PERCEPTIVE PIXEL

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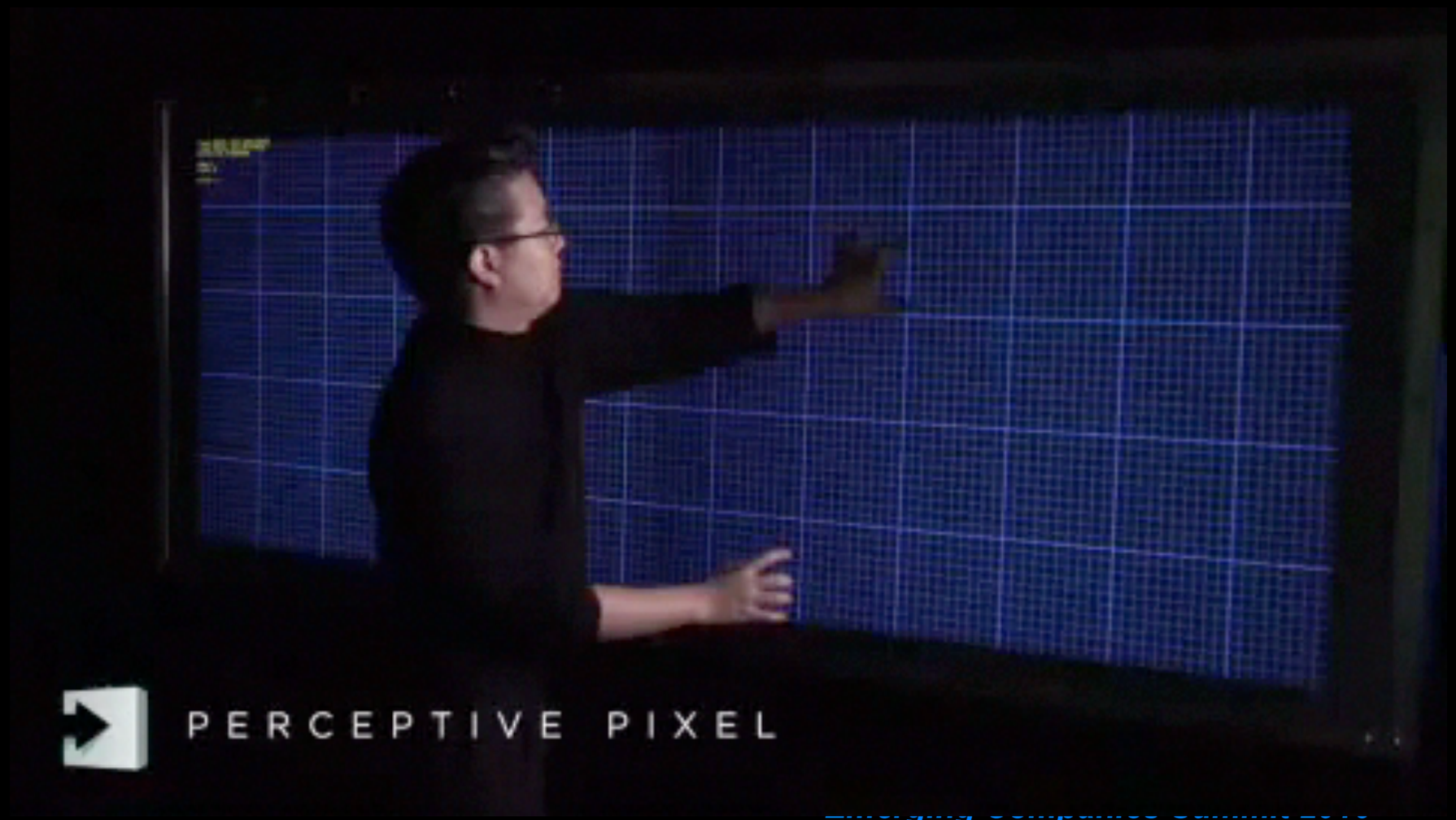
Multi-touch

- “Intuitive”, easy, powerful
- Widens computing for both novices and experts
- Non-traditional form-factors require non-traditional input
- Rich new undiscovered territory for UI innovations
- Multi-touch inherently implies *multi-user*



Multi-touch is NOT…

(just because it uses both hands)

completely distinct interface (and associated issues)

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Overview, Culture

- **Perceptive Pixel is dedicated to the research, development, and deployment of multi-touch/multi-user interfaces for the knowledge worker**

- **First public demonstration at TED conference in February 2006**
  - **Founded in June 2006 by Jeff Han (Chief Scientist)**
  - **Venture backed**
  - **4 offices, headquartered in NYC, along with DC, Portland, Palo Alto**
- **Leadership role in this growing ecosystem**
  - **Very strong recognition for innovation, excellence**
- **Both research and product engineering**
  - **Hardware and software**
  - **Strong research heritage, aggressive green field capture**
  - **Strong IP culture**
- **Strong IP portfolio, > 40 patents in both hardware and software**
  - **contributions in sensors, optics, mechanics,**
  - **interaction techniques (“gestures”)**
- **Markets**
  - **Primary markets: government/defense, broadcast**
  - **Secondary markets: energy, medical imaging, finance, engineering**
  - **Horizontal corporate application (business intelligence, collaboration,**

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Overview - Solutions

The most advanced user-interface solutions available,
tightly integrating both hardware and software together to literally define the market

- **First to market for large-format multi-touch with unprecedented fidelity**

- **100” Wall (flagship) started shipping in Jan 2007**

- **Patent-pending FTIR hardware technology**
- **Unlimited simultaneous points (“true”)**
- **High spatial and temporal resolution**
- **Low latency**
- **True hover discrimination (eliminates false triggers)**
- **Pressure/force sensing**
- **Usable with bare hands, gloves or stylus**
- **Scalable from 55” to 200”, HD to QFHD**

- **Proven mission-critical reliability**

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Customers/Partners/Awards

Jeff Han is about to change the face of computing. Not even the big boys are likely to catch him.

Feb 2007

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Overview - Solutions

- **First to market with large-scale true multi-touch HD LCD (55”)**
  - No compromises in features or functionality
  - Every spec has been improved from RP Walls
  - Scalable from 42” to > 108”, QFHD resolutions

- **Complete Solution Offering**
  - Form-factors spanning the full range
  - 100” Wall, 55” LCD, desktop

  - High-performance Software
    - Advanced core middleware
    - Rich SDKs (C++, Java, Flash, etc.)
    - Integrations with key 3rd party apps
    - Out-of-box Applications

  - Implementation/Services Capability
    - Unrivaled know-how, expertise in user interface technology

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Solutions – Integrated Middleware

- High-performance graphics engine, scene graph
  - Novel event architecture
  - Special considerations for simultaneity, concurrency
- Gesture recognition system
  - Broad library of basics (taps, flicks, drags, chords, double/triple, etc.)
  - Novel, non-trivial gestures (e.g. “menu loop”, etc.)
  - Extensible
- Direct Manipulation Controllers
  - Sophisticated common mathematical framework
  - 2D, 3D, geo, volumetric, slicing planes, etc.
- Rich Dataset Viewers
- Widget library
  - Completely new multi-touch enhanced widgets/controls
- Market Specific Modules: Geo-Spatial, Broadcast, Weather
- High performance Browser
- Multi-device synchronization across network
  - Scalable, down to AIO, laptop, and mobile devices

- C/C++, Java, .NET
- Operating System Agnostic:
  - Runs on all flavors of Windows (XP/Vista, not just 7)
  - Mac OS X
  - Linux
  - both 32 and 64-bit
- Alternative software platforms
  - Flex/AIR/Flash
  - VizRT
- Considering:
  - iPhone/iPad
  - MeeGo
  - Android
  - HTML5
  - Silverlight

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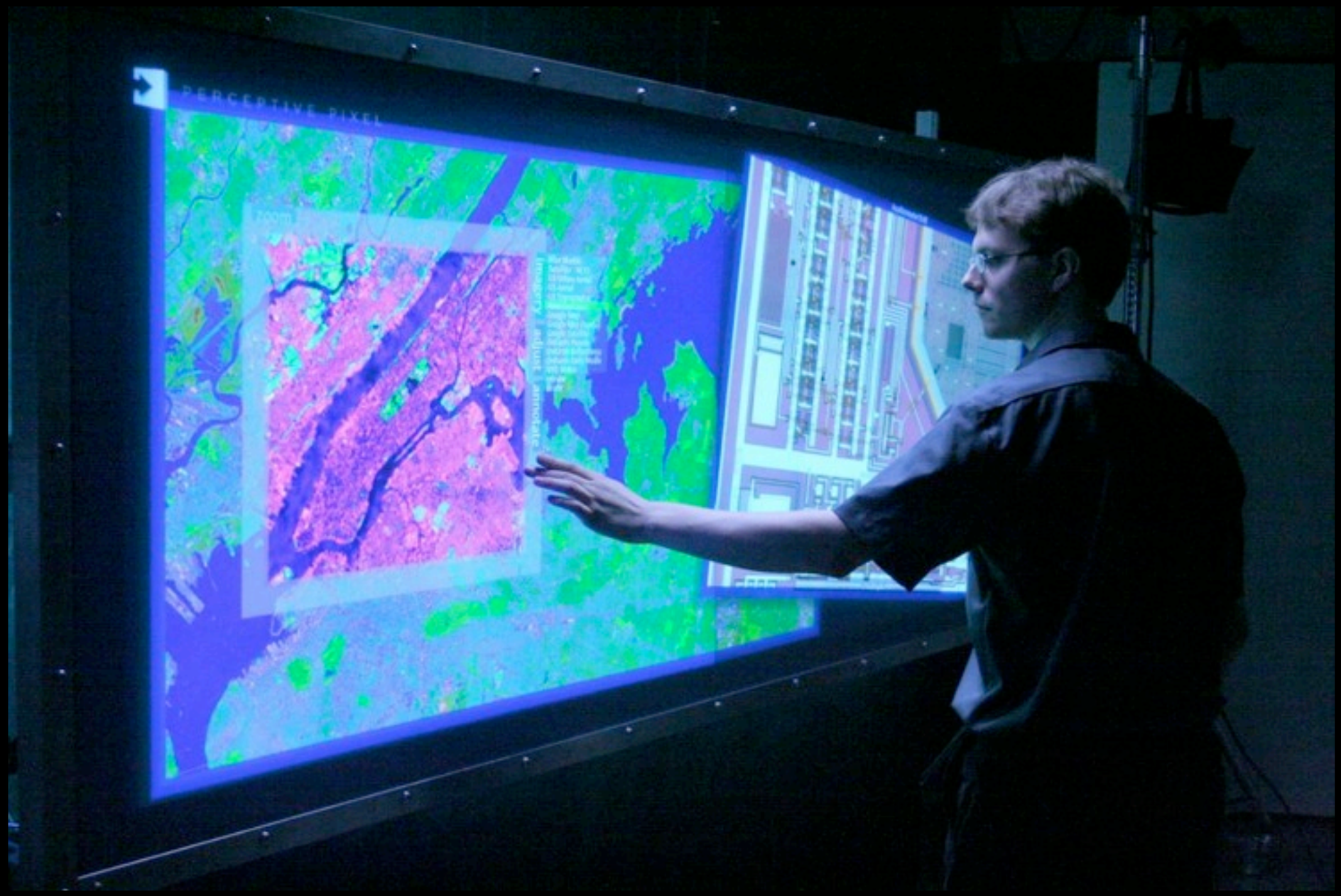
Defense/Government



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Broadcast

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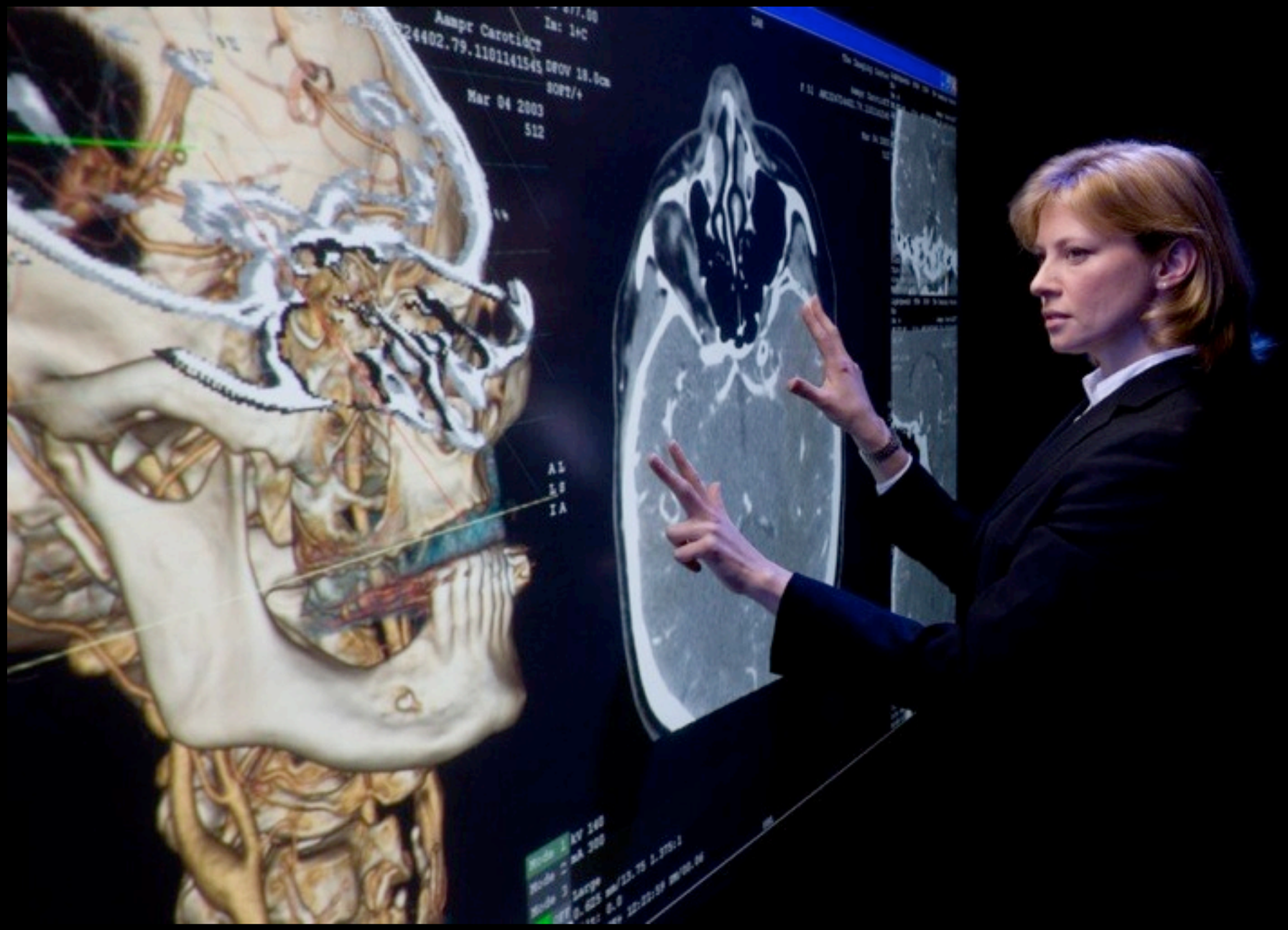
Medical Imaging



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Other form-factors

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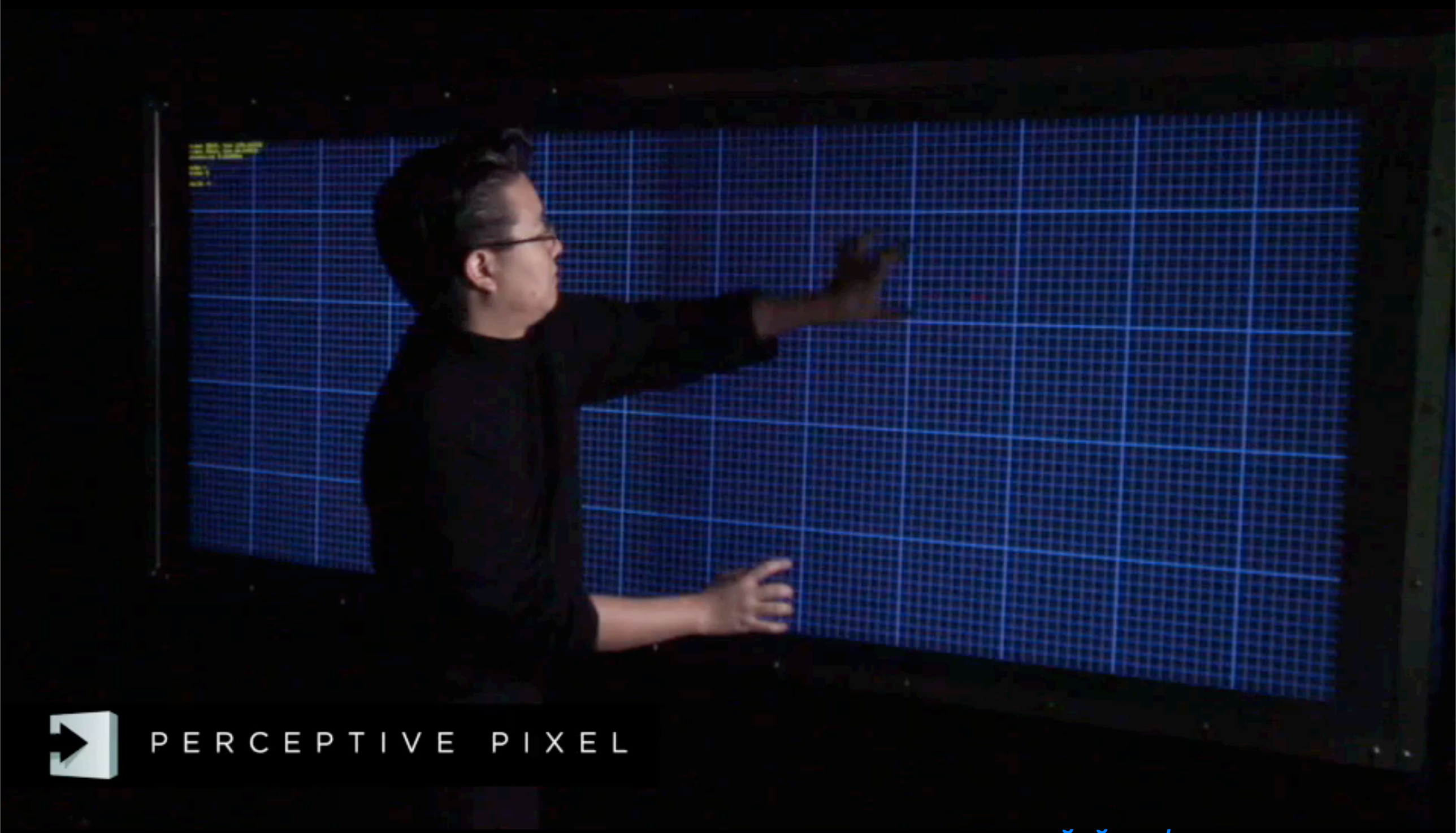
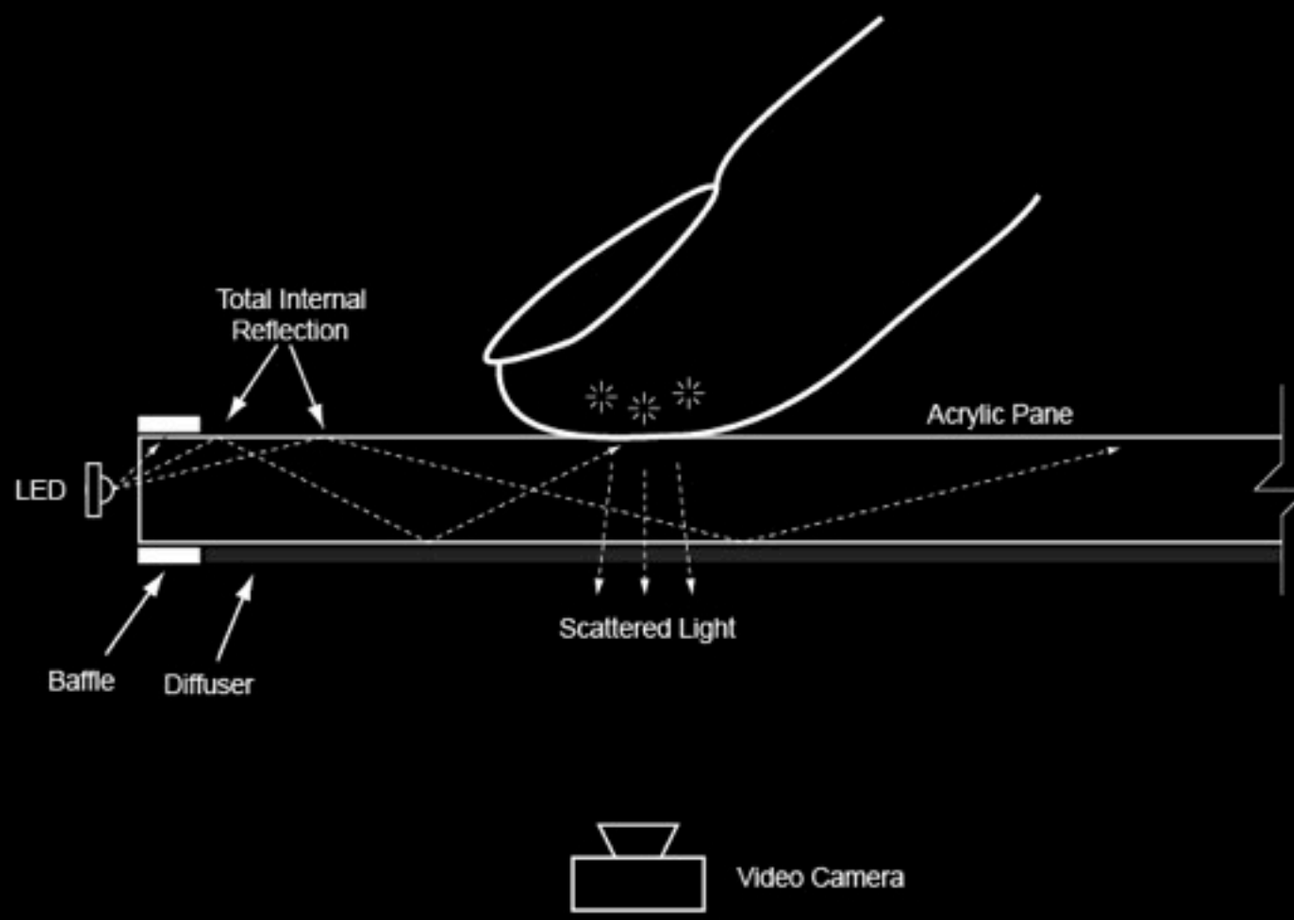
Demo/Video



FTIR sensing technology



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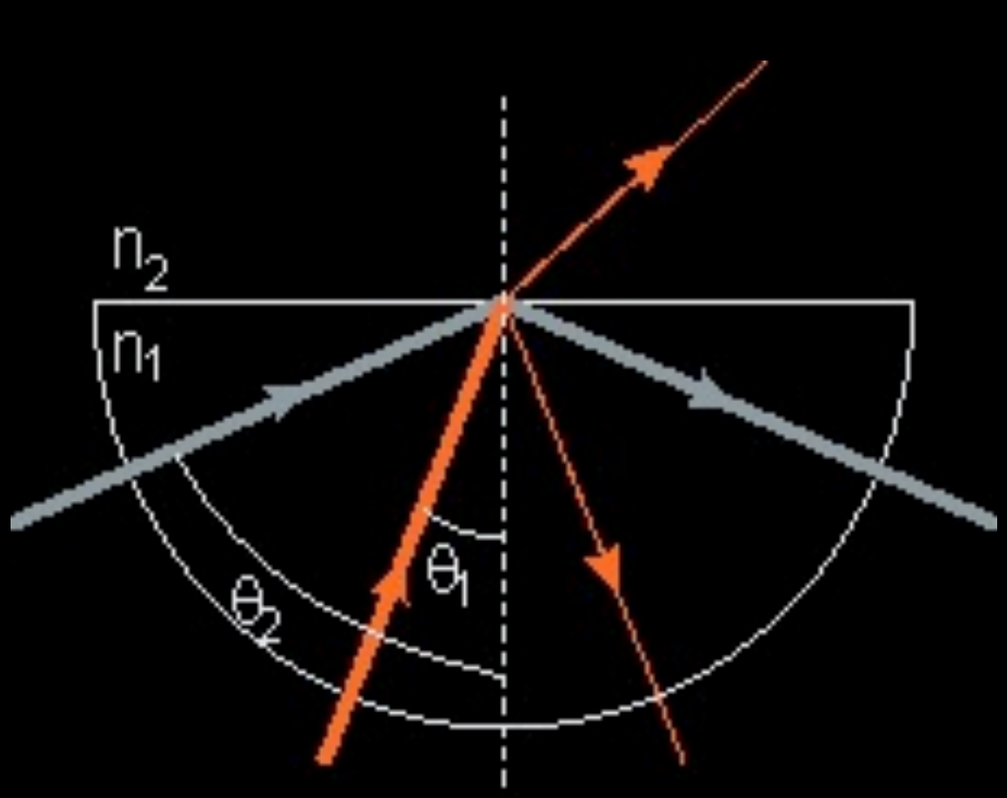
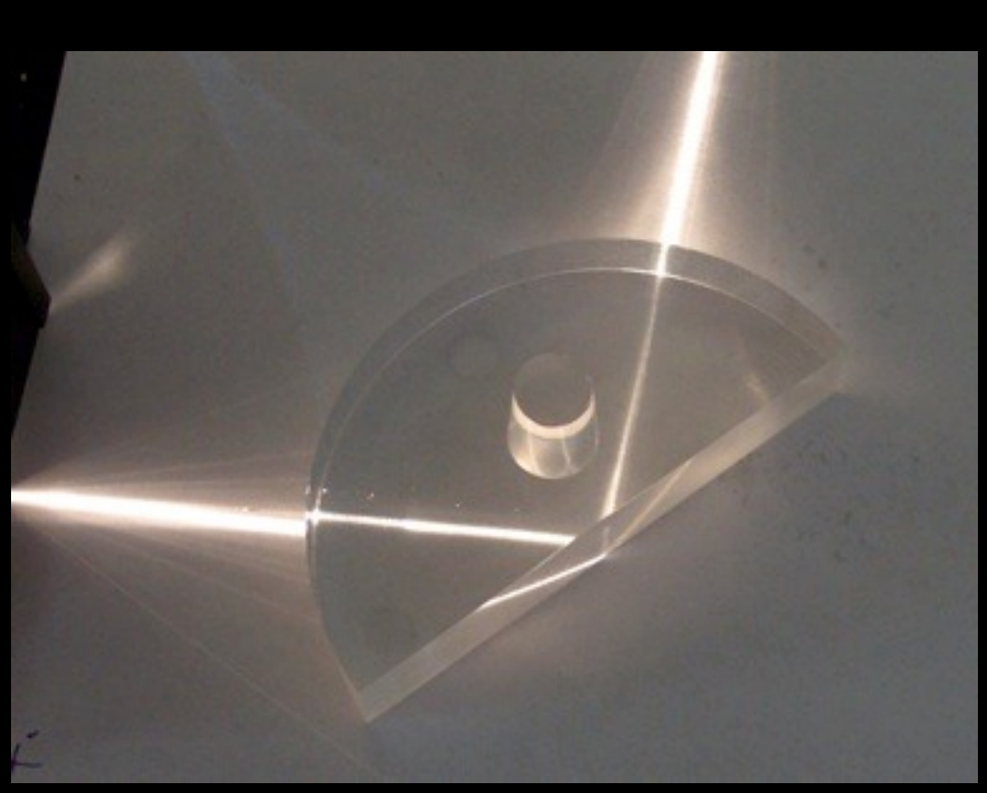
FTIR Approaches

- **Total Internal Reflection (TIR)**
  - **Light meets an interface into a material of lower index of refraction**
  - **This is said to be *frustrated* when another material interferes**





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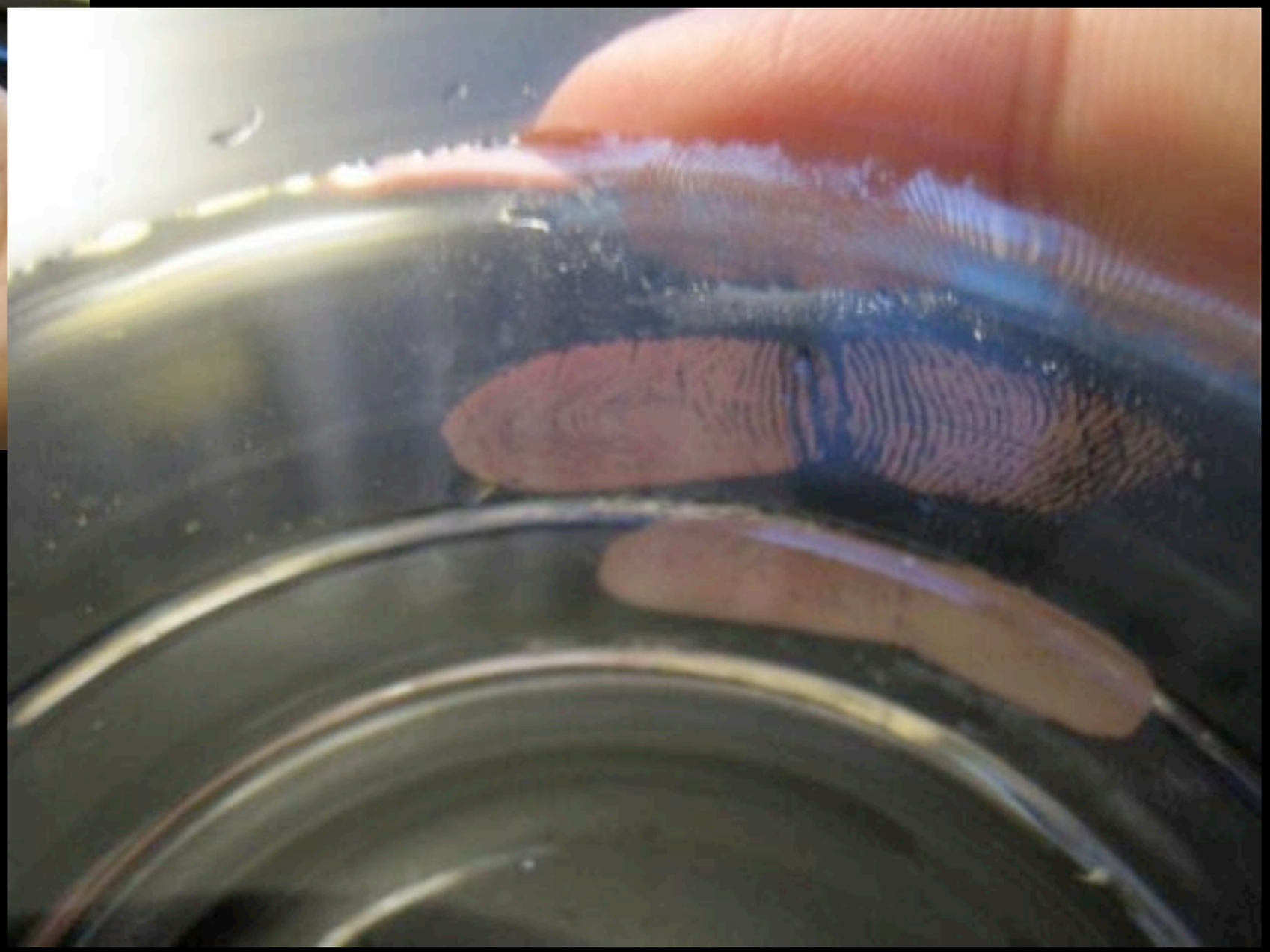
Sensing Theory of Operation



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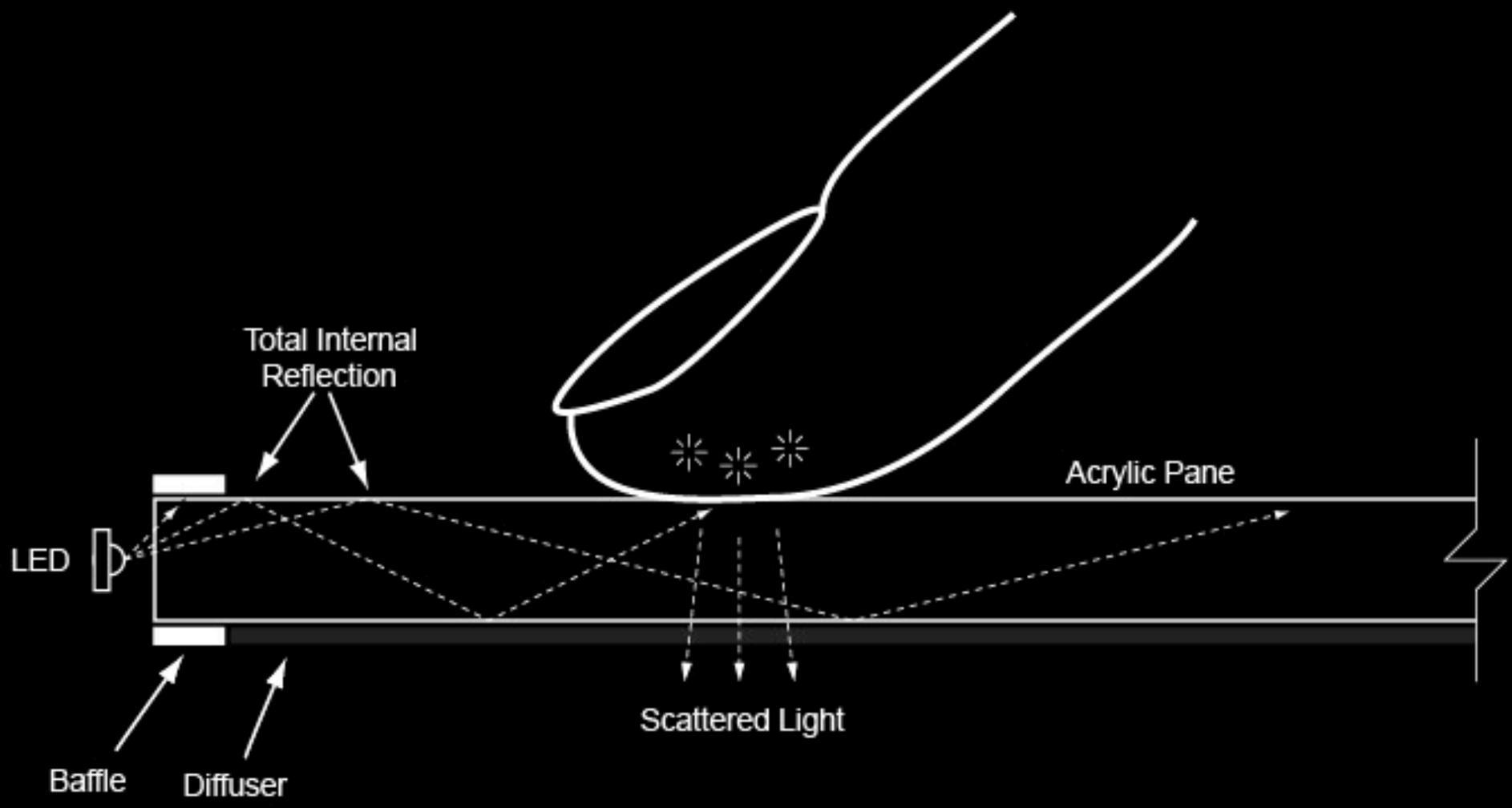
Optical Schematic



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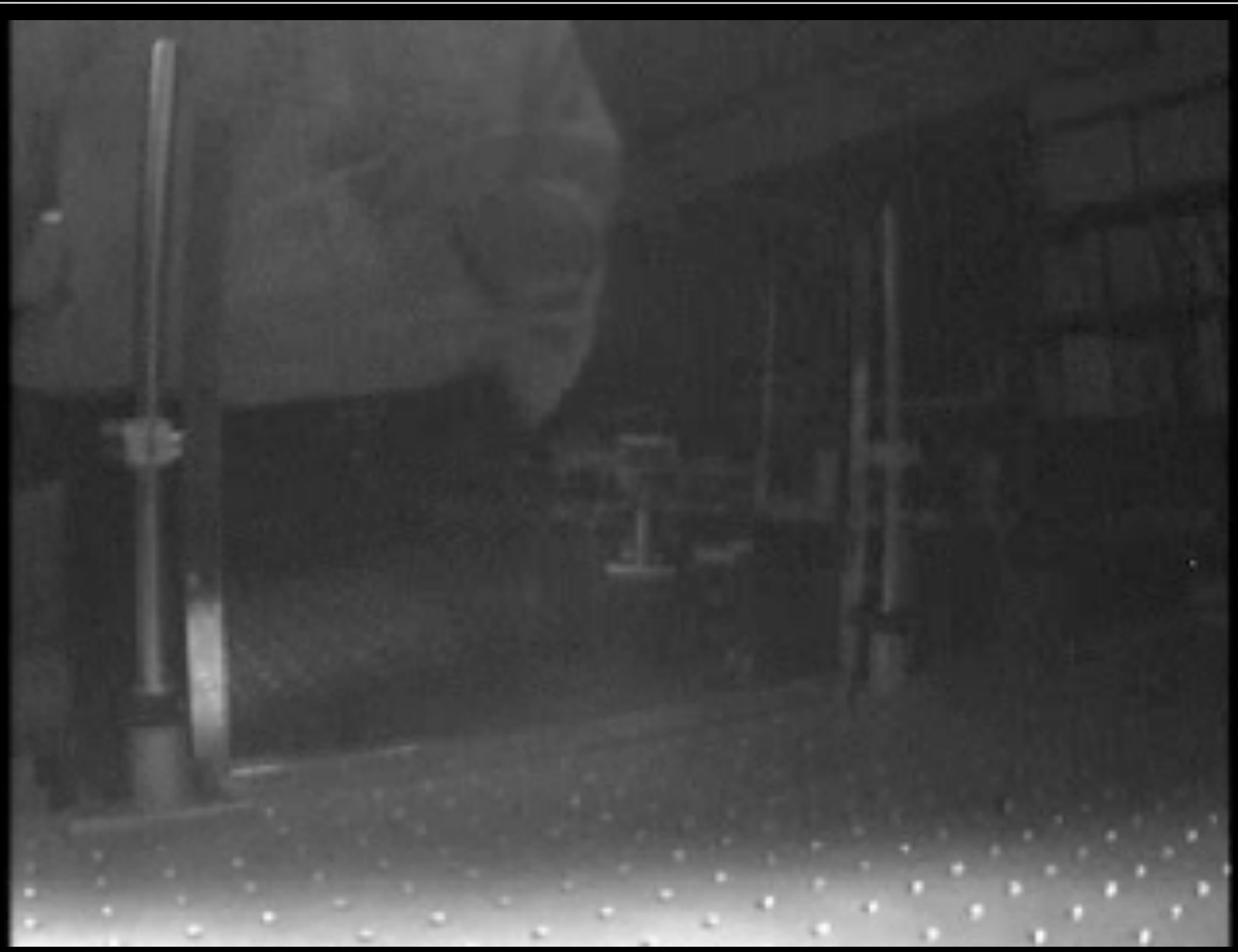
Raw Output


guid= 0x00005878
lifetime= 55
cx,cy= (474, 235)
area= 295
areacot= 440

Raw Infrared View



Raw Infrared View, Pressure Sensing

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LCD55

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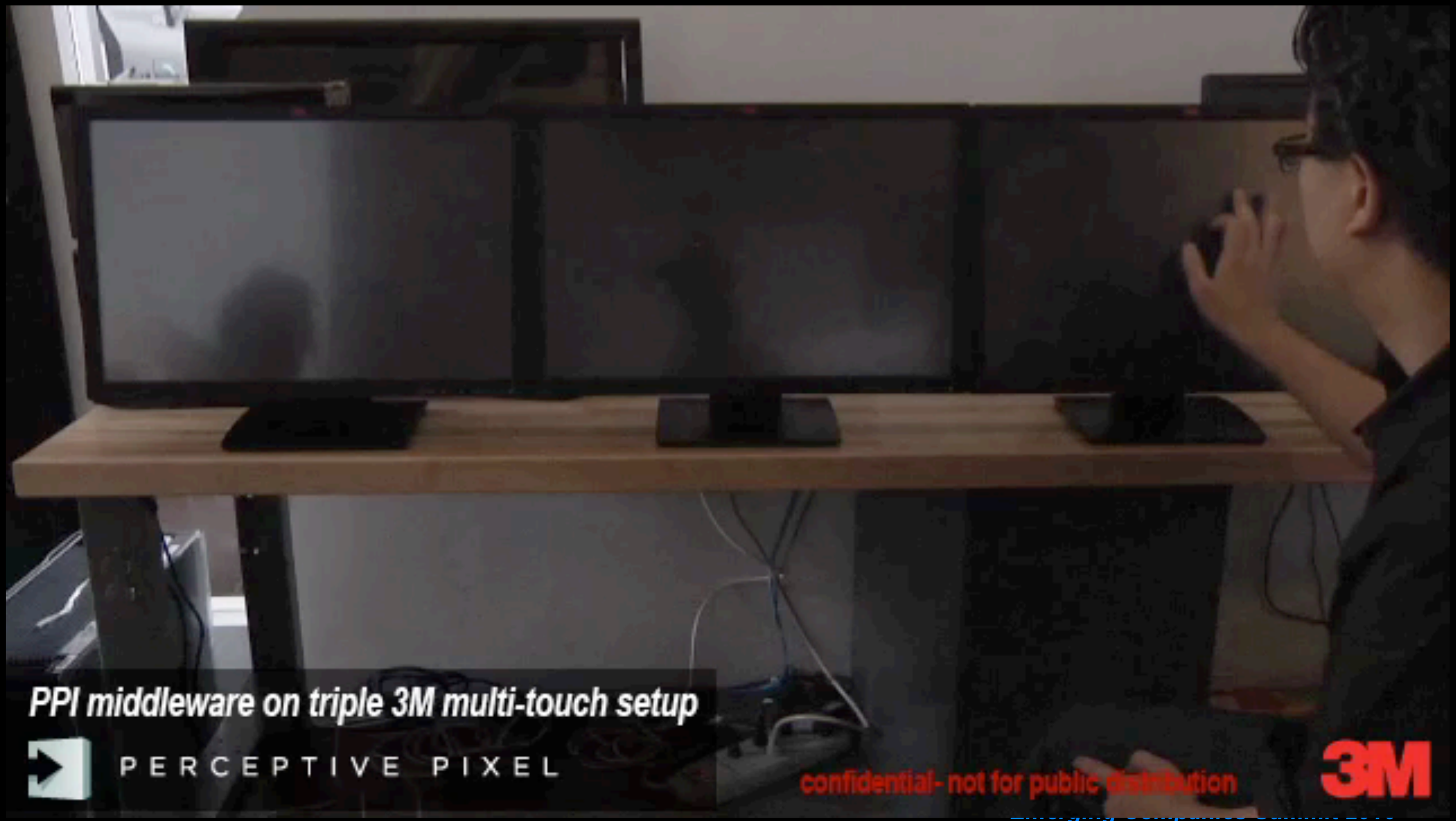
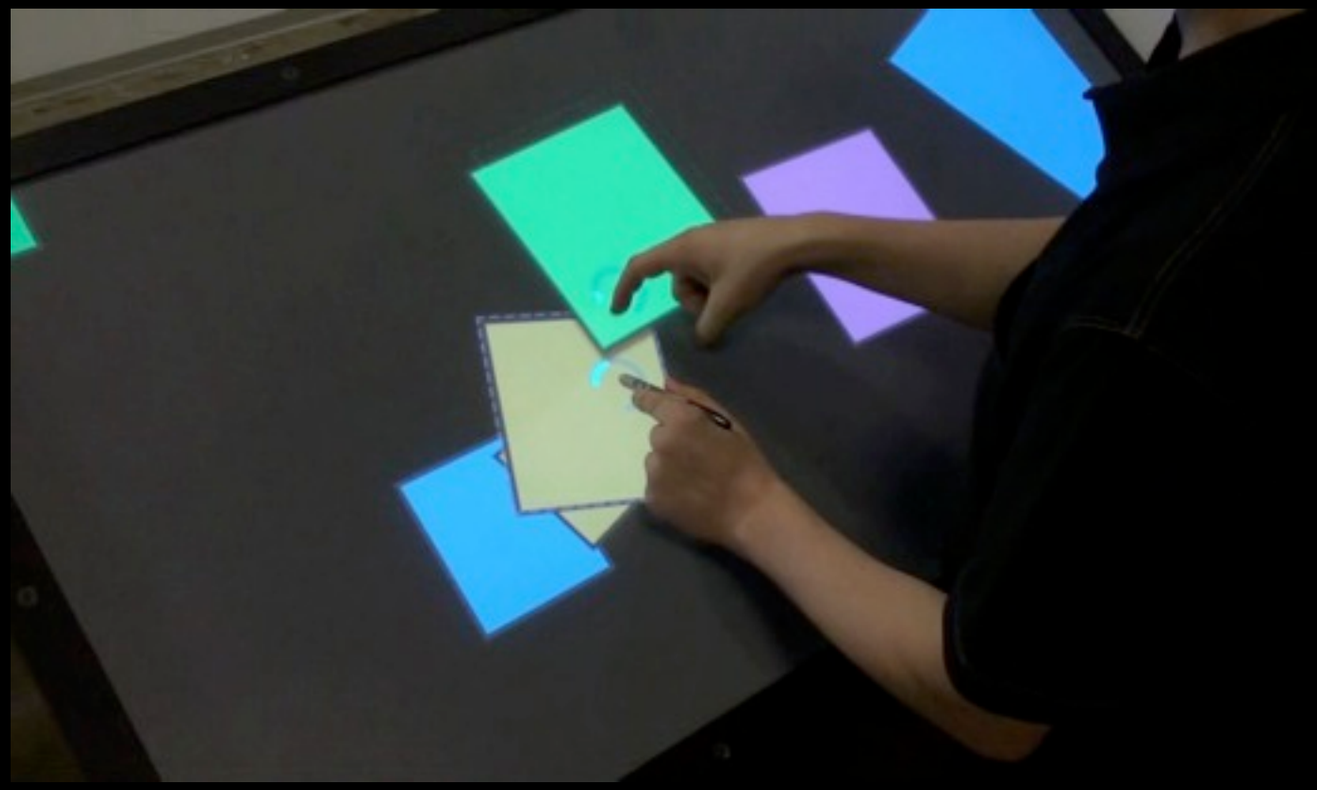
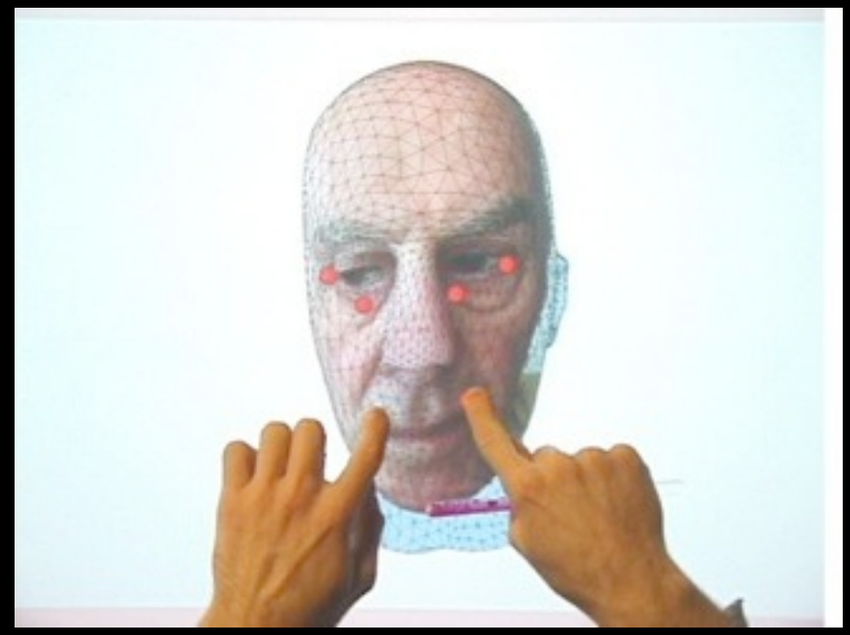
Desktop LCDs, multi-screen



Fundamental Interaction Research

- Hi-DOF dataset direct manipulators
- Multi-user collaboration
- Multi-modal combinations of techniques





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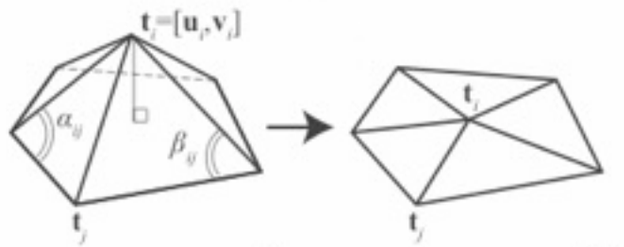
Research (2006)

Parameterization Algorithm

Linearized Bending Energy



$$t^T A t = E = \sum_i \frac{1}{8\,area_i} \left(\sum_{j \in N(i)} (\cot \alpha_{ij} + \cot \beta_{ij})(\mathbf{t}_i - \mathbf{t}_j) \right)^2$$

Constraints

Modify system

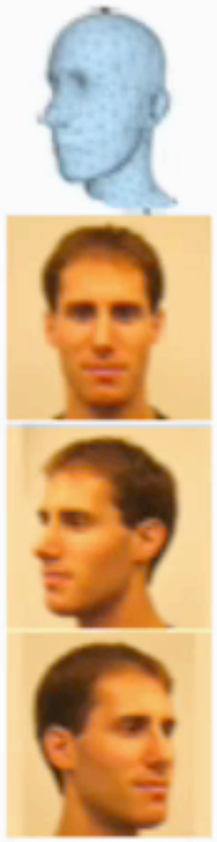
bending energy Hessian

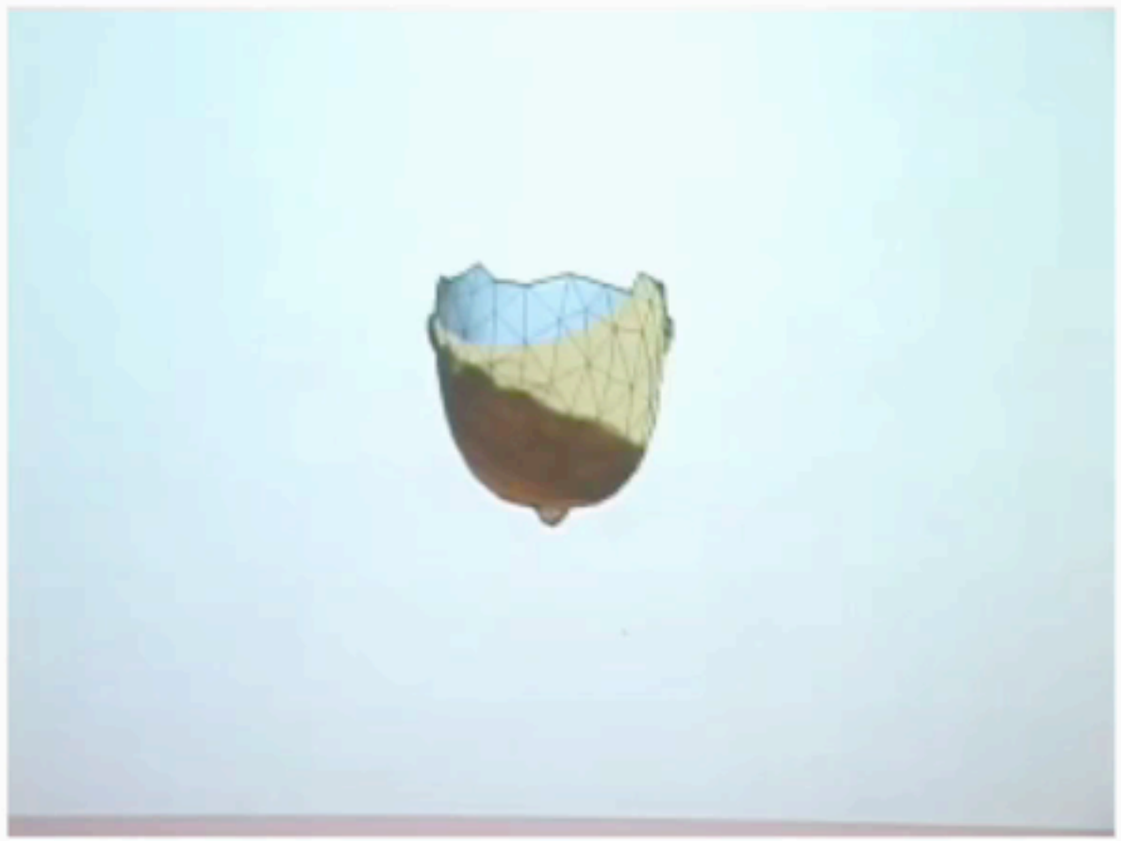
$$A^{ext} = \begin{pmatrix} A & C^T \\ C & 0 \end{pmatrix}$$

constraints $\begin{pmatrix} \beta_1 u_1 + \beta_2 u_2 + \beta_3 u_3 = u_{fixed} \\ \beta_1 v_1 + \beta_2 v_2 + \beta_3 v_3 = v_{fixed} \end{pmatrix}$

Need a scheme for quickly updating inverse

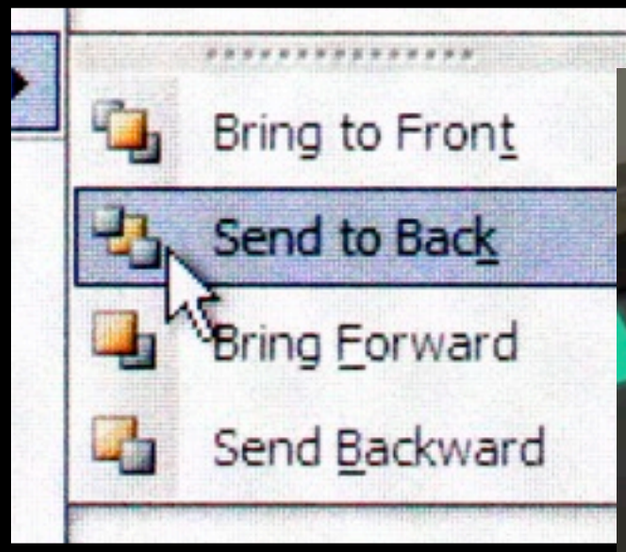
Results

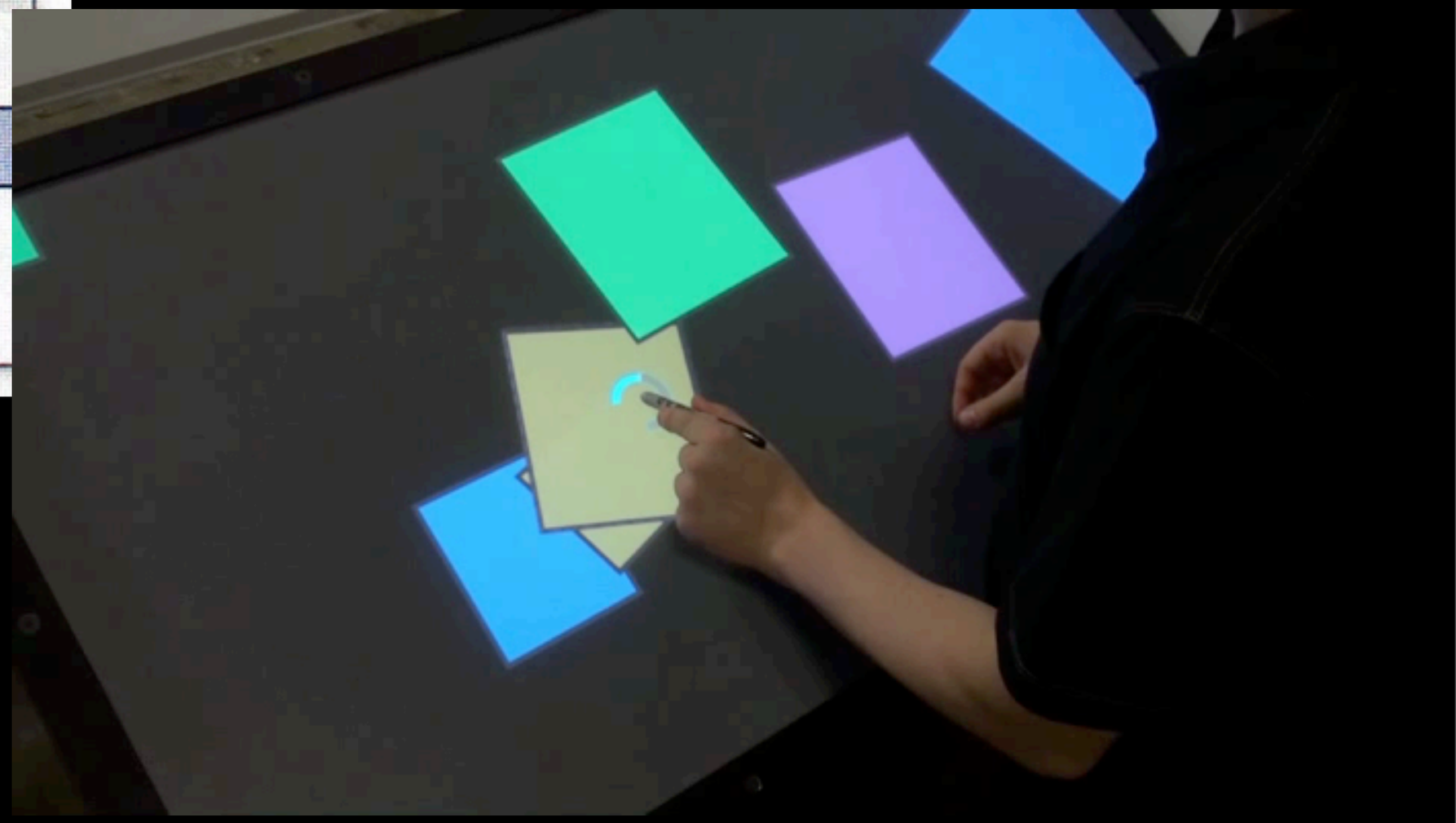




Interaction Research (2008)

- **Using pressure information to solve the classic 2.5D layering problem**





Davidson, P. L. and Han, J. Y. 2008. Extending 2D object arrangement with pressure-sensitive layering cues. In *Proceedings of the 21st Annual ACM Symposium on User interface Software and Technology* **(Monterey, CA, USA, October 19 - 22, 2008). UIST '08. ACM**

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Interaction Research (2009)

- **A constraint-based approach to direct manipulation, allowing users to effectively control 3D and higher DOF models with multi-touch**

Reisman, J. L., Davidson, P. L., and Han, J. Y. 2009. A screen-space formulation for 2D and 3D direct manipulation. In *Proceedings of the 22nd Annual ACM Symposium on User interface Software and Technology* **(Victoria, BC, Canada, October 04 - 07, 2009). UIST '09. ACM**

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Screen Space Constraints

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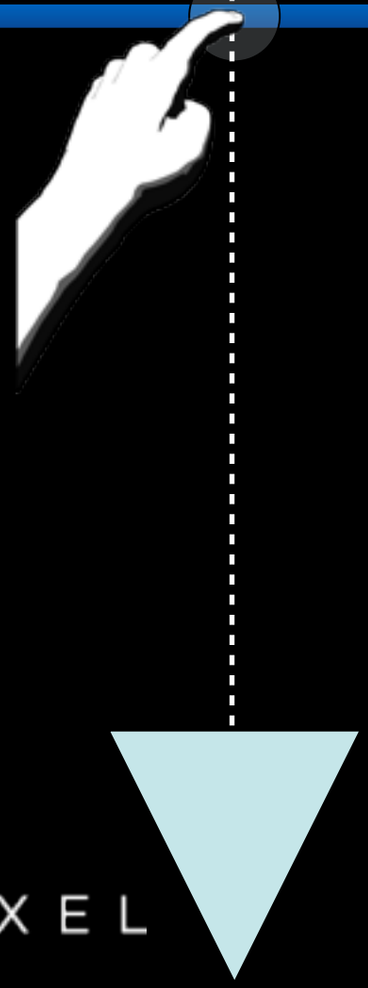
image plane



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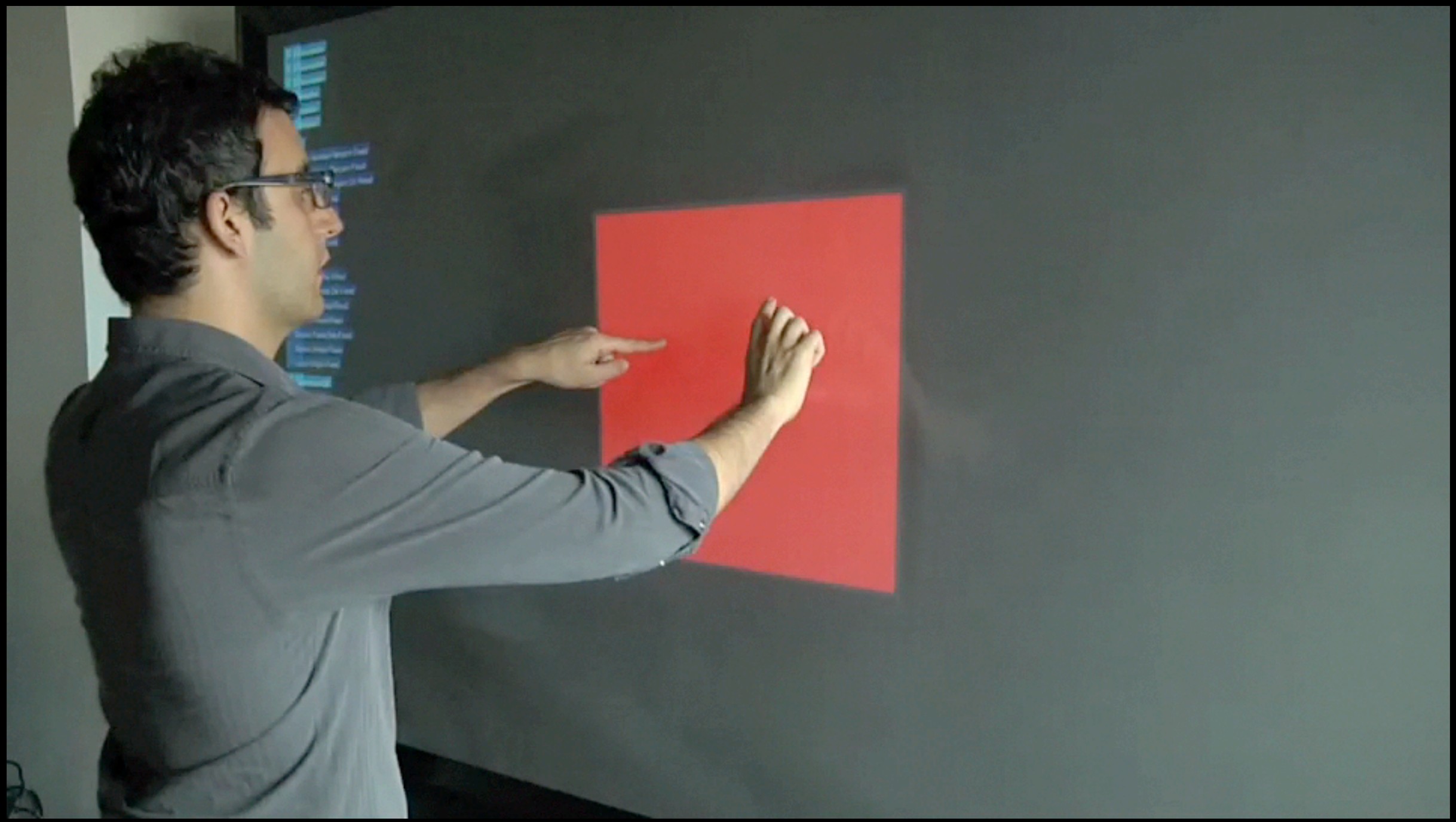
Emergent Interactions



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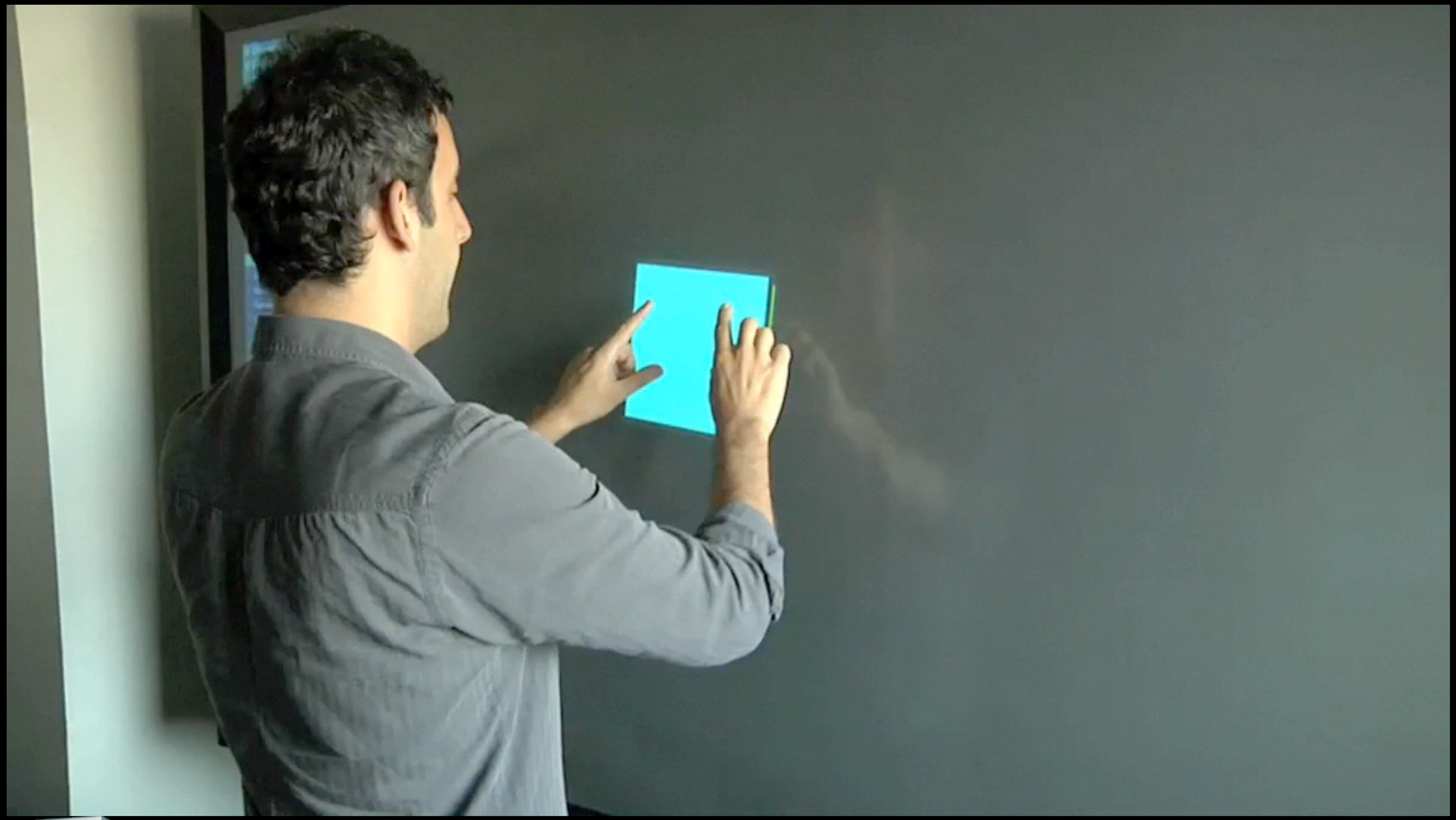
4-point Interactions



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Terrain Navigation

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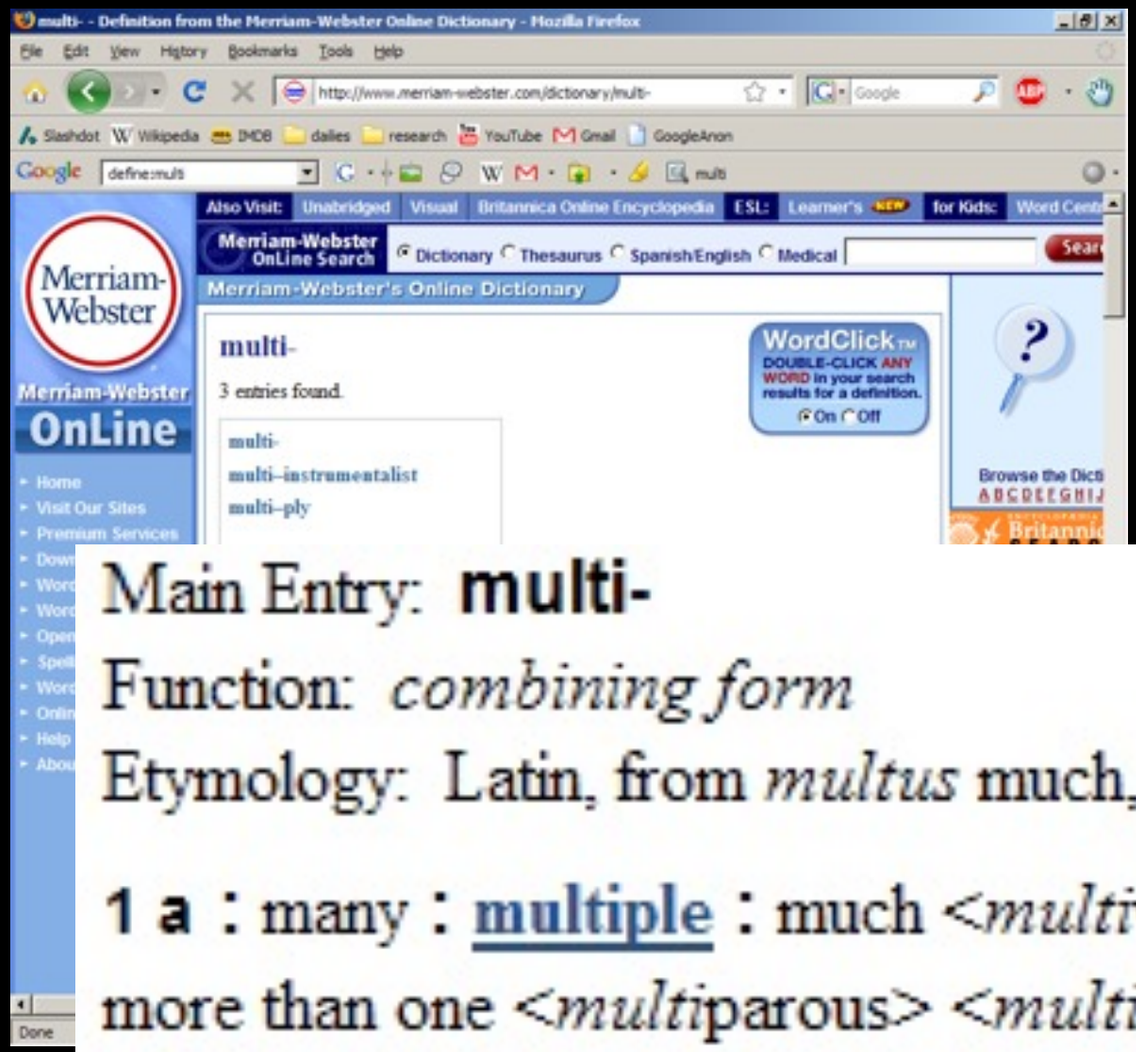
“Multi”



Main Entry: **multi-**

Function: *combining form*

Etymology: Latin, from *multus* much, many — more at MELIORATE

1 a : many : multiple : much <*multi*valent> **b** : more than two <*multi*lateral> **c** : more than one <*multi*parous> <*multi*billion>

2 : many times over <*multi*millionaire>