

Human Computer Interaction

9. Advanced Input Devices (A)

National Chiao Tung Univ, Taiwan

By: I-Chen Lin, Assistant Professor

Objectives

- Advanced control/Input devices and technologies.
- The state-of-the-art systems.

Ref:

- D.A. Bowman, E. Kruijff, J.J. LaViola, I. Poupyrev, 3D User Interfaces: Theory and Practice, Addison Wesley Professional, 2005.
- Course notes, "3D User Interfaces", CS, Columbia Univ.
- Course notes, "Introduction to Human-Computer Interaction Design", CS, Stanford Univ.

Input Device Issues

- What actions does it afford?
- What resolution/sensitivity does it offer?
- What dexterity does it require/allow?
- What is it efficient/inefficient at doing?
- What interaction techniques is it suitable for?
- What are its ergonomic advantages and problems?

Dimensions of Performance

- Continuous vs. discrete
- Resolution and accuracy
- Sampling rate and latency
- Noise, aliasing and nonlinearity
- Direct vs. Indirect
- Absolute vs. relative
- Control-to-display ratio
- Physical property sensed
- Position, motion, force
- Degrees of freedom

Symbolic Input

- Task of entering
 - Text
 - Numbers
 - Symbols
- Desktop symbolic input
- Mobile symbolic input
 - Standing, walking, communicating
- 3D UI symbolic input
 - Tracked, gestural, etc.

Symbolic Input (cont.)

- Conditions for 3D environment
 - Mobile users
 - Not seated: standing, crouching,...
 - About to move → Actively moving
 - No dedicated desk surface
 - Hands busy or full
 - Eyes busy, occluded, or in low light
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Keyboards



Some Ergonomic Issues

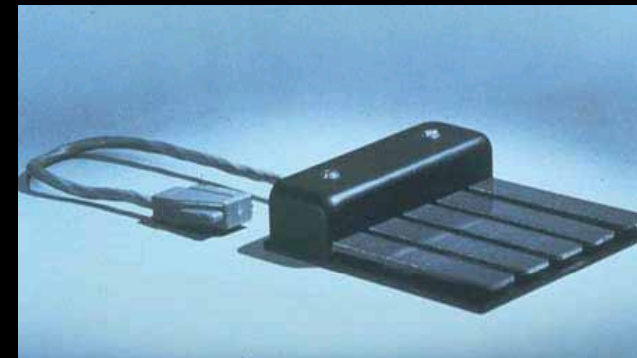
- Hand position - Freedom of hand for positioning device
- Touch typing vs. hunt and peck
- Repetitive stress / fatigue
- One handed use
- Need for support
-

Mobile (Chord, Multi-press,...)



THUMBSRIPT™ www.thumbscript.com

A	B	C	D	E	COMMANDS
Start	Stop	Back	Forward	Home	CMD: CAPS END: RTN SPACE
F	G	H	I	J	Tap once
M	N	O	P	Q	NUMBERS
T	U	V	W	X	1 2 3 4 5 6 7 8 9 0
					Tap center for 5. Zero is written "0" reversed.



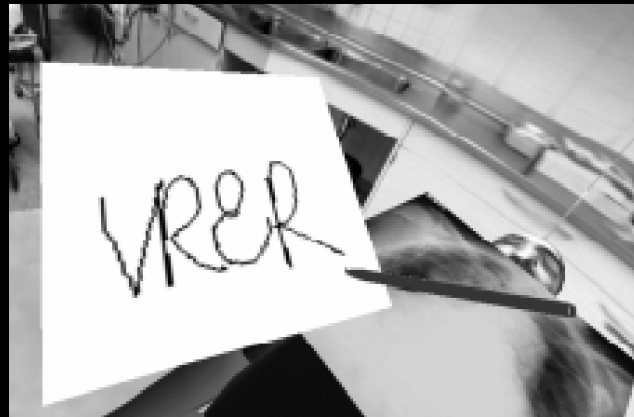
Advanced Symbolic Input



J. Mankoff & G. Abowd, UIST'98



Samsung Scurry



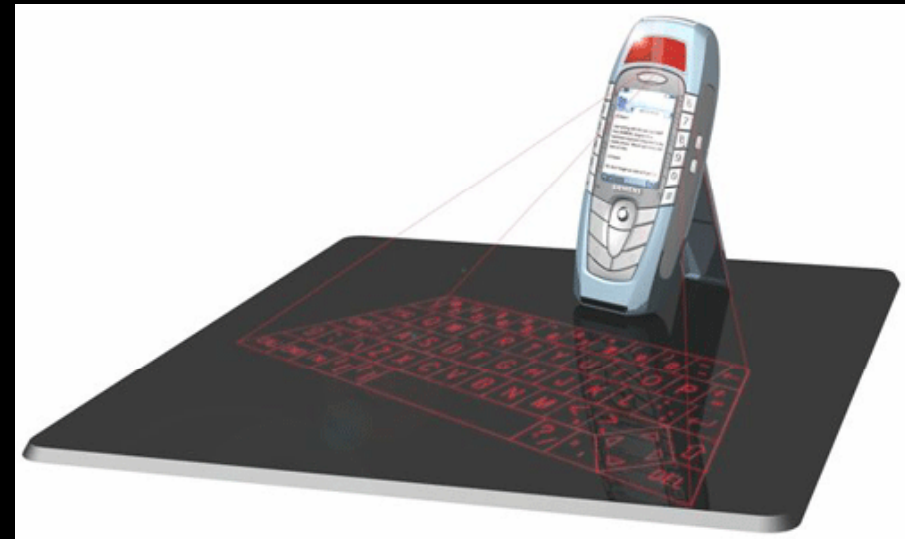
I. Poupyrev, N. Tomokazu, S. Weghorst, VRAIS 98

Advanced Symbolic Input

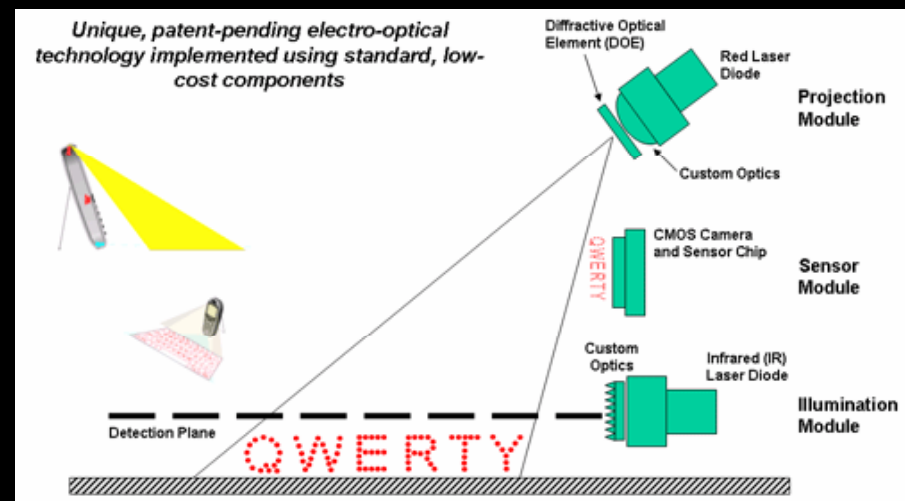
- Data gloves
 - Key poses or continuous sign recognition.
 - HMM-based recognition
 - Learnability
 -



Advanced Keyboards



- Virtual Keyboard



Pointing Devices

- Target acquisition
- Steering / positioning
- Tracking

- Freehand drawing
- Drawing lines
- Tracing and digitizing

- Clicking, Double-clicking, dragging

- Gesture

Indirect Pointing Devices

- Keys (discrete)
- Mouse
- Joystick
- Trackball
- Touchpad
- Tablets (non-display)
-

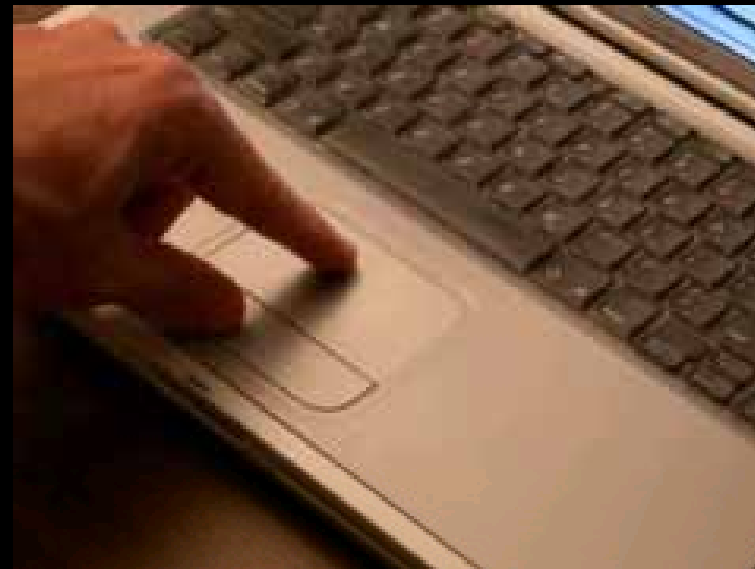


The First Mouse
(Stanford Research Institute, 1964)

Trackball, Trackpad, Trackpoint

■ What is Sensed

- Motion (e.g., mouse)
- Position (e.g., trackpad)
- Force (e.g., trackpoint)



Tracking Pointers



Eye tracker



Head tracker



Tracking by brain signals

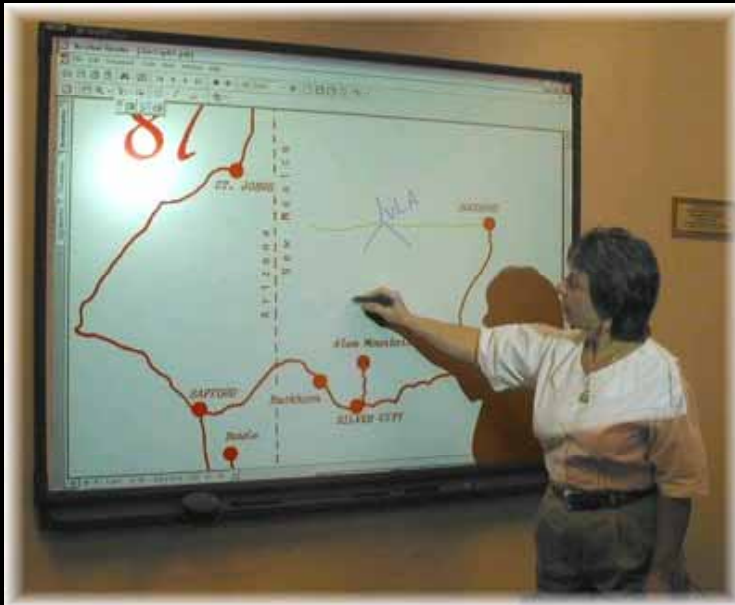
Fitts Law

- $MT = a + b \log_2 (A/W + 1)$
 - a : the start/stop time of the device
 - b : the inherent speed of the device
 - A : the distance from the starting point to the center of the target
 - W : the width of the target (along the axis of motion)
- Target acquisition time is proportional to the log of the ratio of the **Distance** to the **Width** of the target.
- Applies to position control devices
 - Same for direct and indirect

Pen/Touch Input

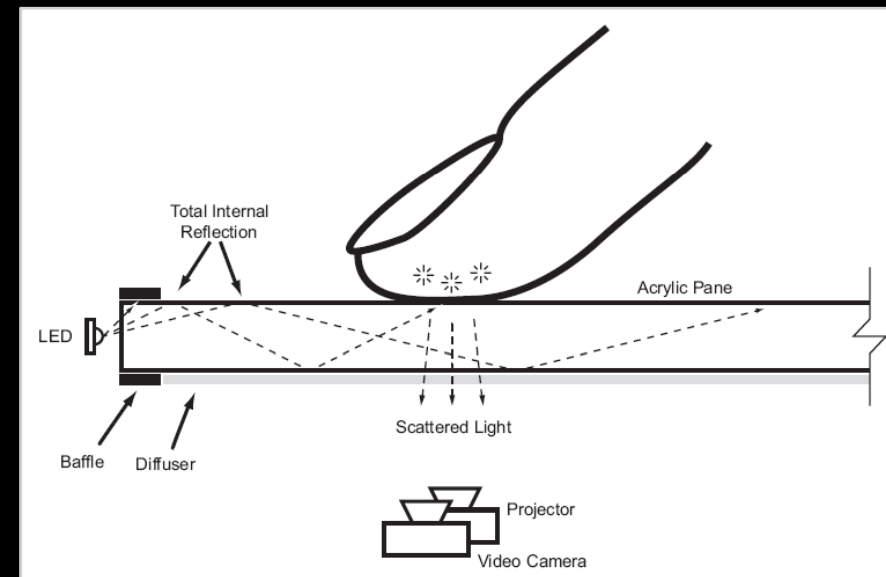
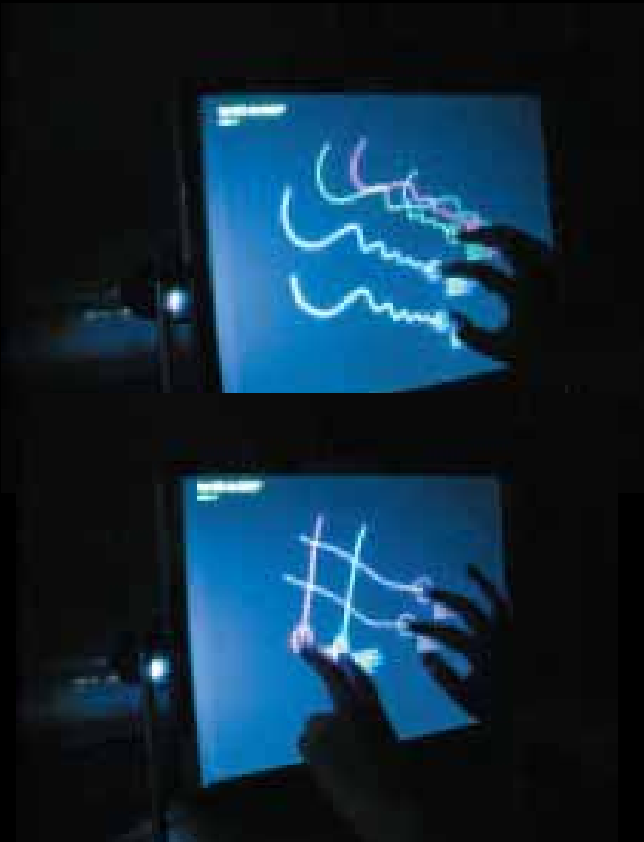
- Good for pointing and drawing
- Natural for gestures
- Possibility of multiple pointers
- Not an efficient way for text entry
- Handwriting
 - Problems of interpretation
 - Special characters/gestures

Touch Screen



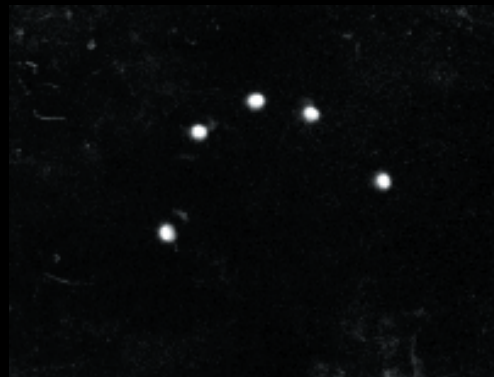
Multi-Touch Screen

- J.Y. Han, "Low-Cost Multi-Touch Sensing through Frustrated Total Internal Reflection", Proc. UIST'05.



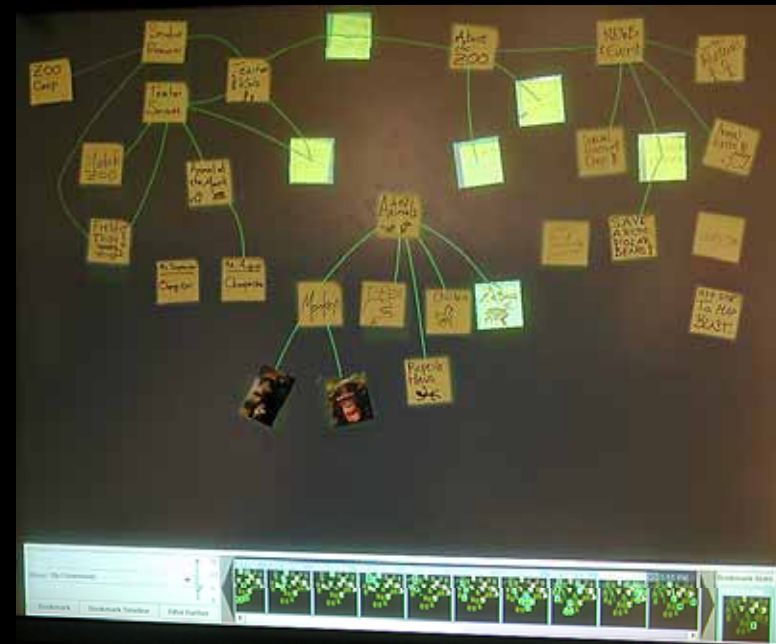
Multi-Touch Screen (cont.)

- Simple image processing operations
 - Rectification, background subtraction, noise removal, and connected components analysis
 - Low cost video capturing
- Inherent drawbacks of vision-based system
 - Requires a significant amount of space
 - Skin reflectance, pixel resolution, etc.



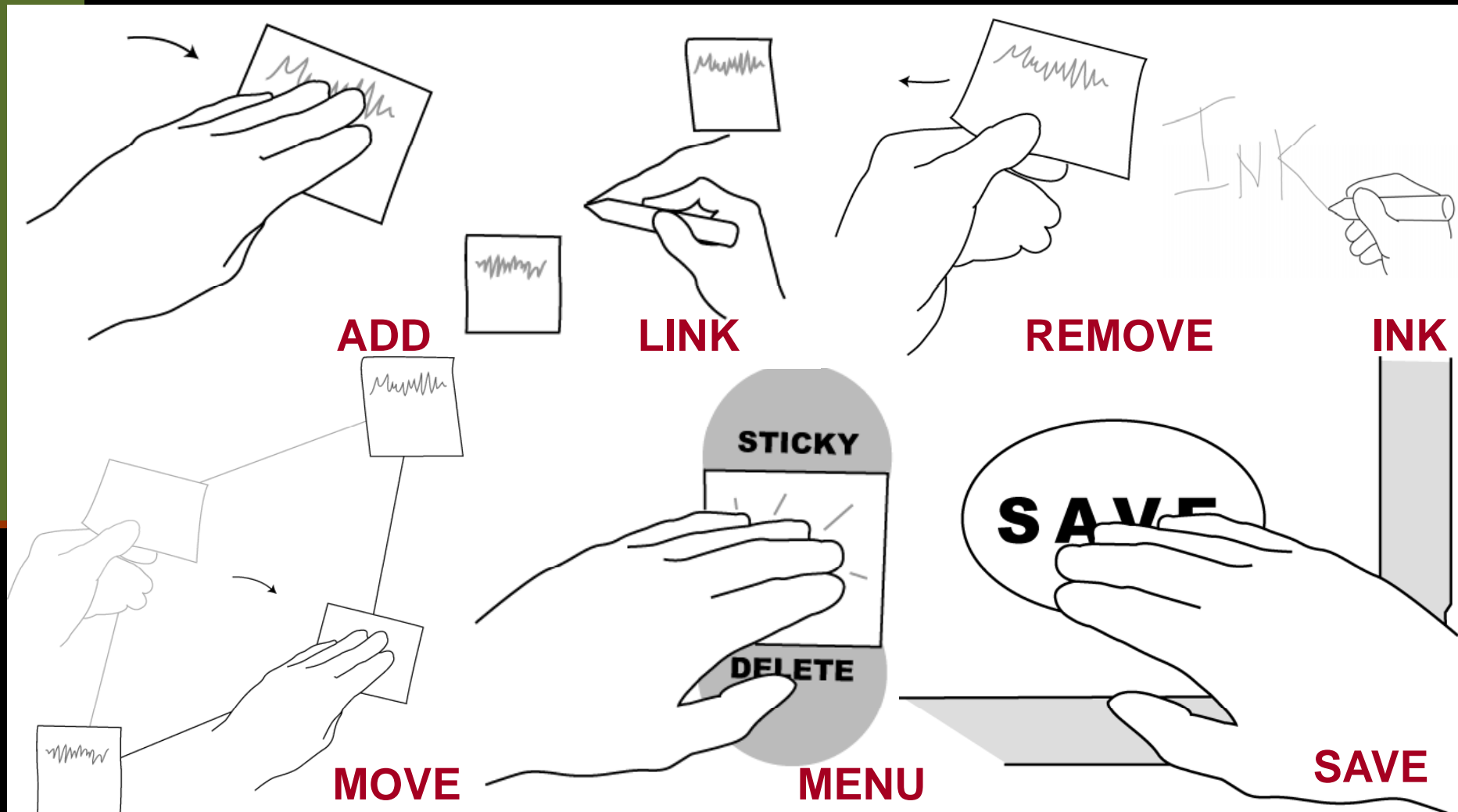
Tangible or Mixing Interaction

- S. Klemmer et al. "Designers' Outpost: A Tangible Interface for Collaborative Web Site Design", Proc. UIST'01.



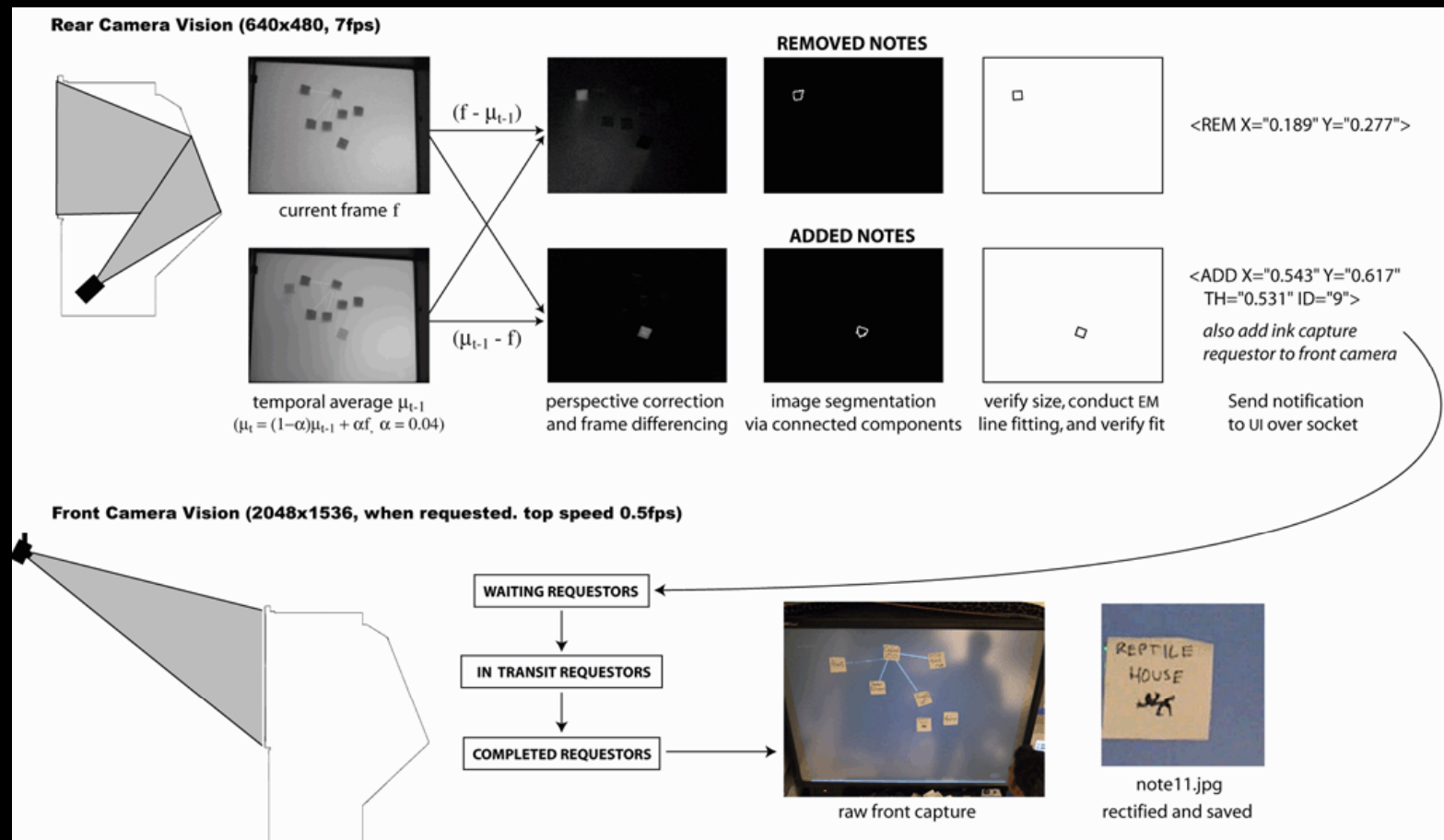
Designers' Outpost

Designers' Outpost



Designers' Outpost

- Touch sensitive SMART board augmented with two digital cameras



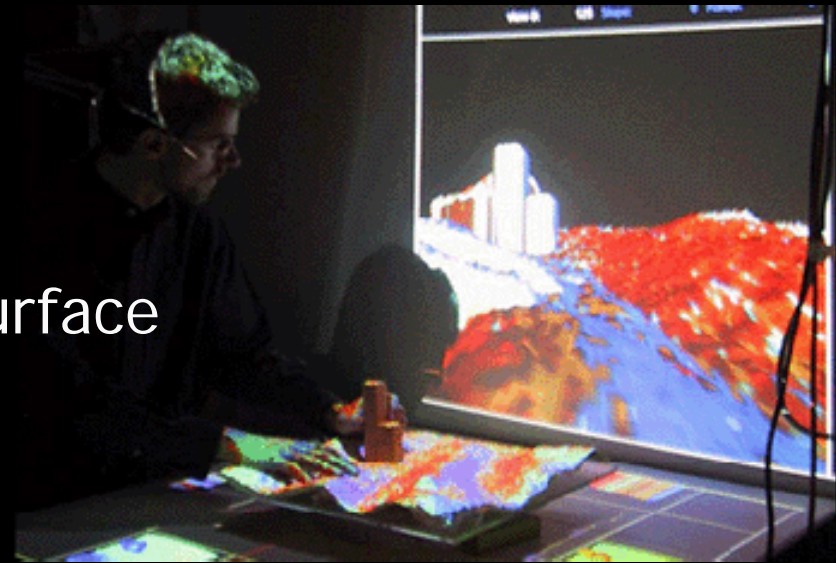
Tangible or Mixing Interaction

MetaDesk



Tangible UI (Illuminating Clay)

- B. Piper, C. Ratti, Y. Wang, B. Zhu, S. Getzoyan, & H. Ishii, Proc. CHI 2002.
- Allow users to interact with real freeform surfaces
- Users
 - Molds surface of clay
- System
 - Determines height of surface
 - Projects imagery corresponding to tasks



Illuminating Clay (cont.)

