Workshop one:

Constructing a multi-touch table

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Introduction

- A Master of Grid Computing (former Computer Science) student at the '*Universiteit van Amsterdam'*
- Currently doing research in the field of multi-touch as a final master's thesis project
- Co-developer for Touchlib

Overview

- Explaining vision based multi-touch systems
- Explaining video processing in Touchlib
- Comparing FTIR with RI
- Building your own table at SOCO Amsterdam

Vision based multi-touch systems

- Camera based technique
- Frustrated total internal reflection (FTIR)
- Diffused illumination (DI)
  - Rear illumination
  - Front illumination (ambient light)

FTIR I

- Frustrated Total Internal Reflection
- Presented by Jeff Han (NYU) in 2005
- Based on research from the early 80’s

FTIR II - Technique

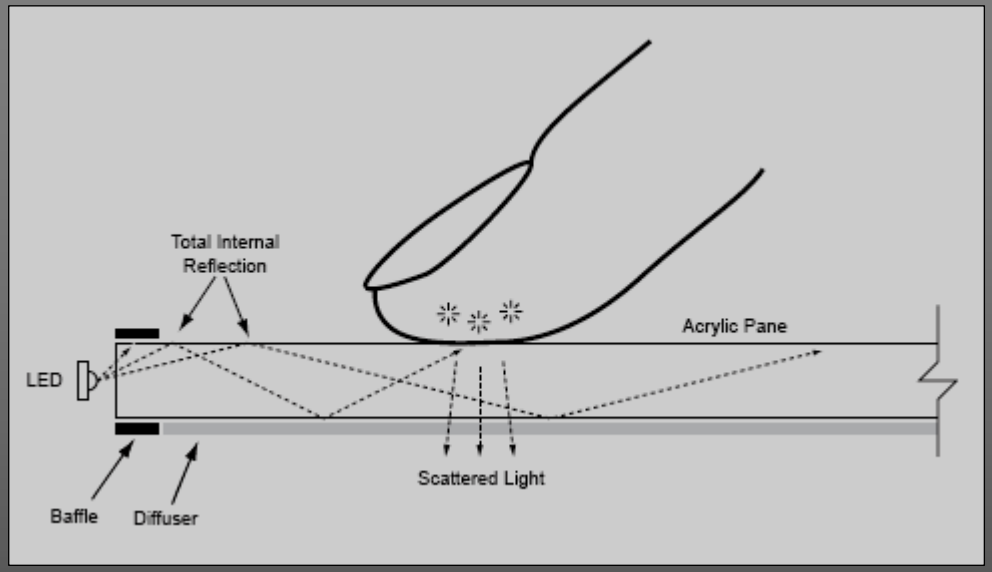


Image by Jeff Han

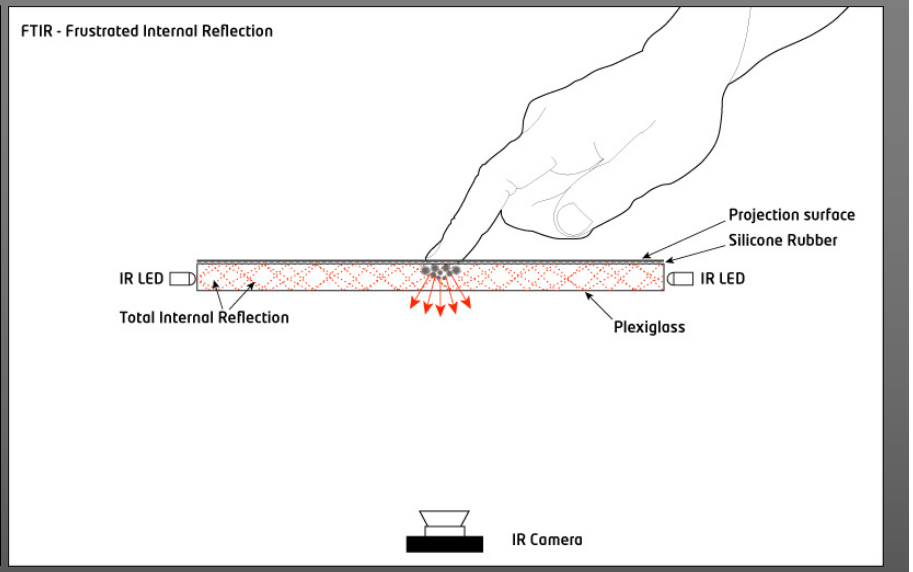


Image by Tim Roth

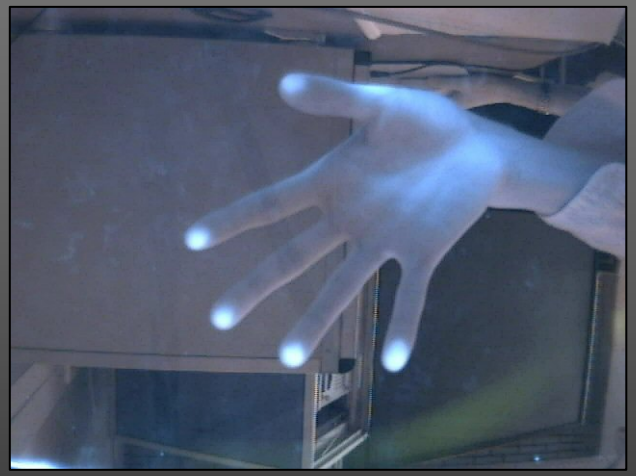
Main components

- Acrylic (thickness ~6 - 10 mm)
- Infrared LEDs
- A diffuser
- Baffles

Improvements by adding more layers

- Compliant surface (Silicon rubber)
- Projection surface (Rosco Gray)
- Infrared blocking filter
- Protective layer

FTIR III - Captured image

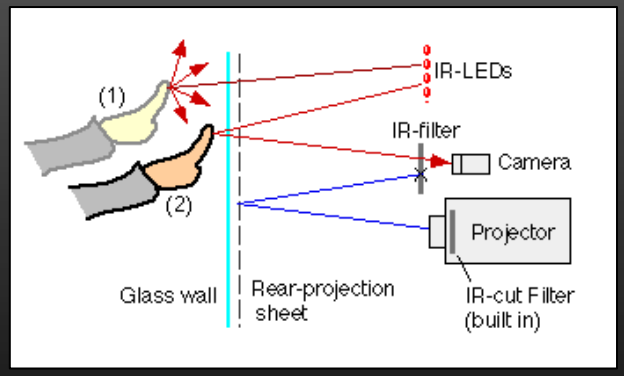


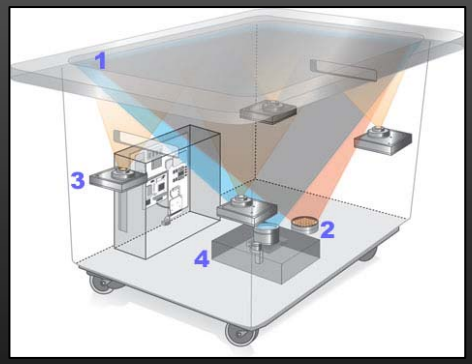
No layers

With the diffuser

DI I

- Diffused illumination
  - Rear illumination
  - Front illumination
- Examples:
  HoloWall (1997) and MS Surface (2007)





DI II - rear illumination

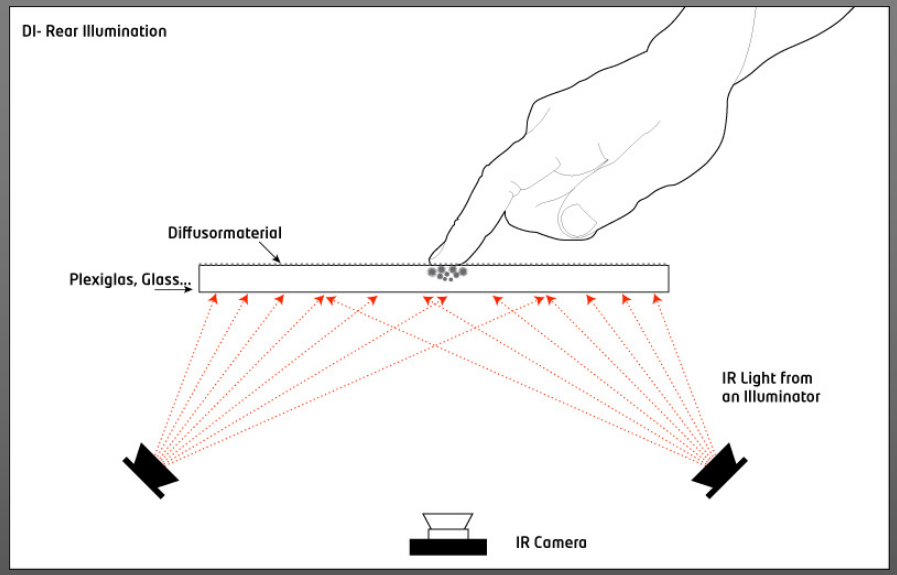
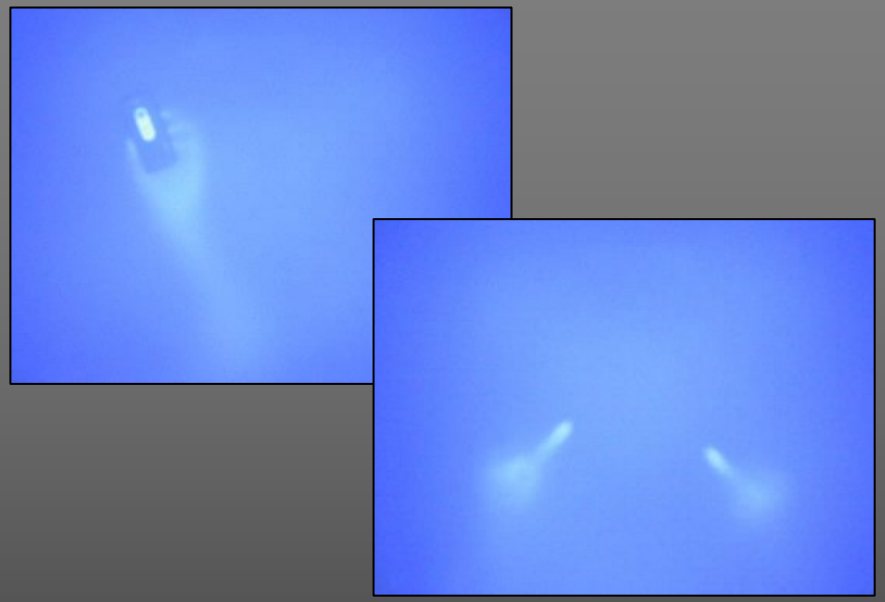


Image by Tim Roth



Main components

- Acrylic
- Multiple infrared illuminators
- A diffuser

Possible improvements

- Put the diffuser material on the bottom to prevent hotspots

DI III - front illumination

- Using the ambient light
- Inverting the source image

Camera requirements

- Infrared sensitive CCD sensor
  (check the spec. sheet!)
- A camera lens without IR blocking filter
- An infrared bandpass filter
  (or for a cheap solution, overexposured negatives)
- Firewire > USB
- Framerate of 30+ fps
- Resolution at least 640x480

Digital projector

- High resolution
  (at least 1024x768)
- Low latency
- Short throwing distance
- Using a mirror
  (front surface)

Video processing in Touchlib

- Touchlib
- Video processing
- Blob Tracking
- Fiducial recognition

Touchlib

- A free open source multi-touch software library
- Supports Windows and Linux platforms
  (the Mac OS X version requires some tweaks)
- The software is written in C++

- Flash/AS3 support available through proxy
  (using the OpenSound Control protocol)
- C# support available through wrapper

Video processing I

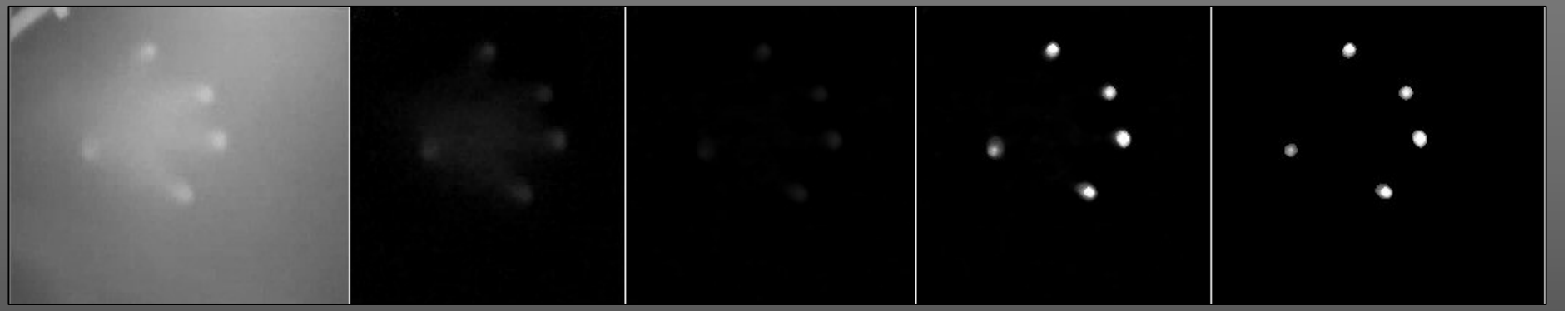
- FTIR

  Filter chain:

1. Camera input (monochrome)
2. Background subtraction
3. End result

Video processing II

- DI - Rear illumination
  Filter chain:



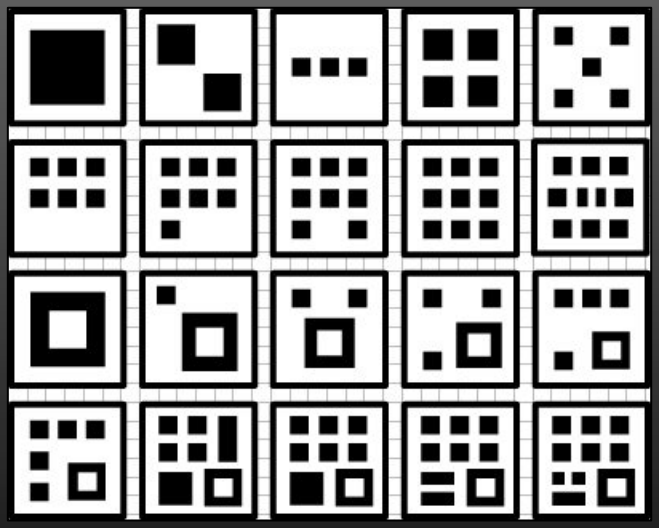
1. Camera input (monochrome)
2. Background subtraction
3. High pass filter
4. Scaler filter
5. End result

Blob tracking

- Looks up the position of a blob a few frames back
- Tracking based on closest previous blob location
- Touchlib delivers the following properties per blob:
  - Unique identifier
  - Position on X and Y
  - Movement, deltaX and deltaY
  - Pressure based on the “size” of the blob

Fiducial recognition

- Capable of detecting square shaped fiducial markers
- Current state: not stable for general usage



Comparing FTIR with DI

FTIR

- Construction is a bit more complex
  (Constructing LED array and creating a compliant layer)
- Reliable blob detection
- Software video processing chain can be very short (3)

DI

- Rear illumination
  - Easy to construct
  - Reliable blob detection
  - Software video processing requires a extra image correction filters (5)
  - Allows the usage of fiducials
- Front illumination
  - Easy to construct
  - Less reliable blob detection
  - Software video processing requires a extra image correction filters (6)

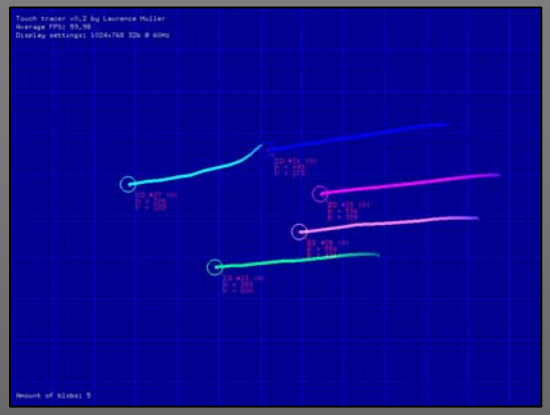
Building your own table

- Dividing the participants into smaller groups
- Each group gets a personal coach
- Don’t hesitate to ask questions!

Useful Links

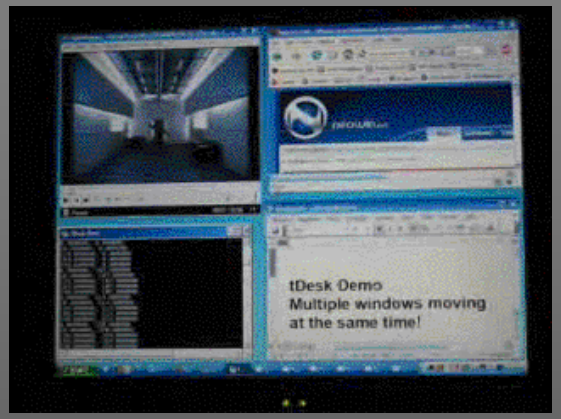
- Touchlib
  http://ww.touchlib.com
- Latest version on SVN (subversion)
  http://code.google.com/p/touchlib/
- NUIgroup
  http://www.nuigroup.com
- SOCO Amsterdam
  http://www.socoamsterdam.nl
- Multigesture (my blog)
  http://www.multigesture.net
- Universiteit van Amsterdam
  http://www.uva.nl
- Section Computational Science
  http://www.science.uva.nl/research/scs/

Some of my applications



Touch Tracer

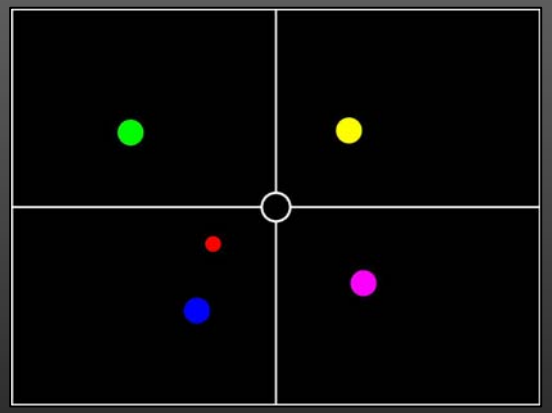
Multi Media Application



tDesk

Multitouch Puzzle Game

Nasa World Wind Plug-in



Air Hockey Pro

Still awake?

Thank you for listening

References

- Jeff Han, NYU
  http://cs.nyu.edu/~jhan/
- Tim Roth
  http://iad.projects.zhdk.ch/multitouch/
- Holowall
  http://www.sonycsl.co.jp/person/rekimoto/holowall/
- MS Surface
  www.microsoft.com/surface/
- Harry van der Veen
  www.multitouch.nl