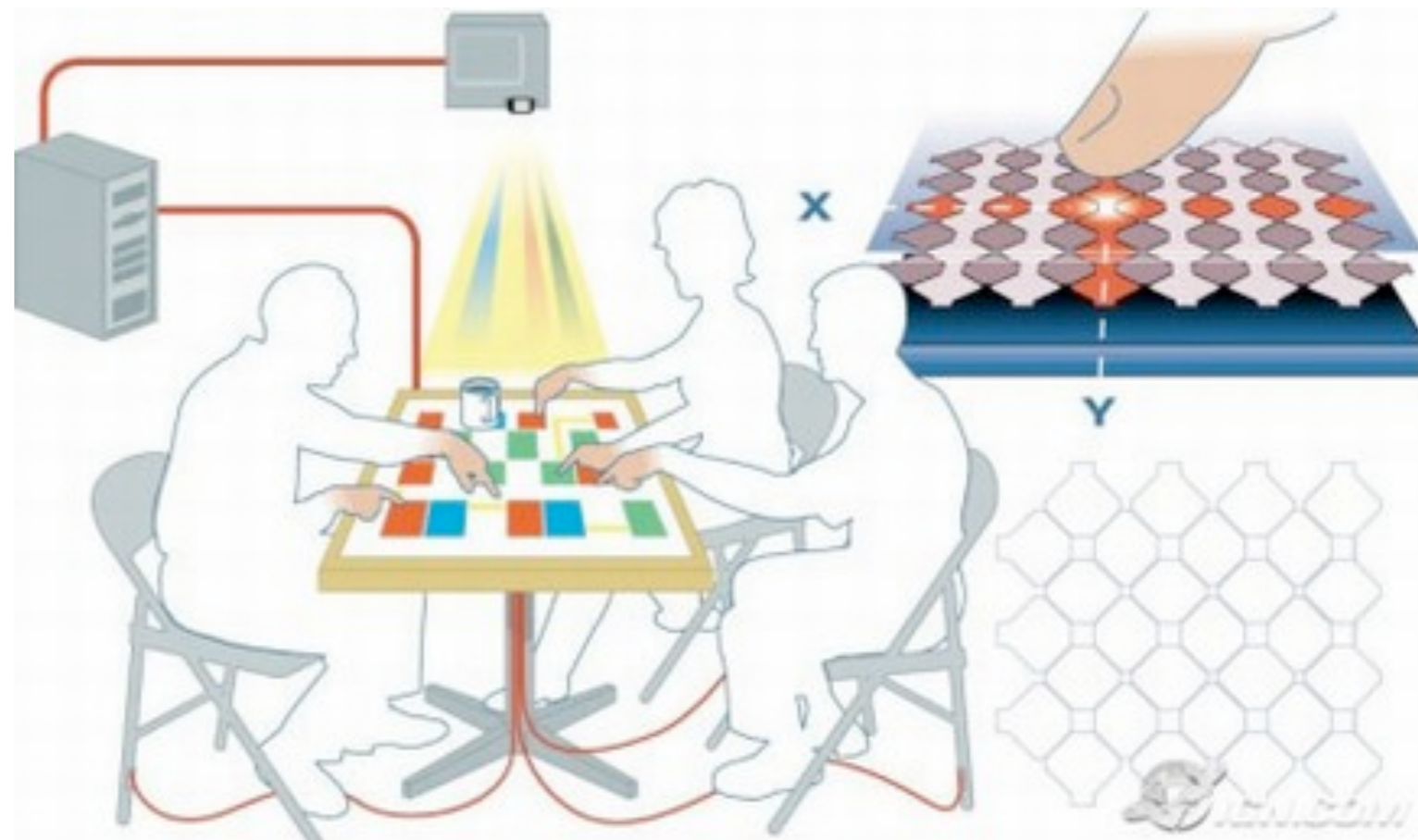
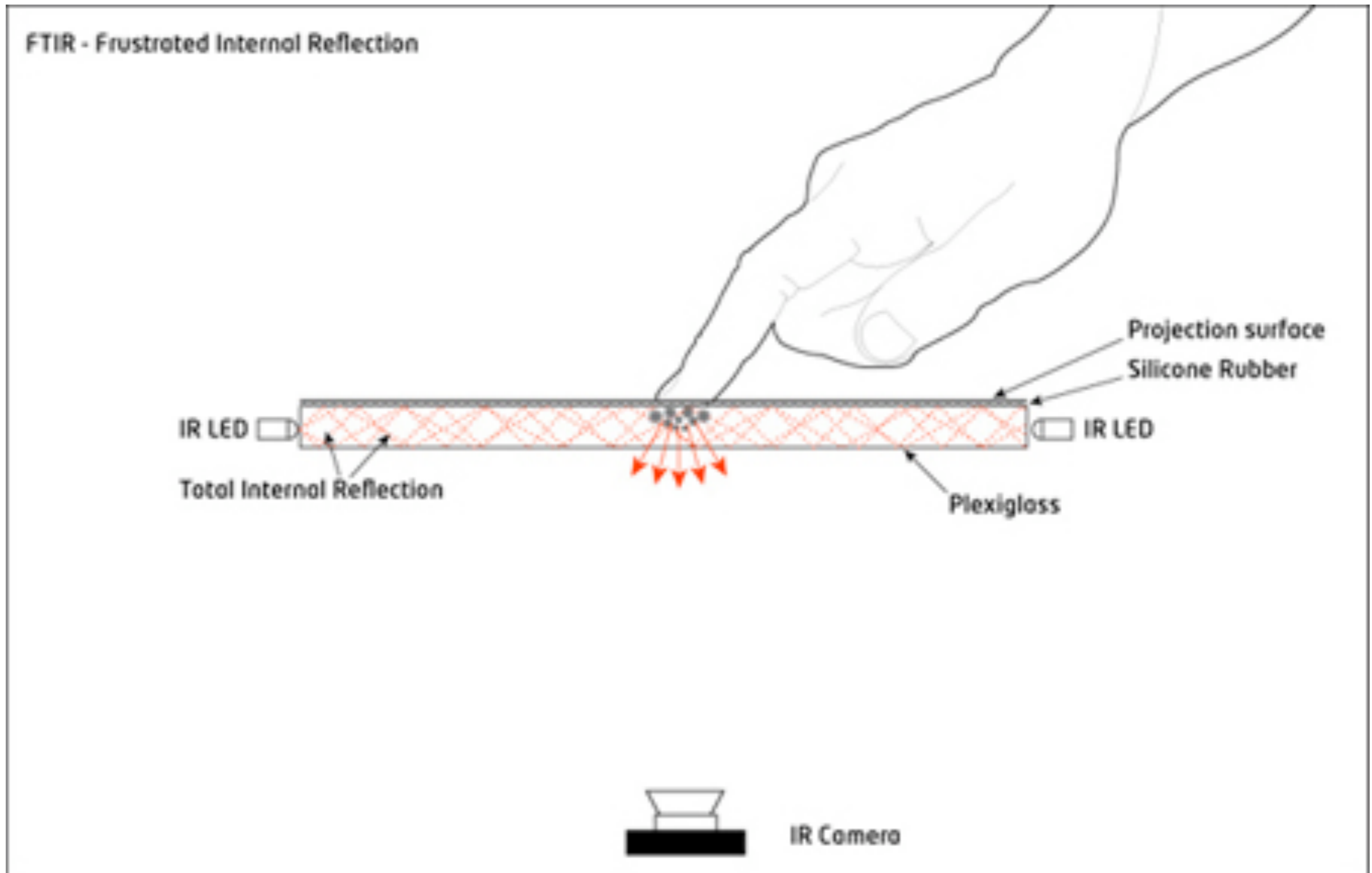


Figure 3: A set of antennas is embedded in the table-top. The antennas are insulated from each other and from the users.



# Optical Sensing - FTIR

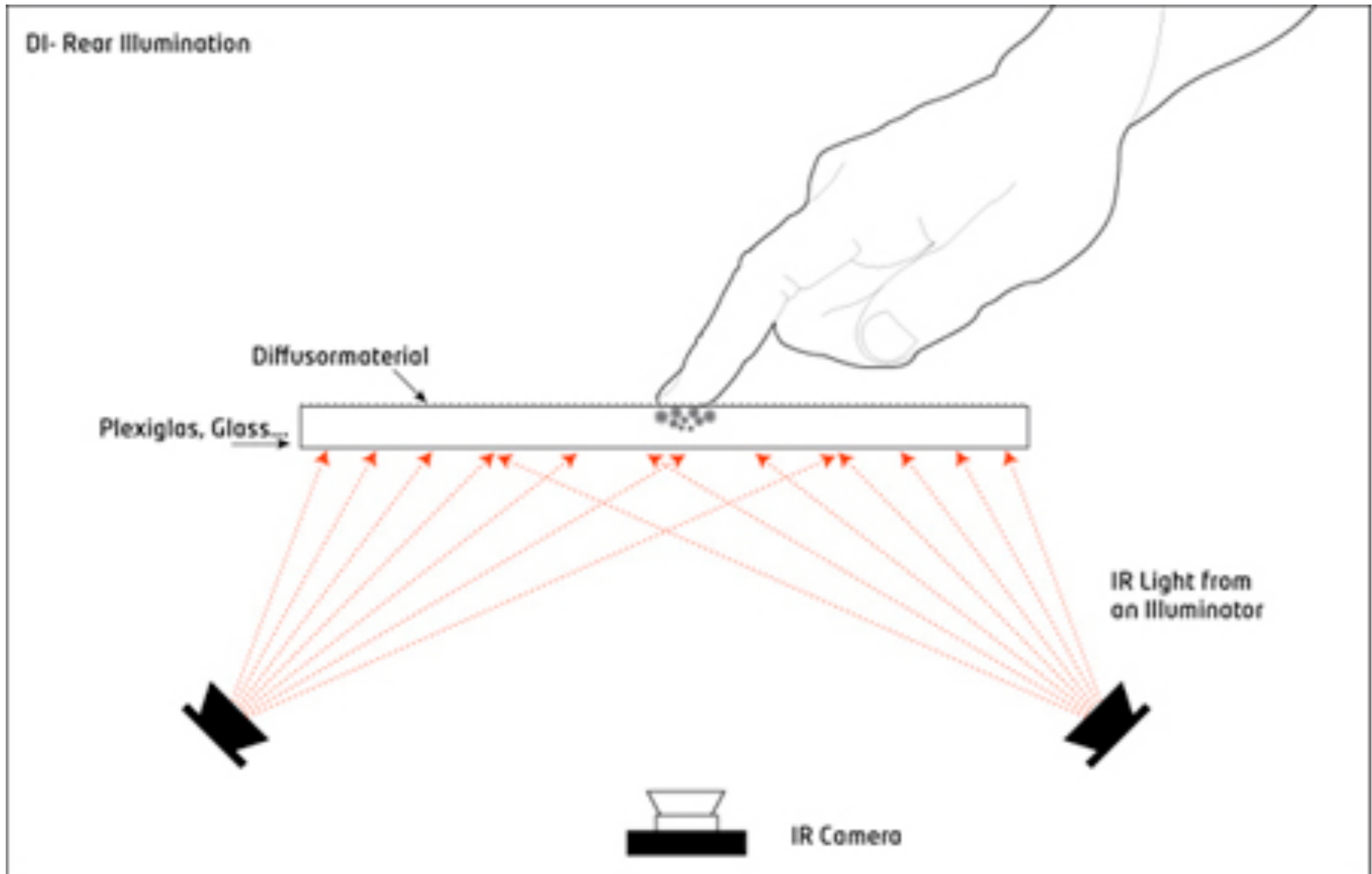






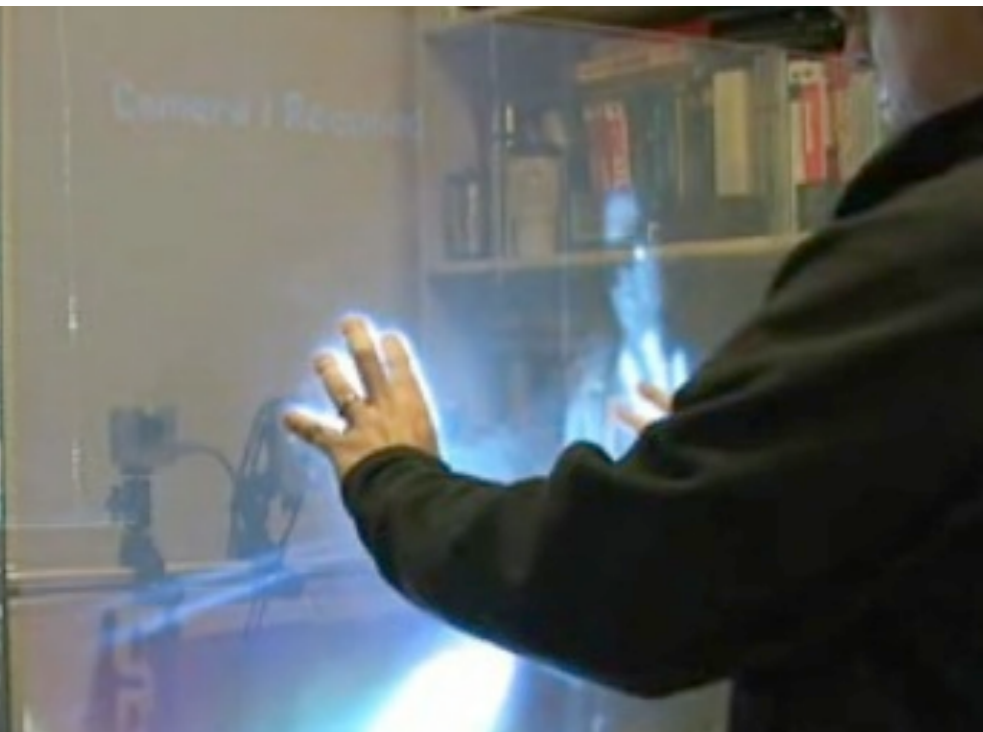


# Optical Sensing - DI





# TouchLight



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

# Optical tracking from the side: SmartTech SmartBoard DViT



Figure 1: DViT Technology Camera

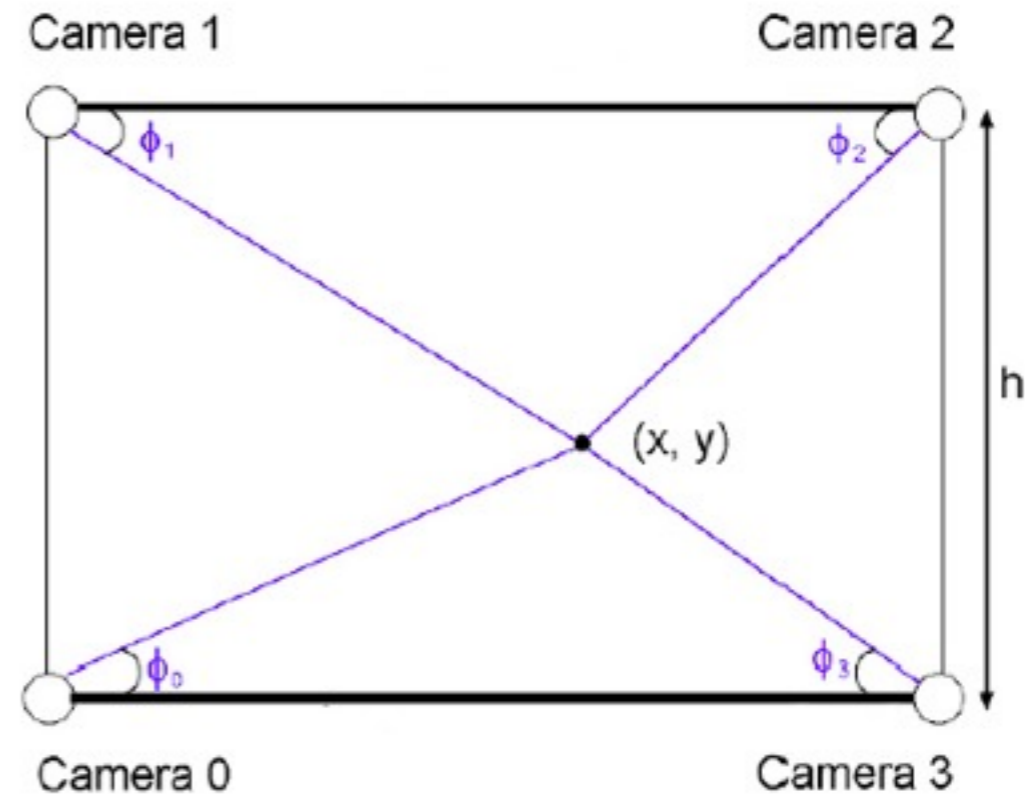
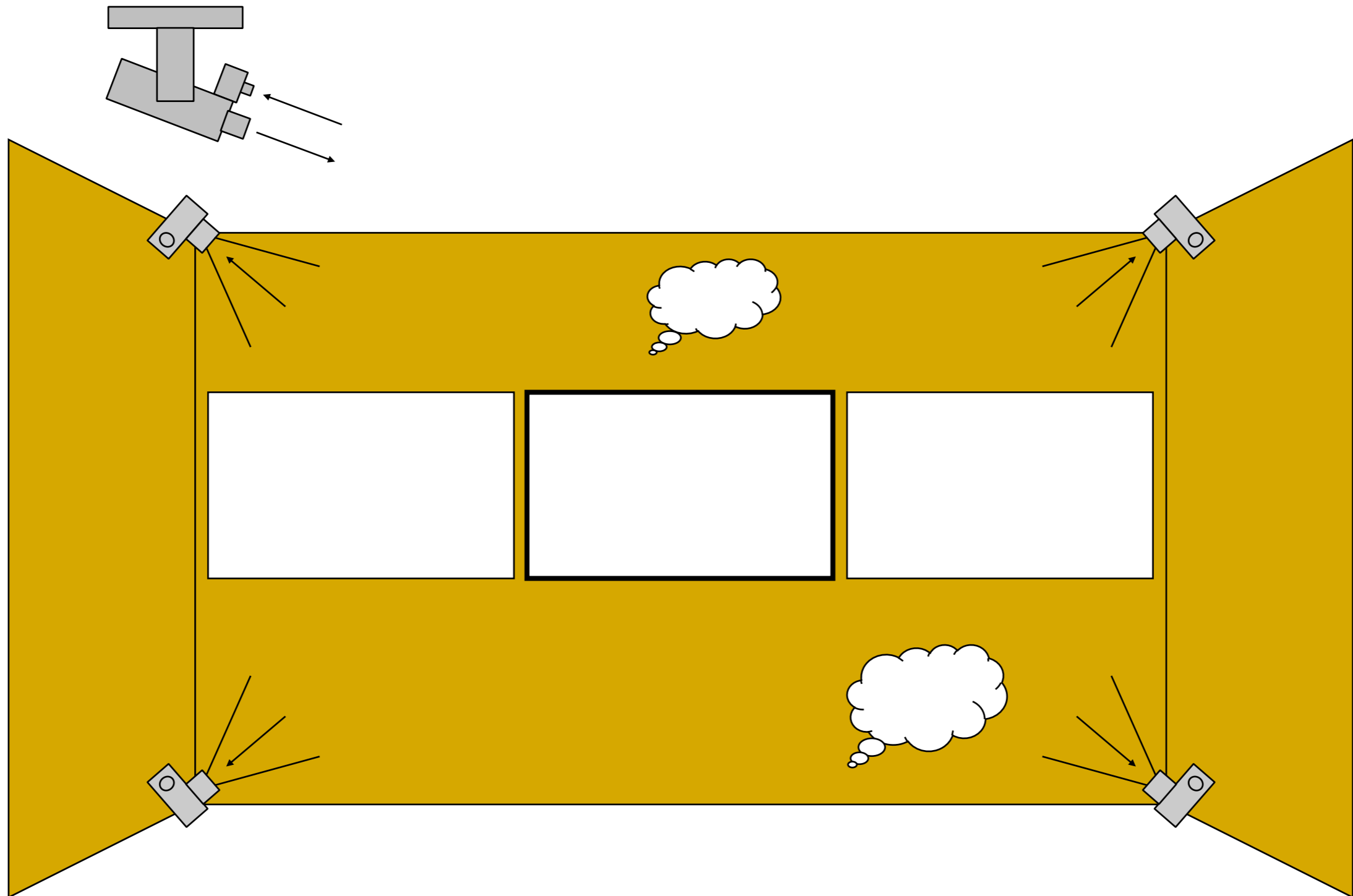


Figure 2: Camera Identification of a Contact Point

- 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>

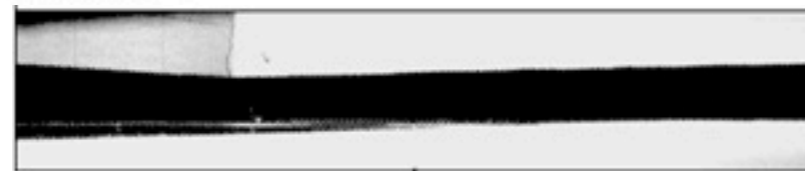
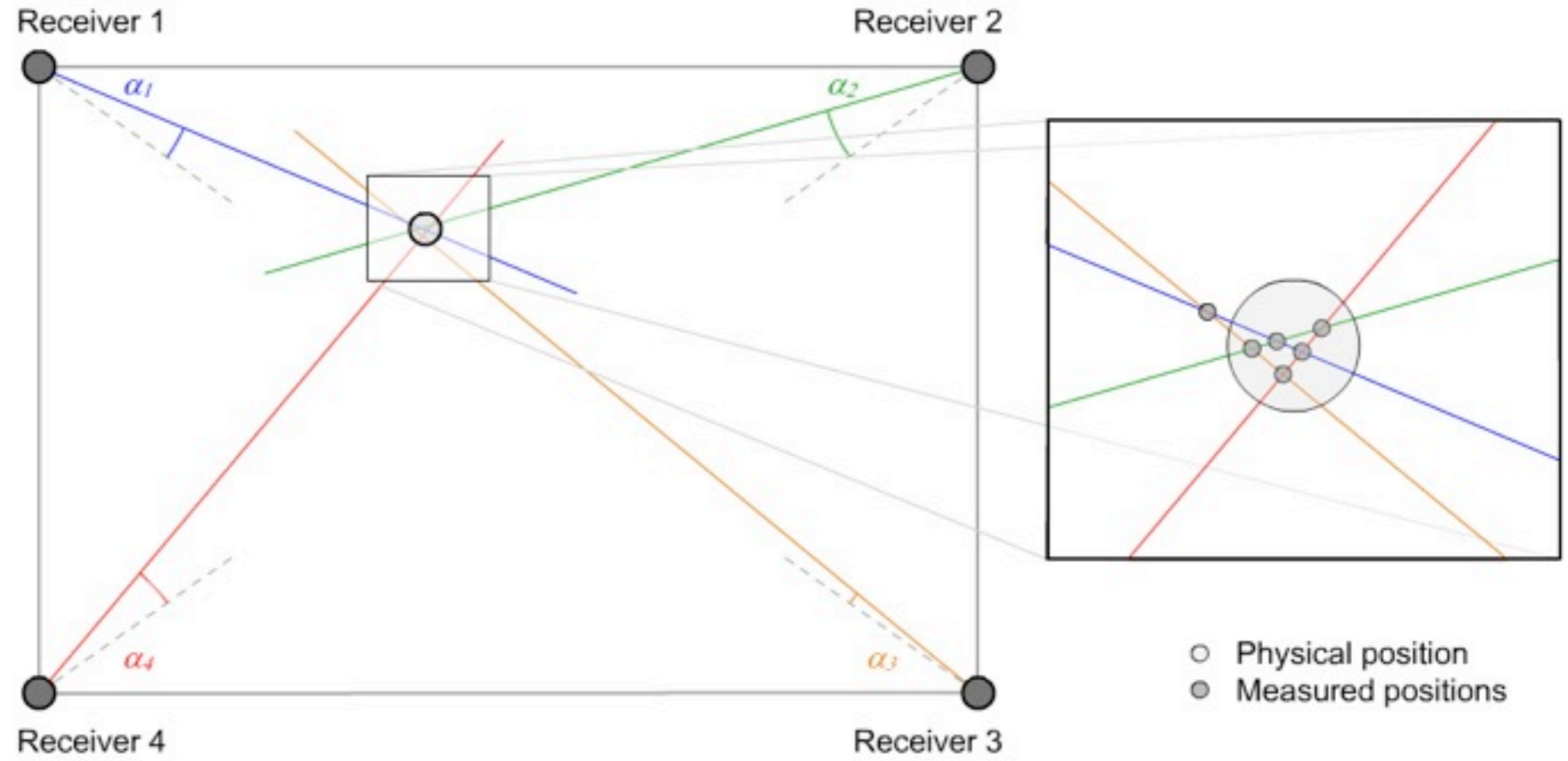
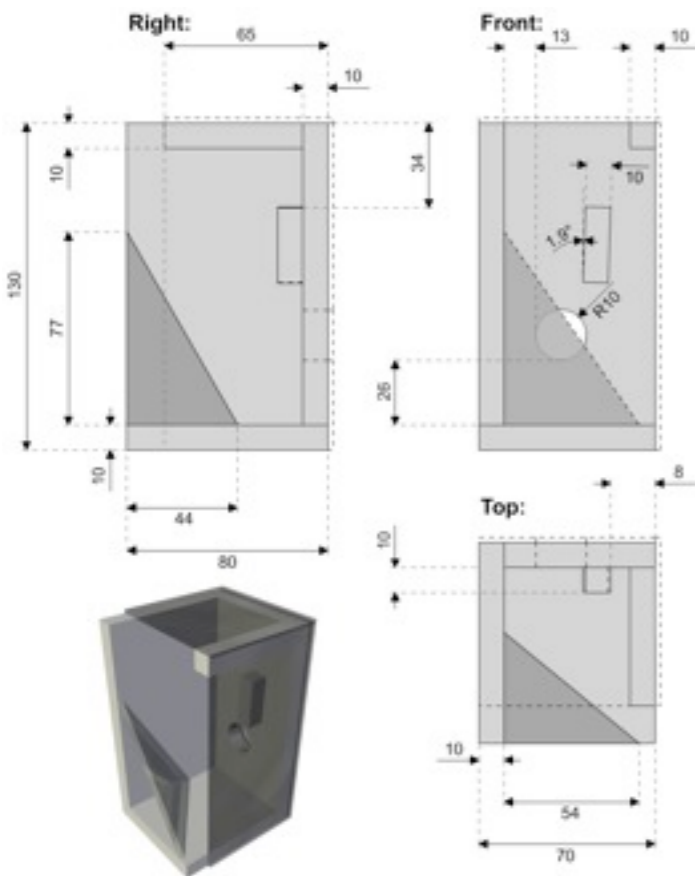
# A Wall-sized Focus+Context Display

[Boring, Hilliges, Butz, PerCom 2007]

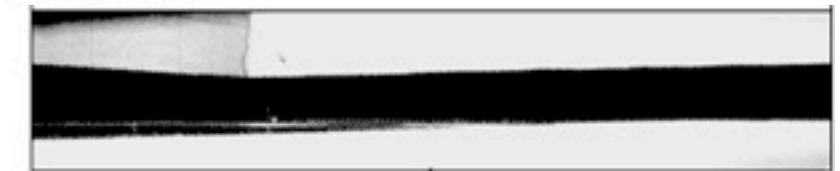


# A Wall-sized Focus+Context Display

[Boring, Hilliges, Butz, PerCom 2007]



Detection possible

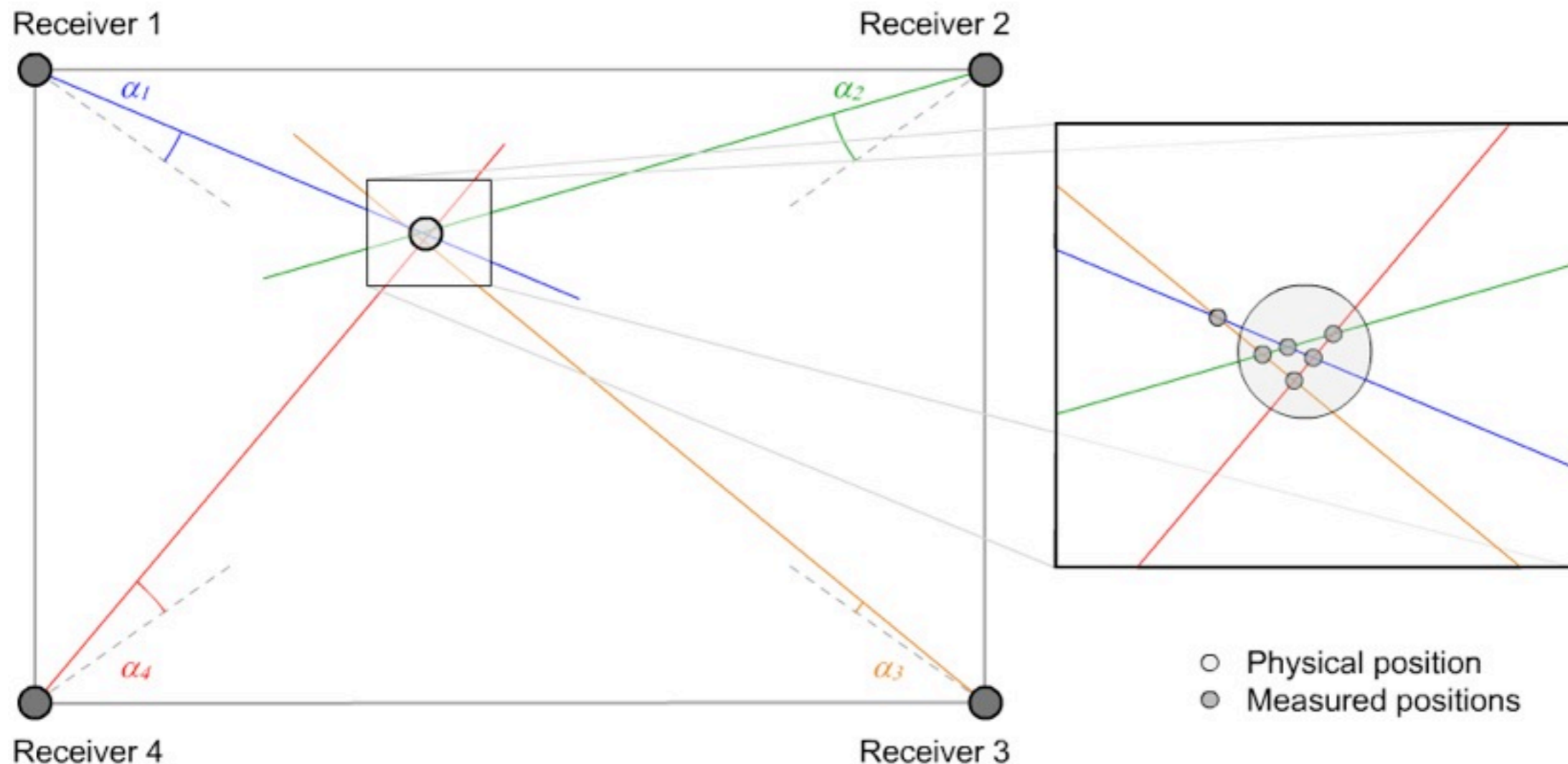


Detection possible



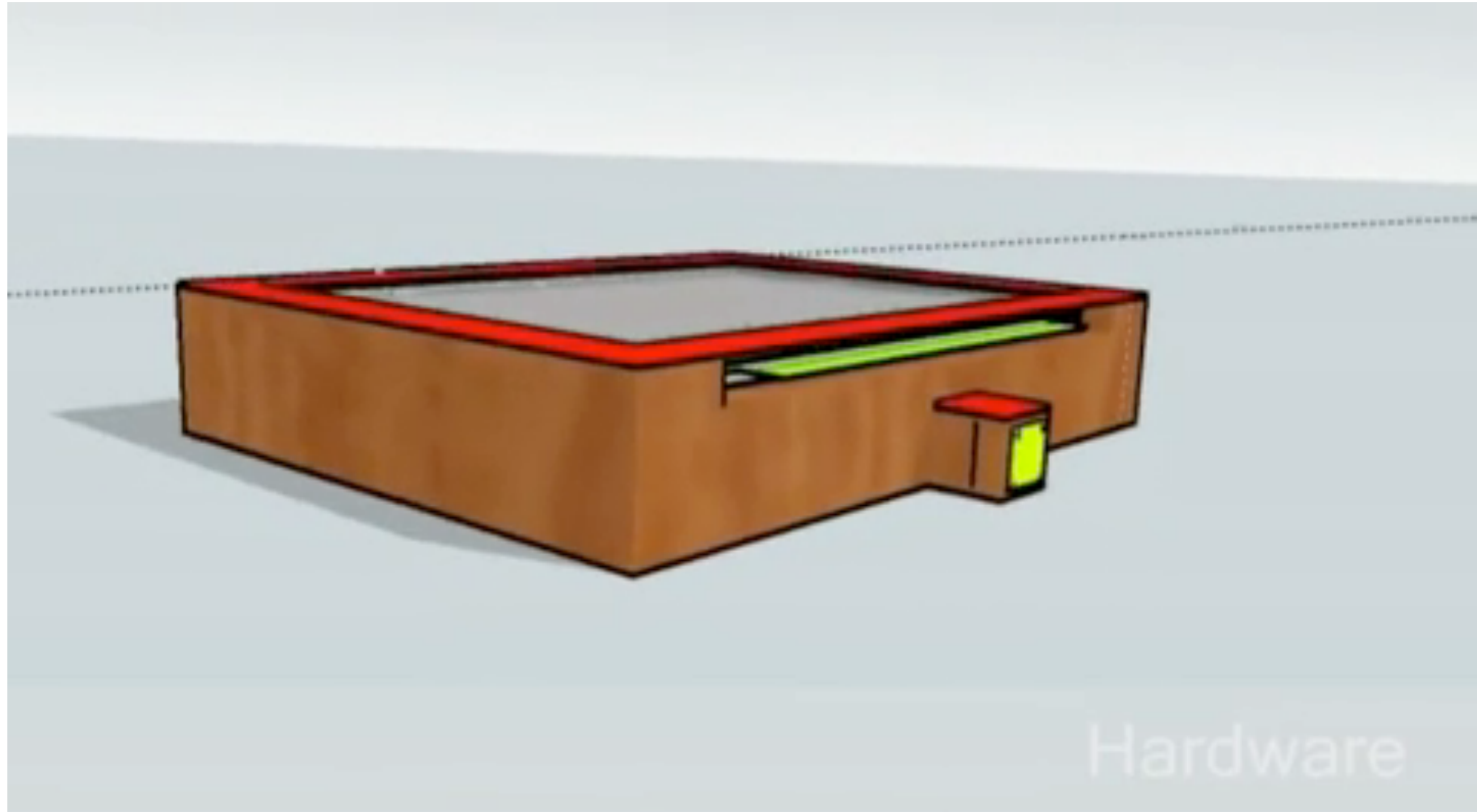
# Brief discussion for understanding

- How many fingers can be detected? Why?
- How can this be formalized mathematically?
- How can we keep finger IDs over time?
- What are the critical cases?



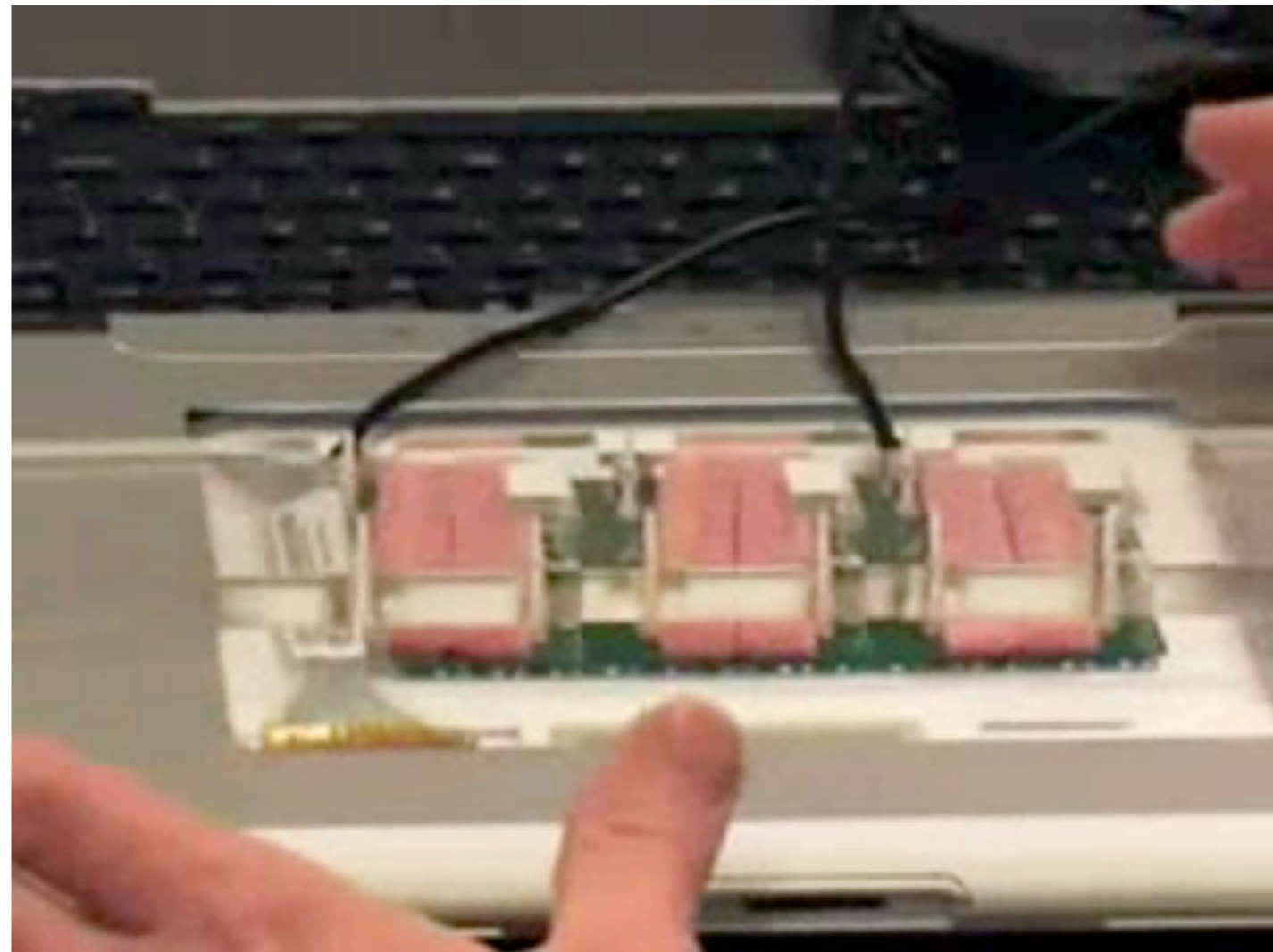
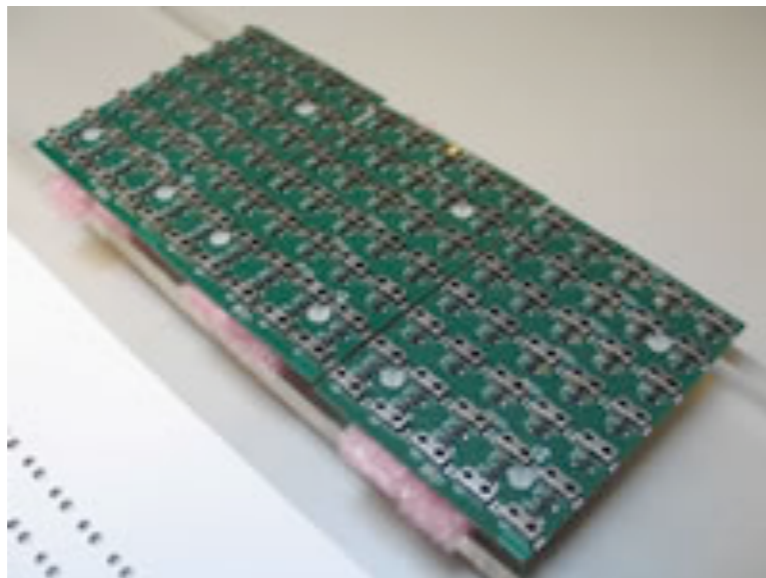
# Optical Tracking twisted: Fiberboard

Daniel Jackson, Tom Bartindale, Patrick Olivier: FiberBoard Compact Multi-Touch Display Using Channeled Light. ITS 2009 Demo



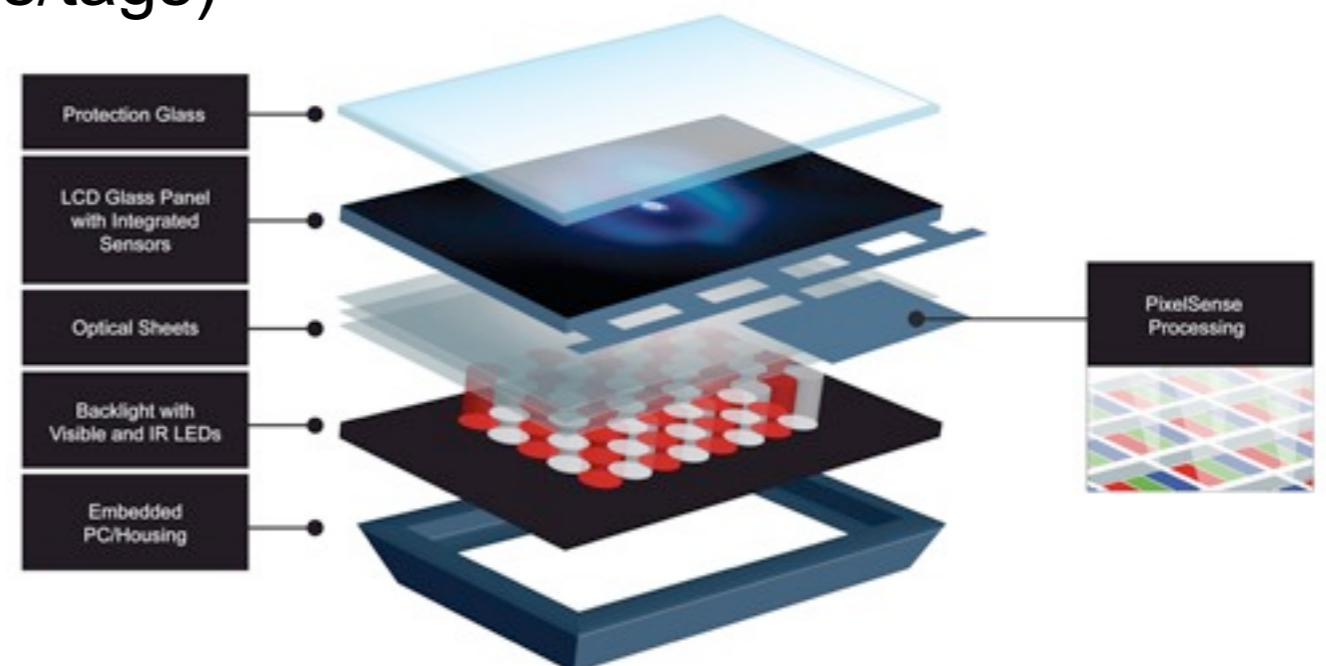
# Screen with integrated sensing: ThinSight

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



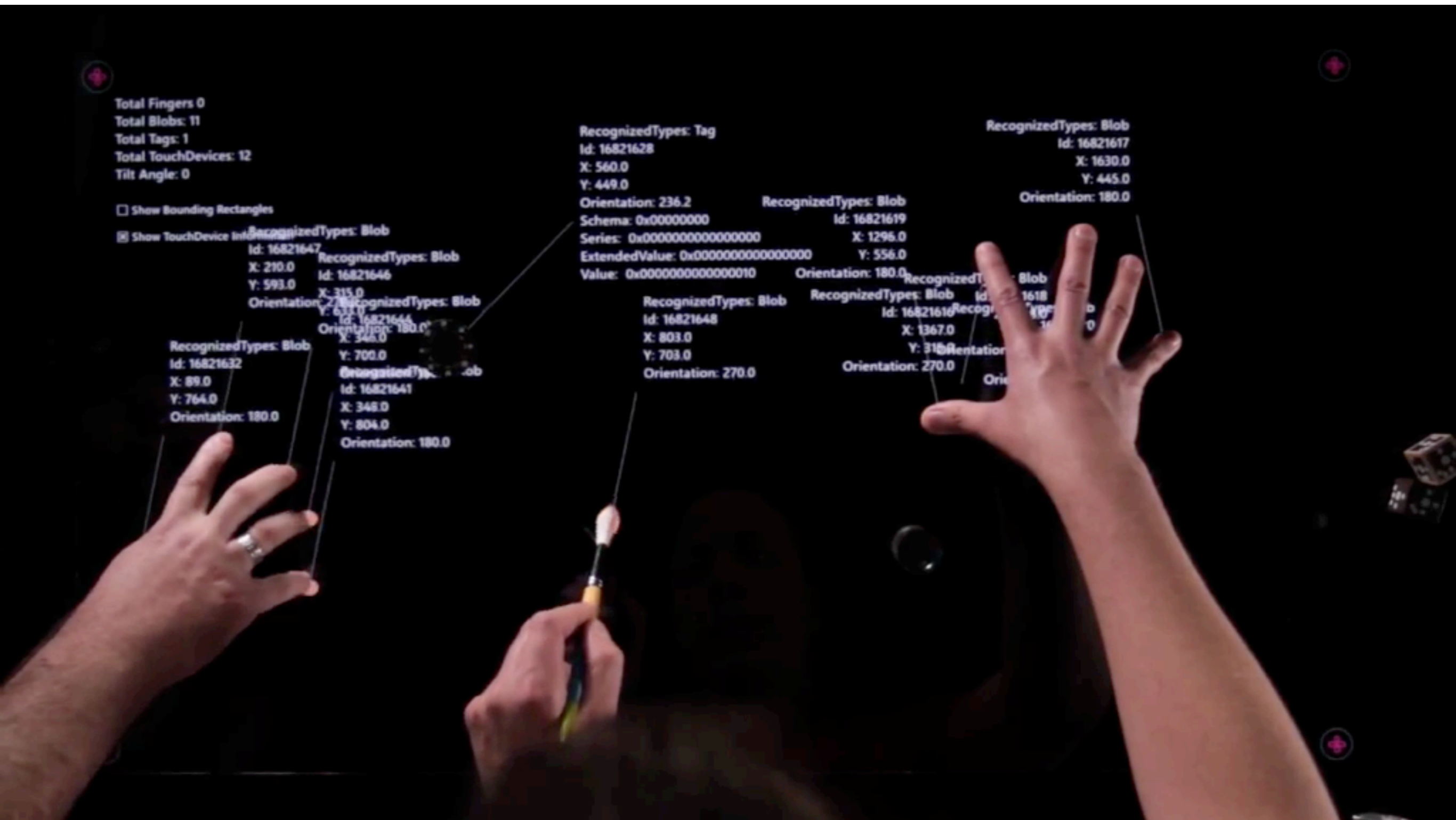
# Microsoft PixelSense (2011)

- A contact (finger/blob/tag/object) is placed on the display
- IR back light unit provides light (through the optical sheets, LCD and protection glass) that hits the contact.
- Light reflected back from the contact is seen by the integrated sensors
- Sensors convert the light signal into an electrical signal/value
- Values reported from all of the sensors are used to create a picture of what is on the display
- The picture is analyzed using image processing techniques
- The output is sent to the PC. It includes the corrected sensor image and various contact types (fingers/blobs/tags)
- source: <http://www.microsoft.com/en-us/pixelsense/>
- <http://www.samsunglfd.com/solution/sur40.do>





# Microsoft PixelSense



# Commercial and semi-OTS

## Interactive tables

context and task

challenges

**input technologies**

challenges in interaction design

output technologies

- MS surface 2 <http://www.microsoft.com/en-us/pixelsense/>
- Interactable <http://www.ipsi.fraunhofer.de/ambiente/english/projekte/projekte/ineractable.html>
- SmartTable <http://www2.smarttech.com/st/en-US/Products/SMART+Table/>
- Reactable <http://www.reactable.com/>
- Lemur <http://www.jazzmutant.com/>

# Microsoft Surface 1



## TECHNICAL SPECIFICATIONS

### Display

- Type: 30-inch XGA DLP® projector
- ATI X1650 graphics card with 256 MB of memory
- Maximum resolution: 1024 x 768
- Lamp mean-life expectancy: 6,000+ hours
- Maximum pressure on the display: 50 pounds per square inch/3.5 kg per cm
- Maximum load: 200 pounds

### Input Devices

- Camera-based vision system with LED infrared direct illumination

### Computing System

- 2.13-GHz Intel® Core™ 2 Duo processor
- Memory: 2 GB dual-channel DDR2
- Storage: Minimum 250 GB SATA hard-disk drive

## PHYSICAL DIMENSIONS

### Surface unit including display and housing (L x W x H)

42.5 x 27 x 21 inches/108 x 69 x 54 cm

With metal panels: 180 pounds/82 kg

Available in U.S. and Canada only

With acrylic panels: 198 pounds/90 kg

### Shipping pallet and container (L x W x H)

49 x 34 x 32.5 inches/124.5 x 86 x 82.5 cm

Pallet, box, foam: 80 pounds/36 kg

## Network Protocols and Standards

- Network adapter: Intel Gb LAN
- Wireless LAN connectivity supported: Yes
- Networking and Data Protocols: IEEE802.11b, IEEE802.11g, Bluetooth 2.0, Gigabit Ethernet

## I/O Connections

- 2 headphone jacks
- 6 USB 2.0 ports
- RGB component video
- S-VGA video (DB15 external VGA connector)
- Component audio
- Ethernet port (Gigabit Ethernet card [10/100/1000])
- External monitor port
- Bays for routing cables
- On/Standby power button



# Microsoft Surface 2 = Samsung SUR40

<http://www.samsunglfd.com/solution/feature.do?modelCd=Surface>

## PixelSense™

PixelSense™ allows an LCD display to recognize fingers, hands, and objects placed on the screen, including more than 50 simultaneous touch points. With PixelSense™, pixels in the display see what's touching the screen and that information is immediately processed and interpreted.

## Samsung SUR40 with Microsoft® PixelSense™

Samsung SUR40 provides business customers a premier touch-first experience for their end-users, built on the principles of direct interaction and together computing, with a new look and feel. It also allows commercial application developers to use a new version of the Microsoft® Surface® SDK and familiar Microsoft development tools to take full advantage of the massive multi-touch and object recognition capabilities of PixelSense™ and deliver experiences not possible on any other platform.

## 40-Inch High-Definition Screen

The 40-inch high-definition screen enables unparalleled multi-touch, multi-user experience with a 1080p, 16:9, 1920 x 1080 display.

## Thin Form Factor with Multiple Configuration Options

The product is four inches thin, which makes it easy to use in a horizontal deployment, hang on the wall with the VESA mount, or embed in walls or custom enclosures. There are standard legs available or a customer can design and attach their own.

## Powerful Embedded System

The product uses the embedded AMD Athlon™ II X2 Dual-Core Processor 2.9GHz paired with AMD HD6750M GPU featuring DirectX® 11 support to deliver significant processing horsepower and outstanding graphics capability.



# FhG Interactable

- The new InteracTable® is 90 cm high with a display size of 70 cm x 125 cm. The horizontal workspace is realized with a touch-sensitive plasma-display (PDP) which is integrated into the table top of the InteracTable.
- People can use pens and fingers for gesture-based interaction with information objects. The IT components are mounted below. The margin of the table surface can be used to lean on it and to place additional material or coffee cups and the like.
- SmartTech DViT sensing: dual touch
- [http://www.wilkhahn.com/loadframes.html?/2\\_produkte/2142.htm](http://www.wilkhahn.com/loadframes.html?/2_produkte/2142.htm)

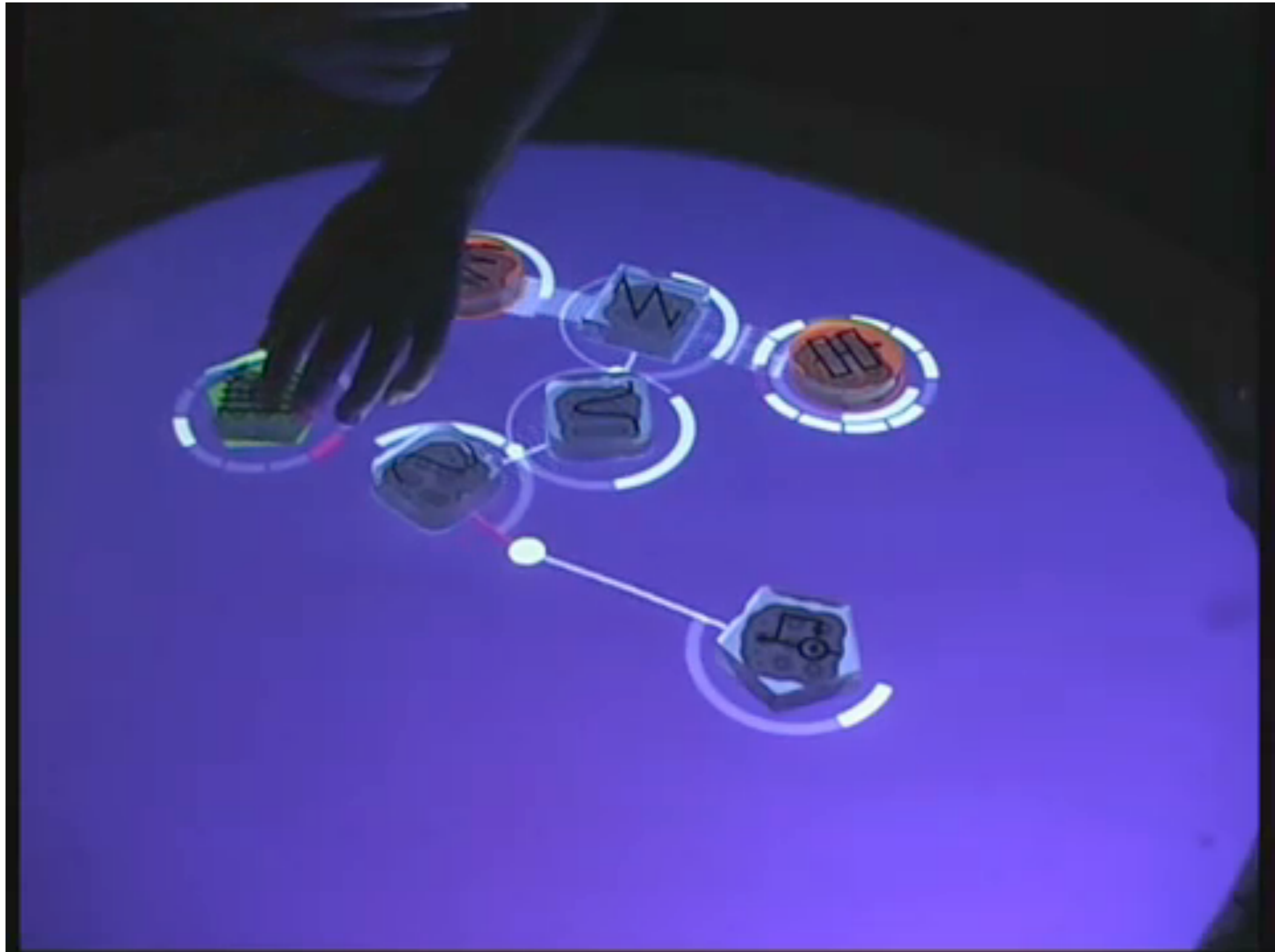




# SMART Technologies SmartTable

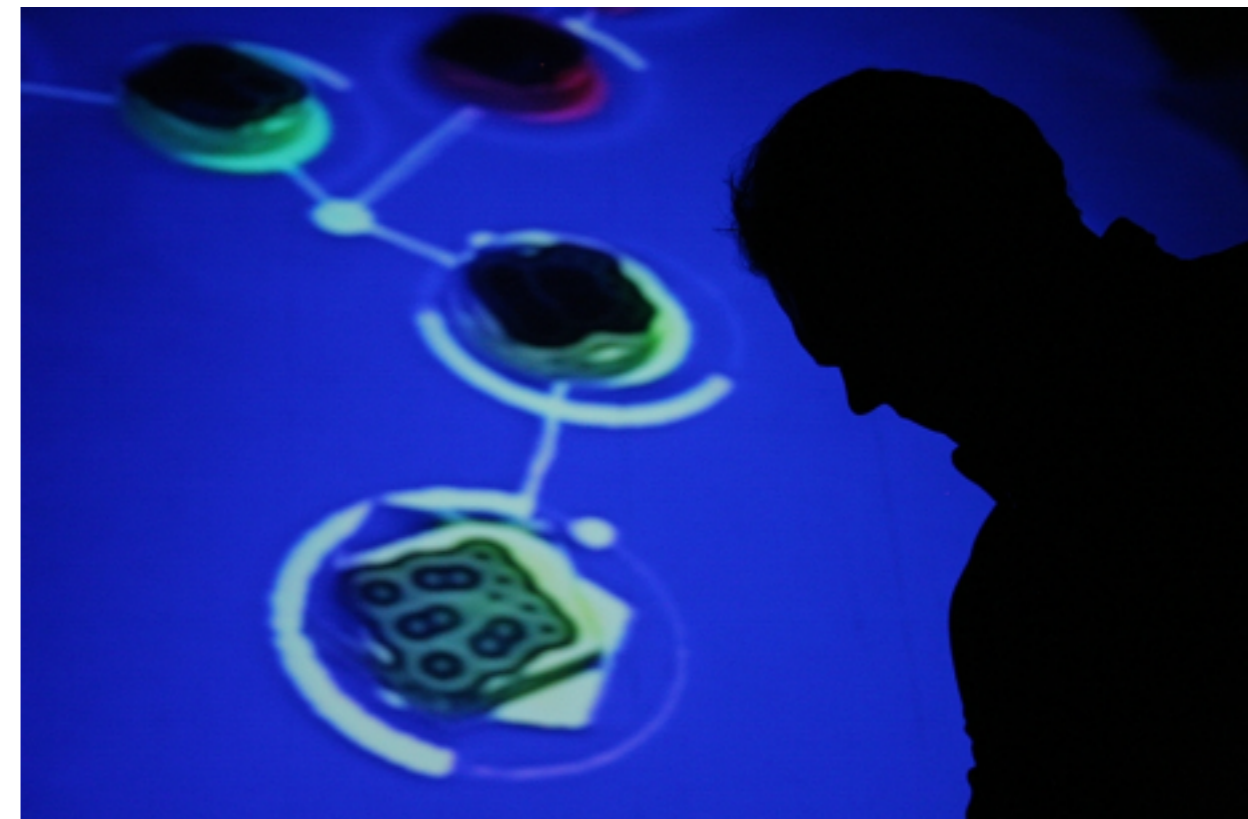


# Reactable



# Lecture: Martin Kaltenbrunner

- (Kunstuniversität Linz)
- Title: Tangible Music
- Date: 27.01.2014, 12 Uhr
- Room B006, LMU Hauptgebäude, Geschwister-Scholl-Platz 1
- Organizer: Karin Guminski





context and  
task

challenges

**input  
technologies**

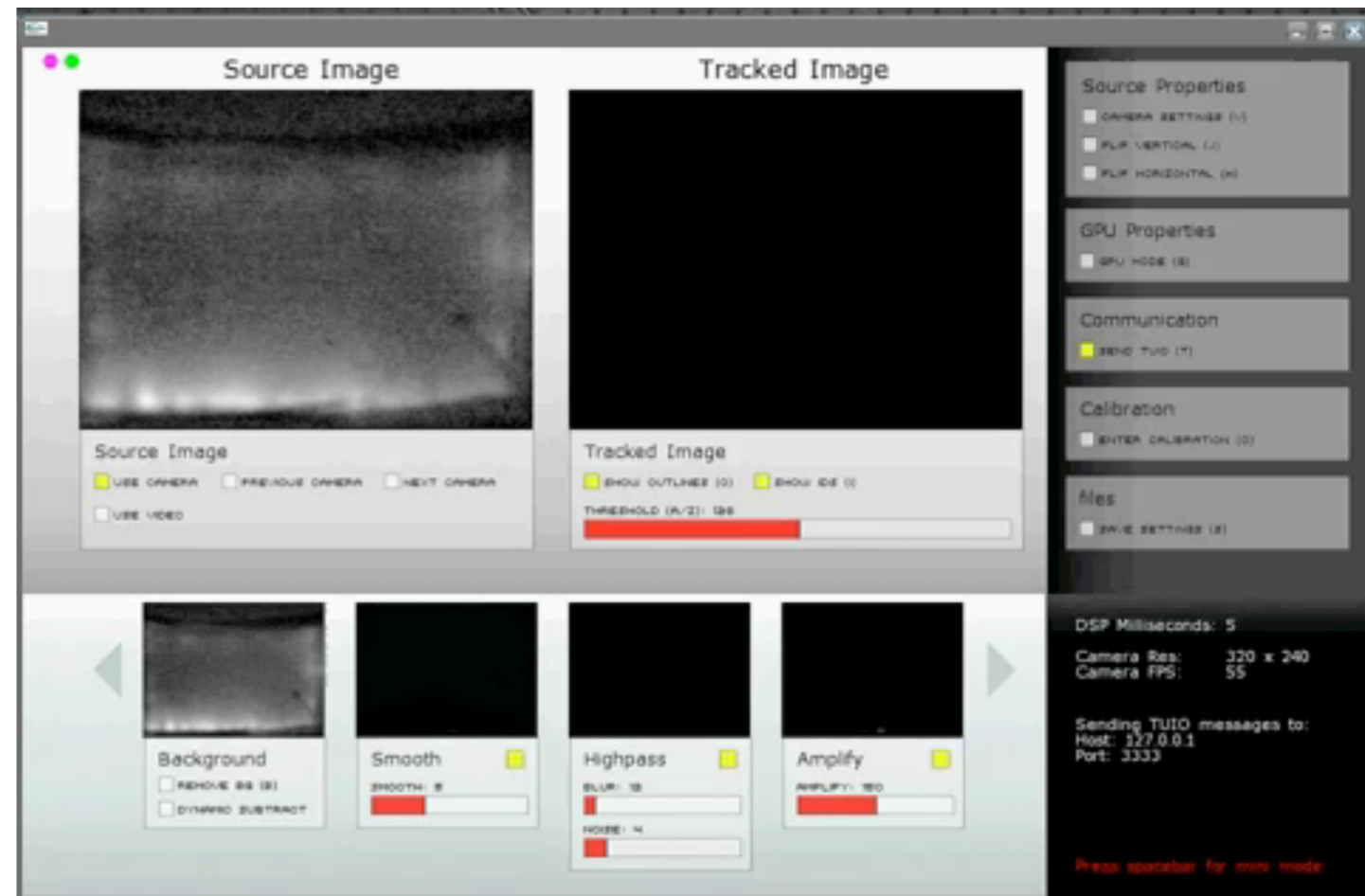
challenges in  
interaction  
design

output  
technologies

# Software for Interactive Surfaces

- Touchlib <http://nuigroup.com/touchlib/>
- Reactivision <http://reactivision.sourceforge.net/>
- the TUIO protocol <http://www.tuio.org/>

# Touchlib and CCV

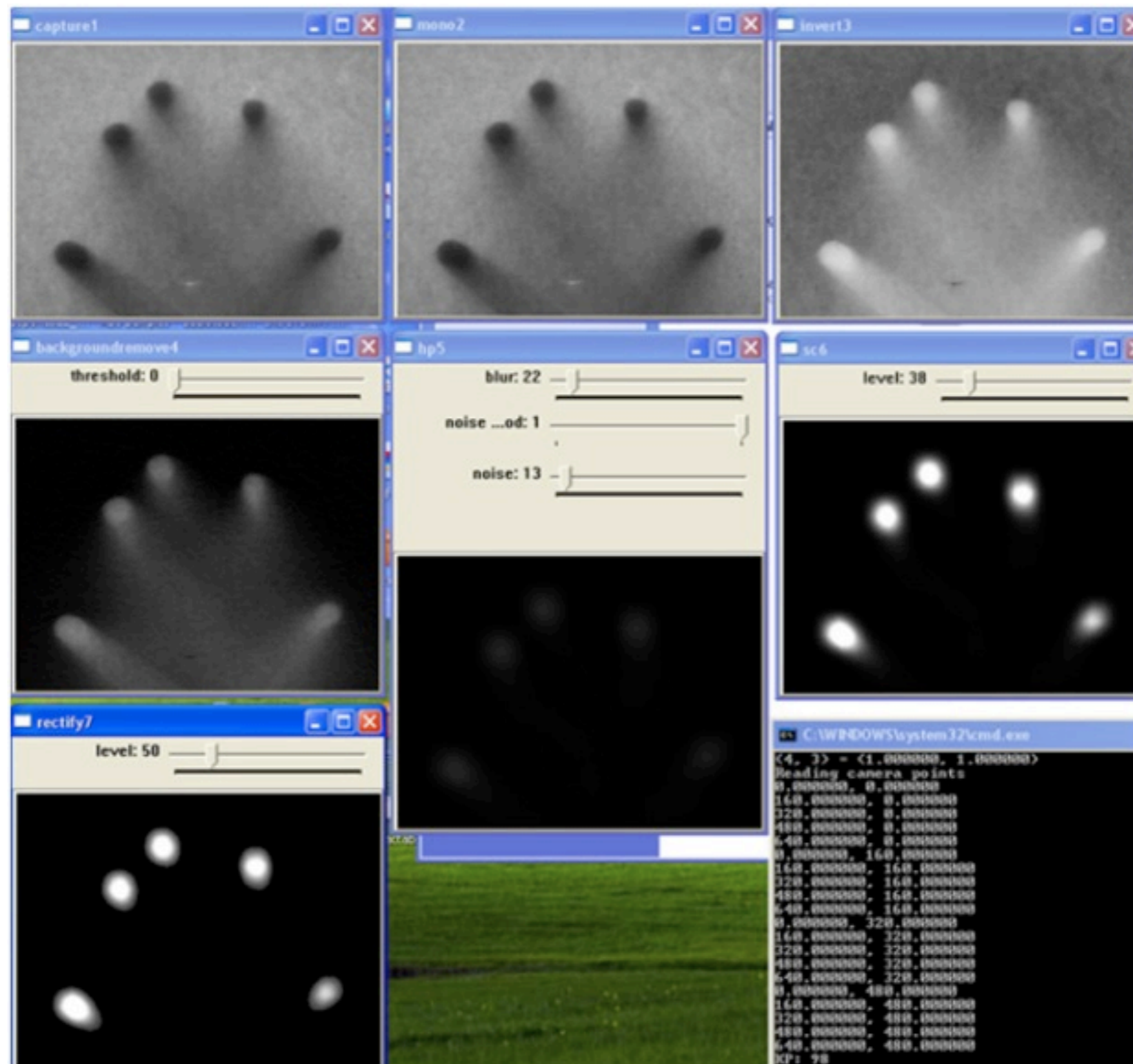


- The „classic“
- Touchlib is windows only
- CCV also Linux + OSX
- library for finger touch
- works w. diff. technologies
- also comes with a calibration app and several demos
- flame demos often seen in multi touch demo videos

# Multitouch DIY project for the weekend!

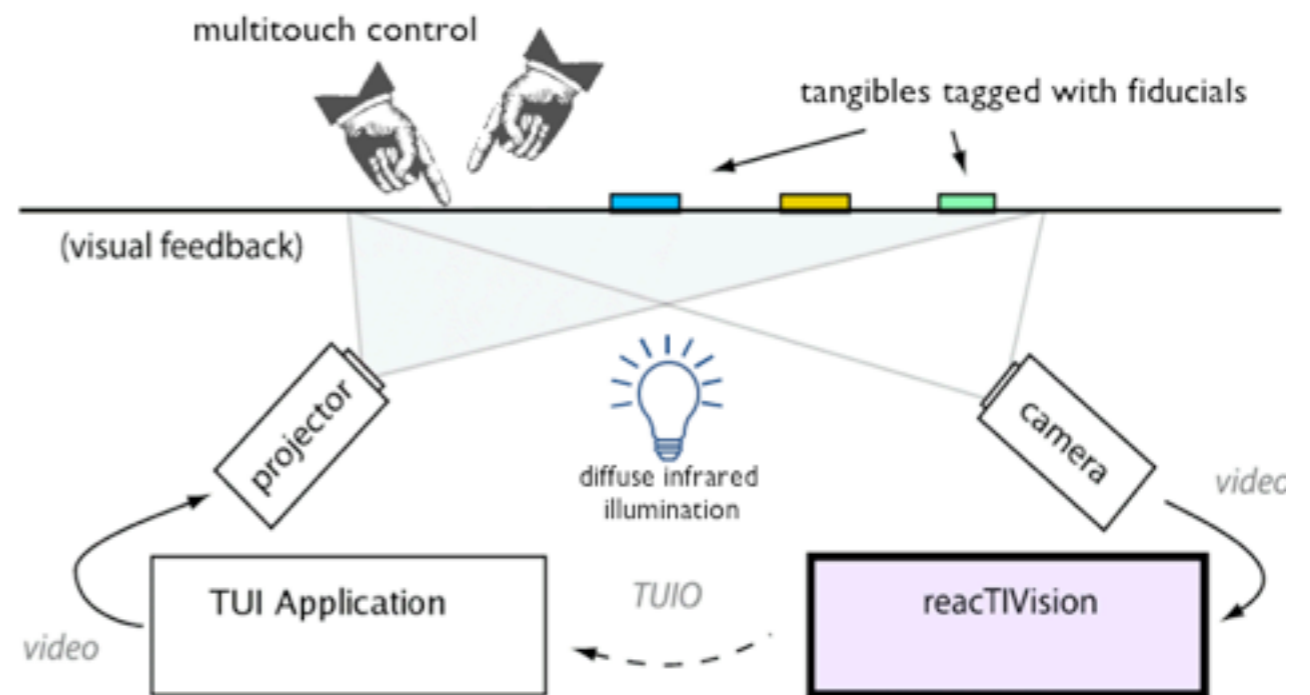
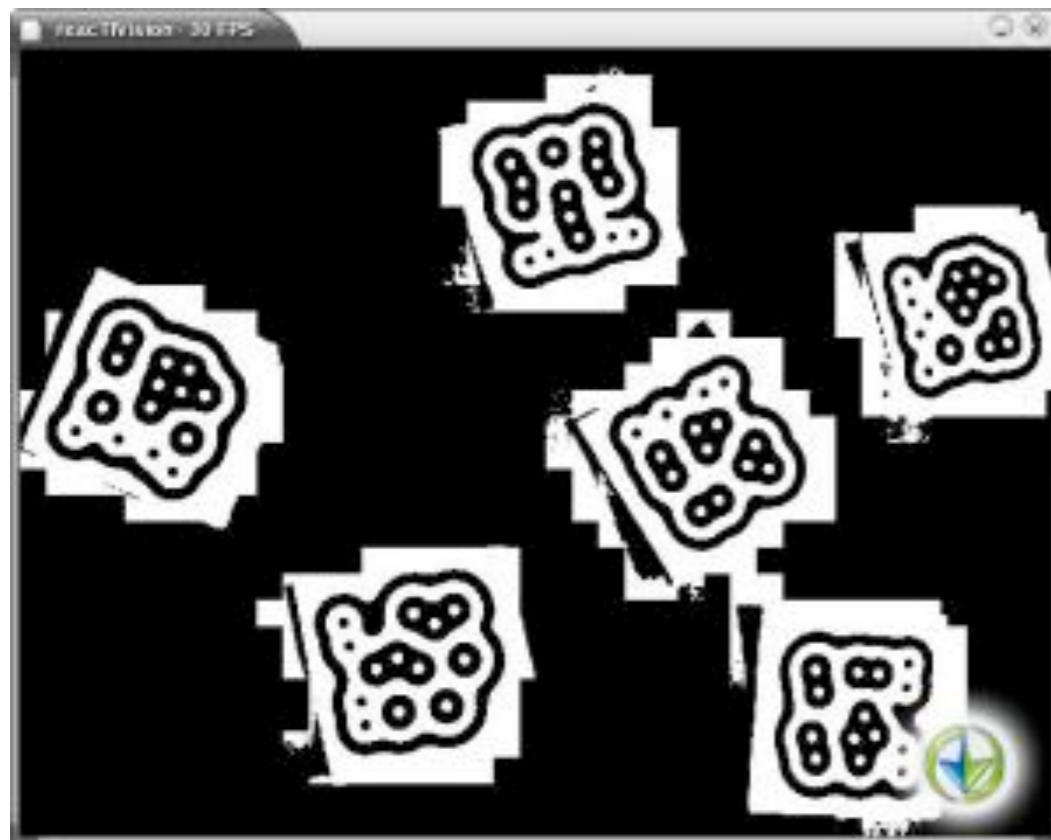


<http://sethsandler.com/multitouch/mtmini/>



# Reactivision

- includes marker (aka fiducial) tracking
- uses the TUIO protocol
- originally built for the ReacTable musical instrument
- used in research for various purposes

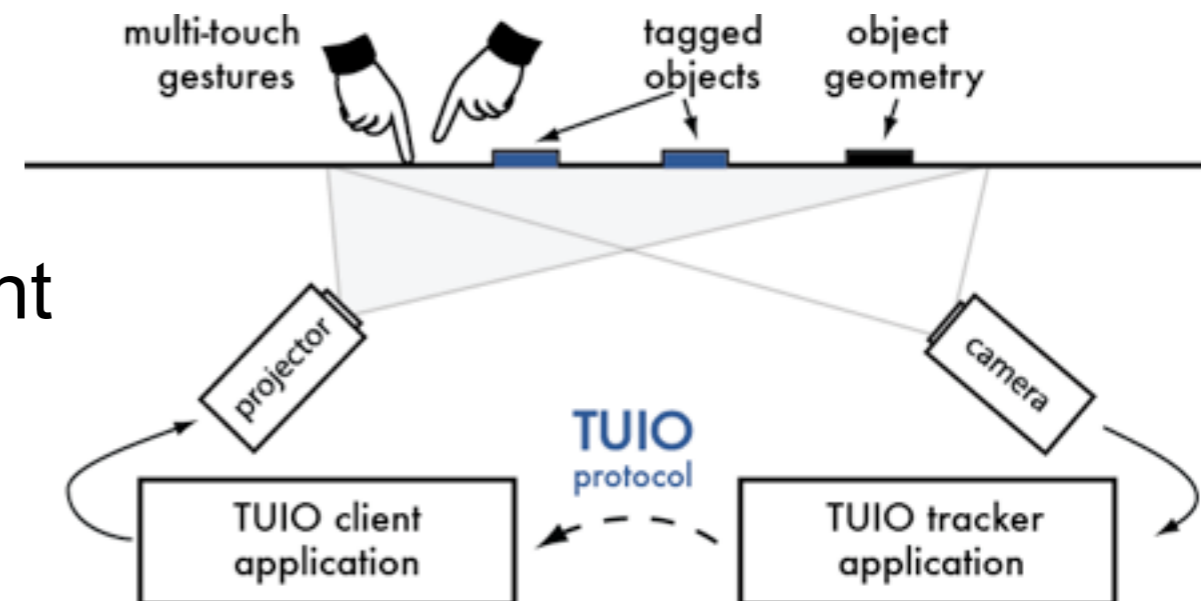




# TUIO protocol

- Standardized protocol to send touch events
  - can describe fingers, shapes and visual markers
  - Sent over a network socket (often UDP packets on port 3333)
  - input can also be simulated
  - platform independent
- Various implementations (e.g., reactivision + CCV)
- Various demo clients available

- version 2.0 since April 2011
  - extensions to the message content
  - new capabilities
  - <http://www.tuio.org/?tuio20>



# 3D tracking technologies

context and task

challenges

**input technologies**

challenges in interaction design

output technologies

- **historic: magnetic 3D trackers**
  - tons of side effects, calibration difficult, but: high frame rate!
- **active marker tracking**
  - need cables or batteries
  - robust tracking in exchange
- **passive marker tracking**
  - mainly sold for MoCap
- **tracking without markers**
  - popularized by Microsoft Kinect

context and task

challenges

**input technologies**

challenges in interaction design

output technologies

# 3D tracking (passive markers)

- As an example: OptiTrack
- Uses retroreflective marker balls (why??)
- Needs several cameras for 3D reconstruction (how many??)
- Mainly sold for MoCap in 3D animation
- Small version also available in our lab!

<http://www.youtube.com/watch?v=tBAvjU0Scul>





# Kinect - depth camera (no markers)

- projects a pattern using an IR laser projector
- films this pattern and computes depth from it
- projector different from camera position! why?
- also contains RGB camera + microphones
- provides RGB image, depth map, skeleton



<http://www.codeproject.com/Articles/317974/KinectDepthSmoothing>

# Kinect sensor data example

context and task

challenges

input technologies

challenges in interaction design

output technologies



<http://blogs.msdn.com/b/csharpfaq/archive/2012/02/06/start-coding-for-the-kinect.aspx>

# Kinect Fusion

<http://msdn.microsoft.com/en-us/library/dn188670.aspx>

context and task

challenges

**input technologies**

challenges in interaction design

output technologies





context and  
task

challenges

input  
technologies

challenges in  
interaction  
design

output  
technologies

# Take-away Message

- Interactive Surfaces still a developing field
- Robust & cheap sensing for large curved surfaces still an open problem
- Instrumented environments enabled by a multitude of different sensors
- commercialization only for mainstream markets (TV, gaming, Movies)
- „abuse“ of these cheap sensors in research
- fascinating playground for your thesis ;-)

[Startseite](#) > [Lehrveranstaltungen](#) > [WS 2013/2014](#) > [MMI2](#) > Mbl

## Michel Beaudouin-Lafon

### Instrumental Interaction in Multisurface Environments

Date: February 5th, 2014

Time: 10:15 - 11:15 am

Room: 112 (Amalienstrasse 73A)



#### Abstract

Today's user interfaces are based on the desktop metaphor and the principles of direct manipulation that were created more than 25 years ago. With the diversity of hardware platforms, contexts of use and types of information that we face today, this paradigm clearly shows its limits. I introduced Instrumental Interaction over ten years ago to address some of