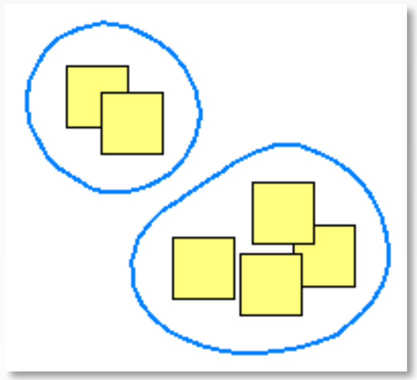
Week 1

Graphical User Interfaces



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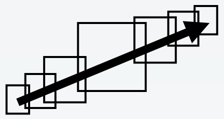
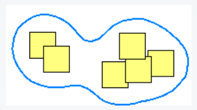
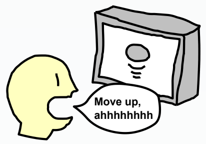
Introduction

- Graphical user interfaces turn computer control problem into visual problem solving.
- This lecture introduces five attempts to improve current GUI operations.

Graphical User Interfaces

- Scrolling Interface
- Desktop Icons
- Pointing
- Digital Ink
- Voice Interaction



Graphical User Interfaces

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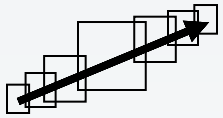
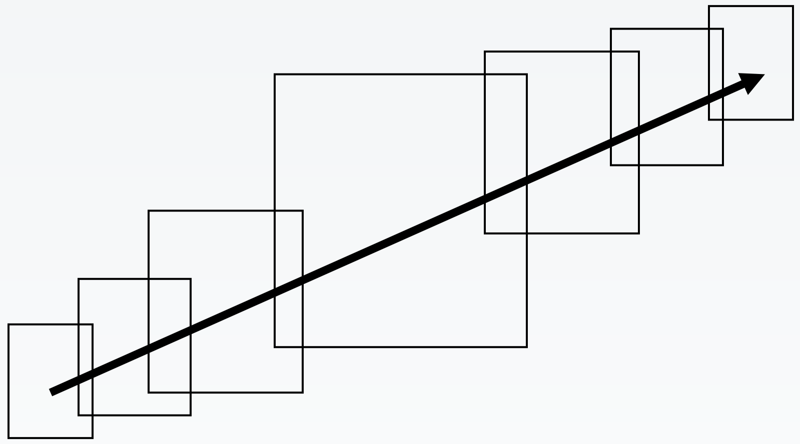


Speed Dependent Automatic Zooming for Browsing Large Documents



Takeo Igarashi (Univ of Tokyo)
Ken Hinckley (Microsoft Research)

Problem

Navigation of a large document is difficult.

Scrolling Interfaces

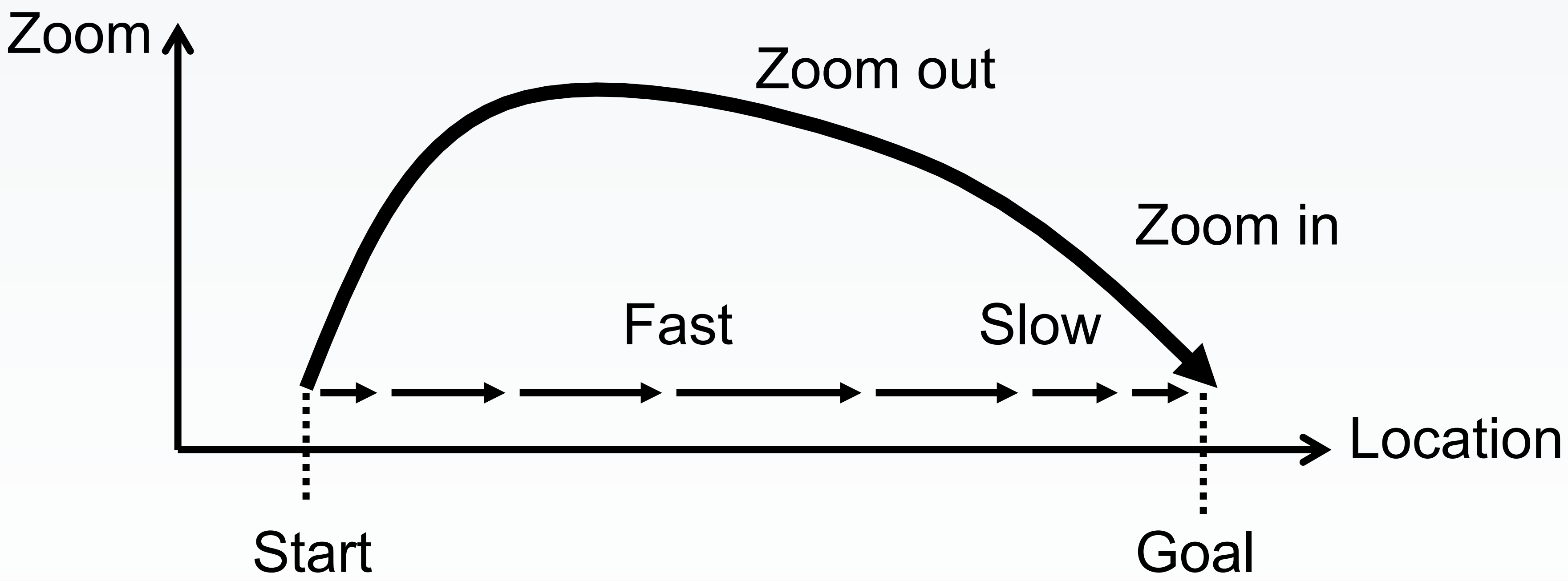
Zooming Interfaces

autozoom

Solution

Speed dependent Automatic Zooming

Fast ⇒ Zoom out
Slow ⇒ Zoom in



Demo

autozoom

3. Implementation Issues

Basic Algorithm

$$\boxed{\textit{scale} \bullet \textit{speed} = \textit{constant}} \quad \text{(Eq.1)}$$

This ensures that the perceptual scrolling speed remains constant.

Refining the Implementation

Straightforward implementation of the equation causes problems.

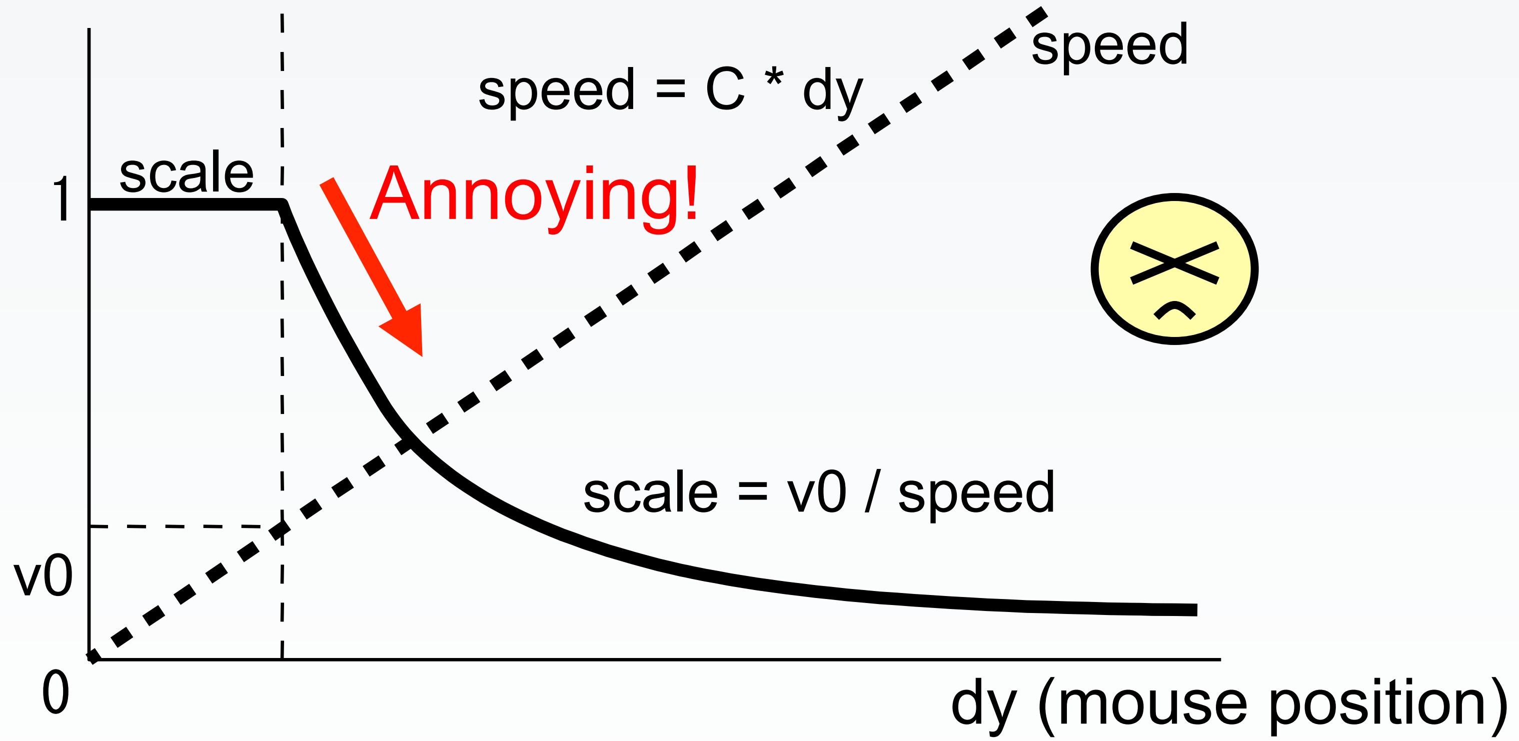
1) Sudden zoom-out at the beginning.

2) Abrupt swelling at turning.

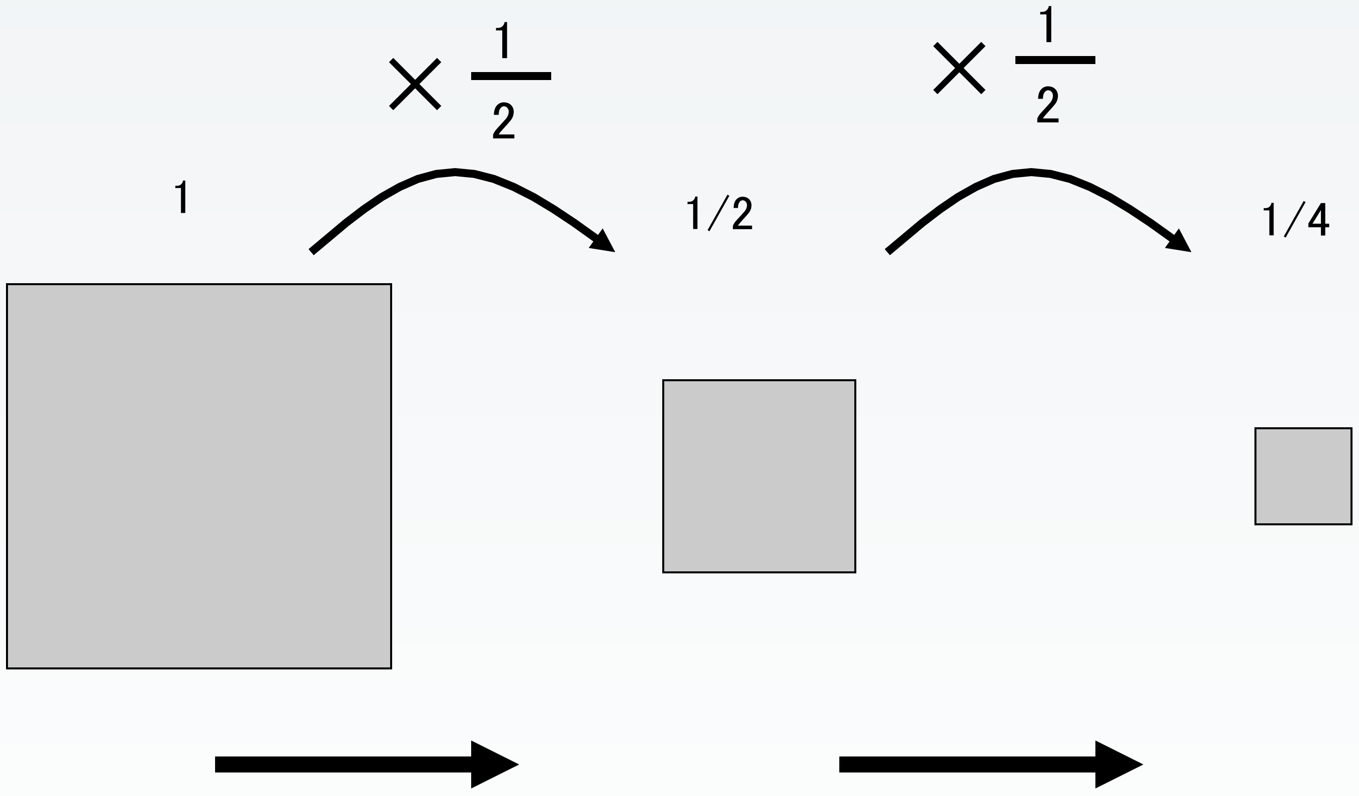
1) Sudden zoom-out at the beginning

Naïve implementation:

- Speed is proportional to mouse movement
- Scale is then calculated based on eq. 1.



Zooming should be exponential!

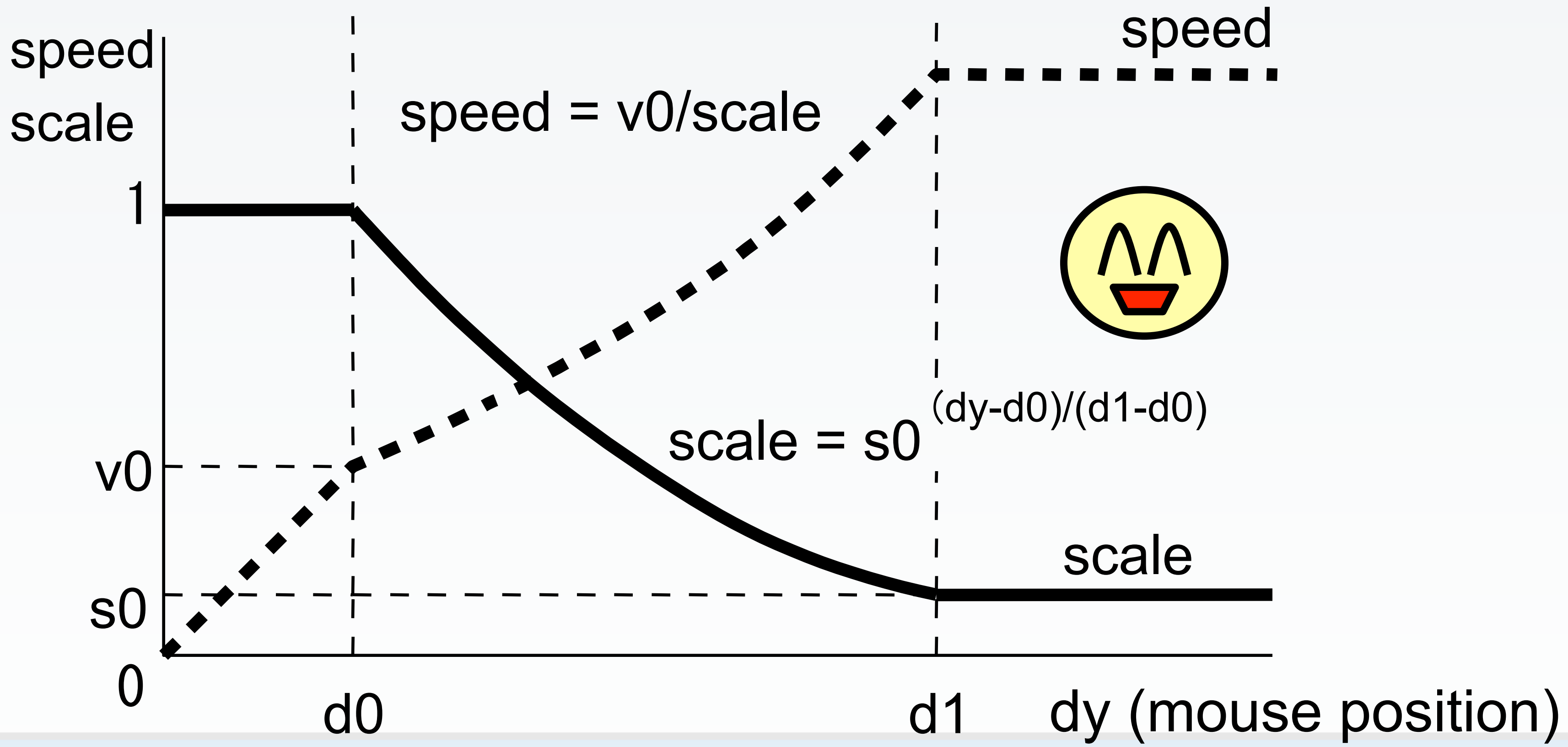


Mouse motion

Revised implementation:

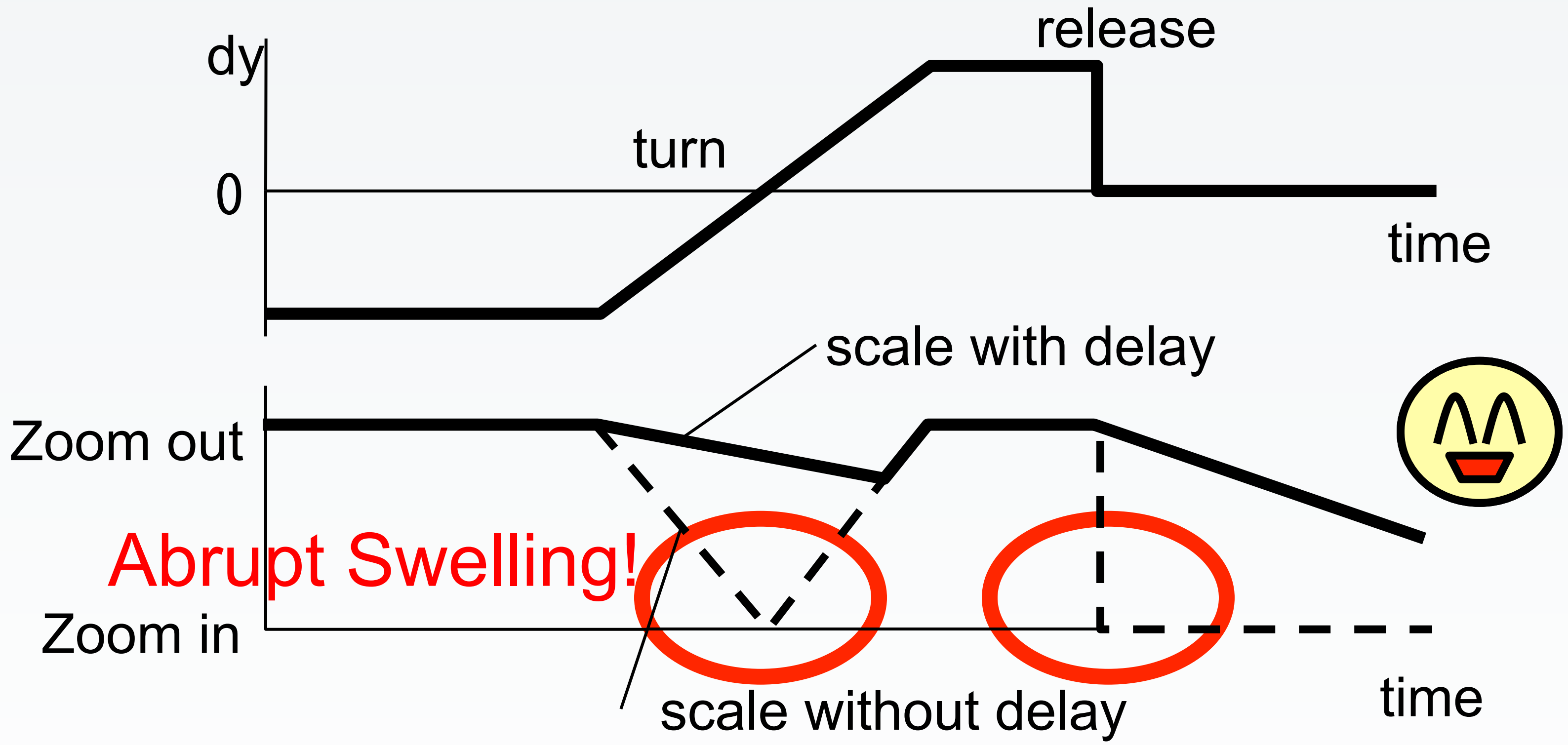
Scale is exponential to mouse movement

Speed is then calculated based on eq.1.



2) Abrupt swelling at turning

Solution: delayed scale change (dumping)



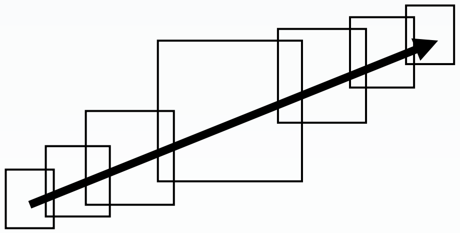
Summary

Problem:

Browsing large document combining scrolling and zooming.

Solution:

Automatically zoom in and out depending on scrolling speed.



To Learn More…

The original paper:

- Igarashi and Hinckley. Speed-dependent automatic zooming for browsing large documents. UIST 2000.

Zooming interface:

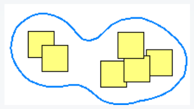
- Perlin. Pad: an alternative approach to the computer interface. SIGGRAPH 1993. http://mrl.nyu.edu/projects/zui/

Information visualization:

- Edward Tufte's The Visual Display of Quantitative Information.
- (and many courses available on the net).

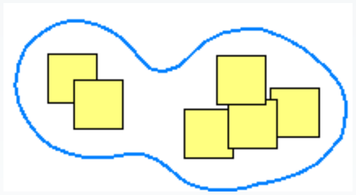
Graphical User Interfaces

- Scrolling Interface
- Desktop Icons
- Pointing
- Digital Ink
- Voice Interaction



Bubble Clusters

An Interface for Manipulating Spatial Aggregation of Graphical Objects

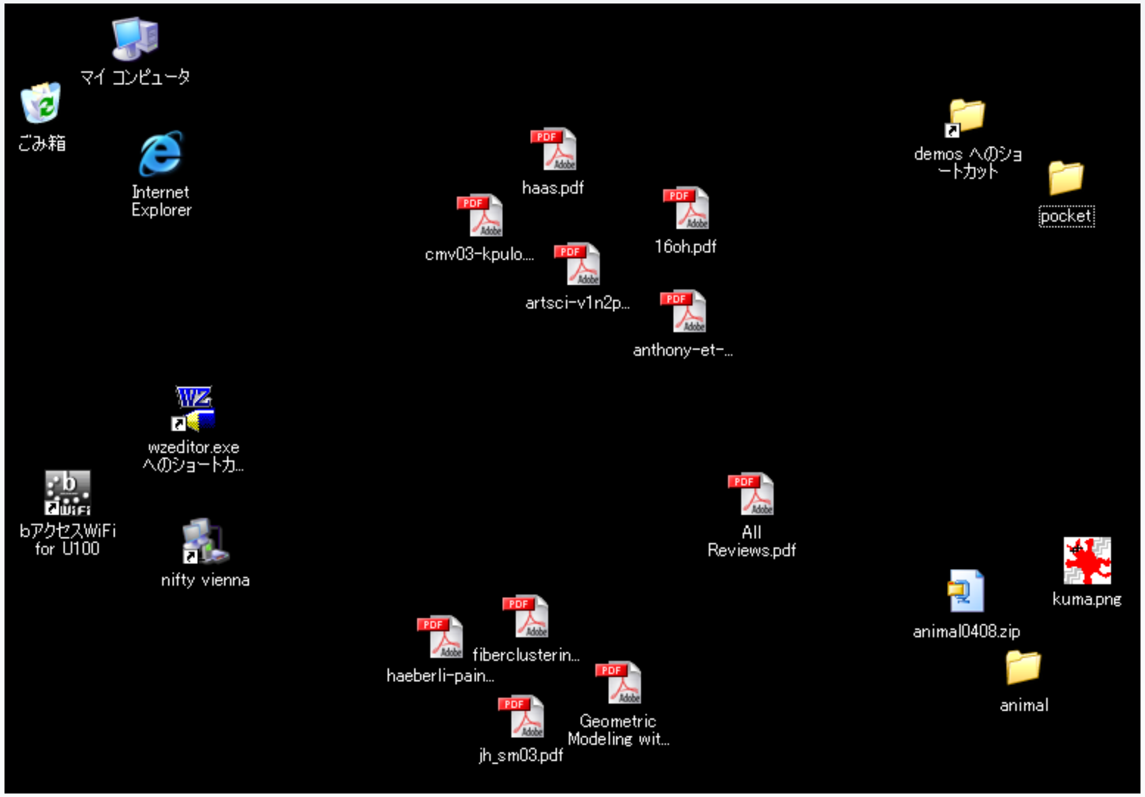


Nayuko Watanabe, Motoi Washida, Takeo Igarashi

(The University of Tokyo)

Introduction

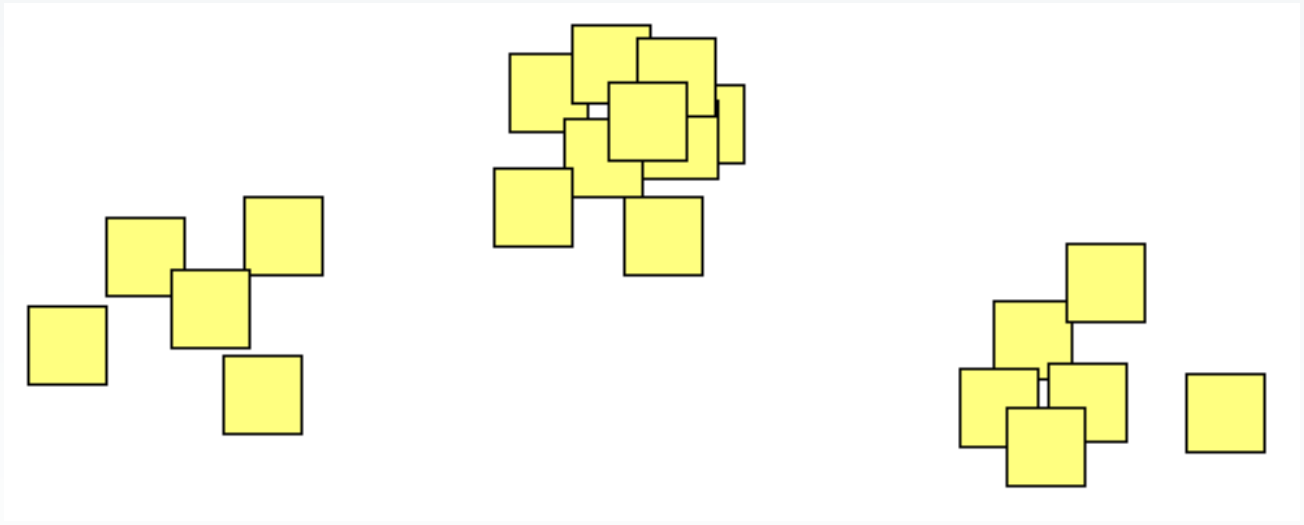
Introduction



Spatial aggregation supports loose clustering of information

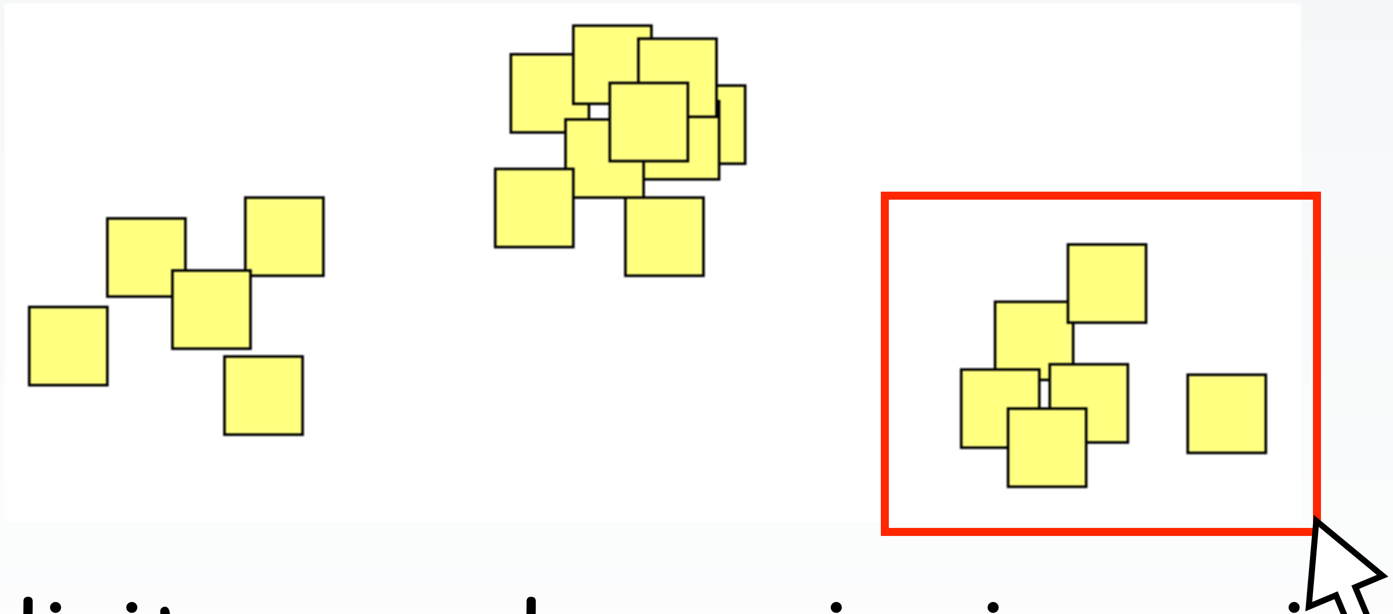
Problem (1)

Visual cluster Semantic cluster



Problem (1)

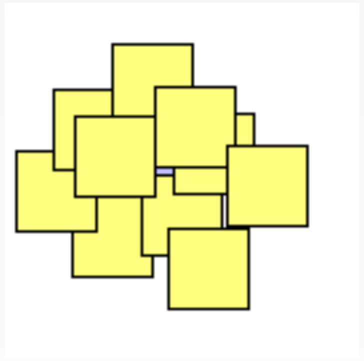
Visual cluster Semantic cluster



Explicit, manual grouping is required

Problem (2)

Target can be hidden in a dense cluster



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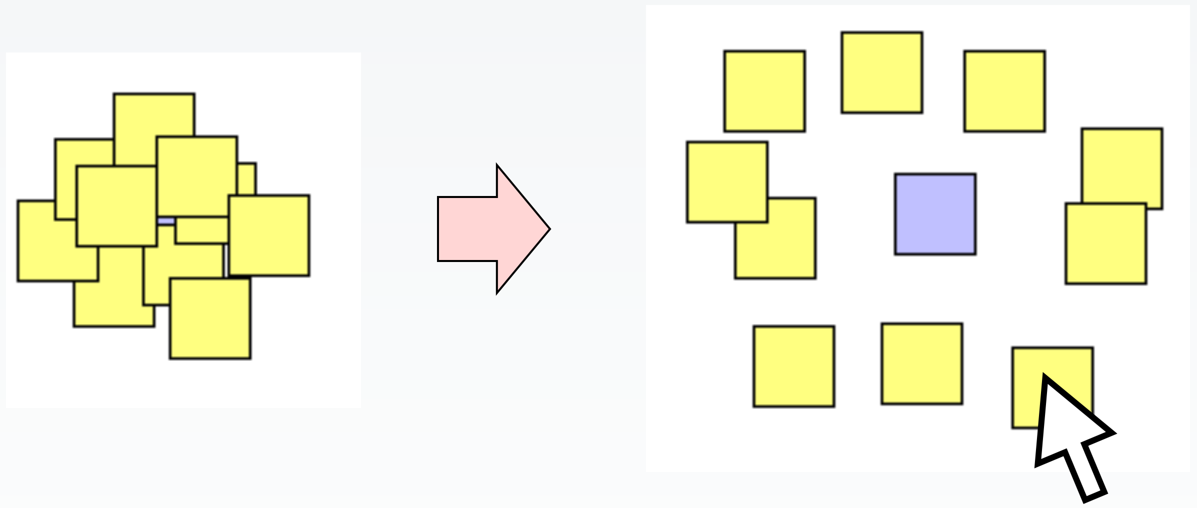
Problem (2)

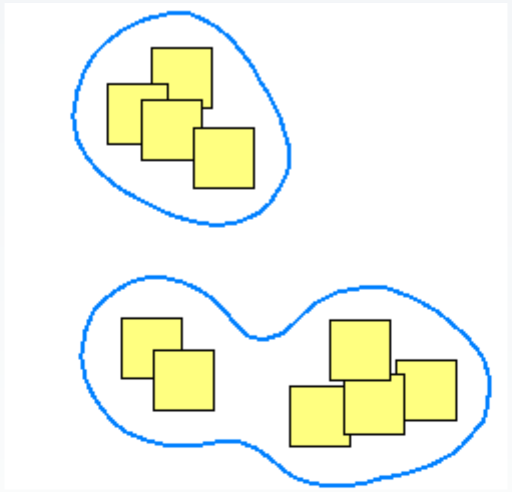
Target can be hidden in a dense cluster



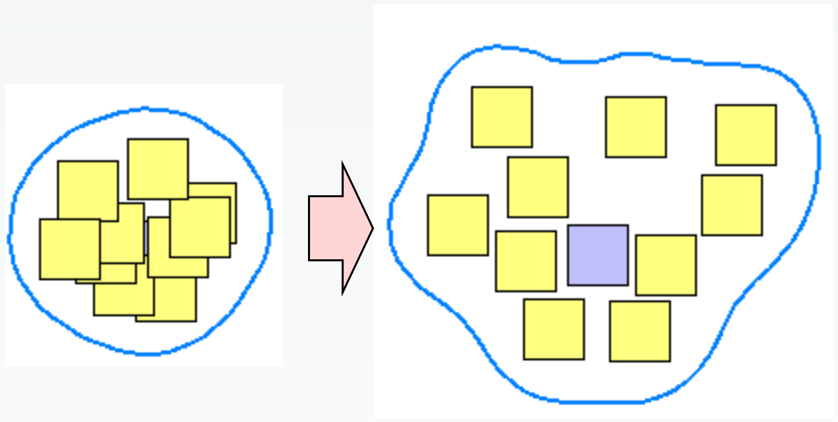
The user needs to uncover it manually

Bubble Clusters

Bubble Clusters



Automatic Grouping



Automatic Spreading

Demonstration

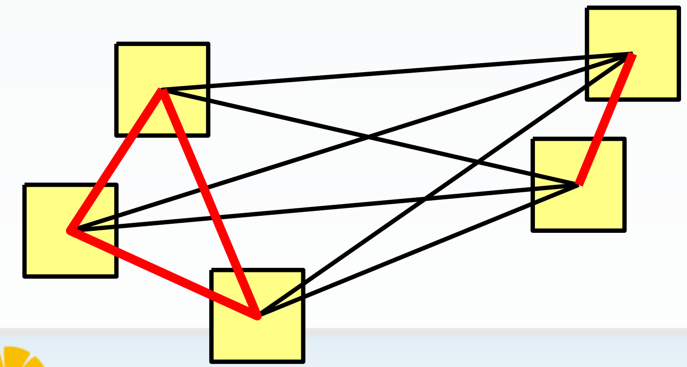
bubble ink

Implementation

Clustering

Simple pair-wise distance thresholding.

```
for ( all objects $o_i$ )
    $c(o_i) = \{o_i\}$;
for ( all object pairs $o_i$, $o_j$ )
    if ( $distance(o_i, o_j) < threshold[o_i, o_j]$ )
        merge( $c(o_i)$, $c(o_j)$ );
```



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Clustering

Simple pair-wise distance thresholding.

```
for ( all objects $o_i$ )
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for ( all object pairs $o_i$, $o_j$ )
    if ( distance($o_i$, $o_j$) < $\underline{\text{threshold}[o_i, o_j])}$ )
        merge( $c(o_i)$, $c(o_j)$ );
```
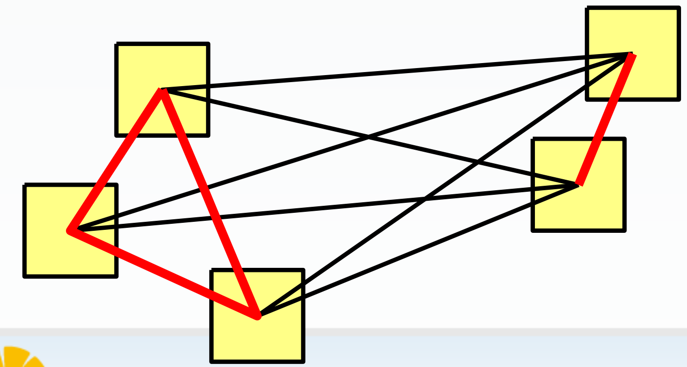
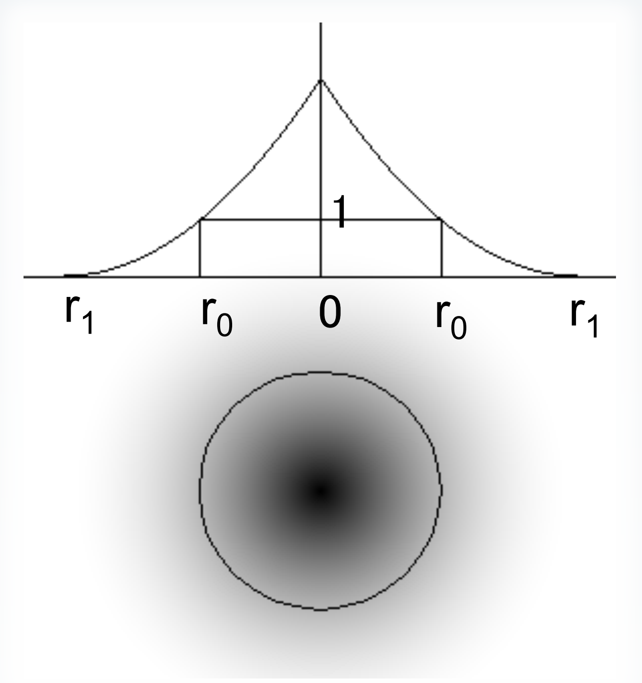
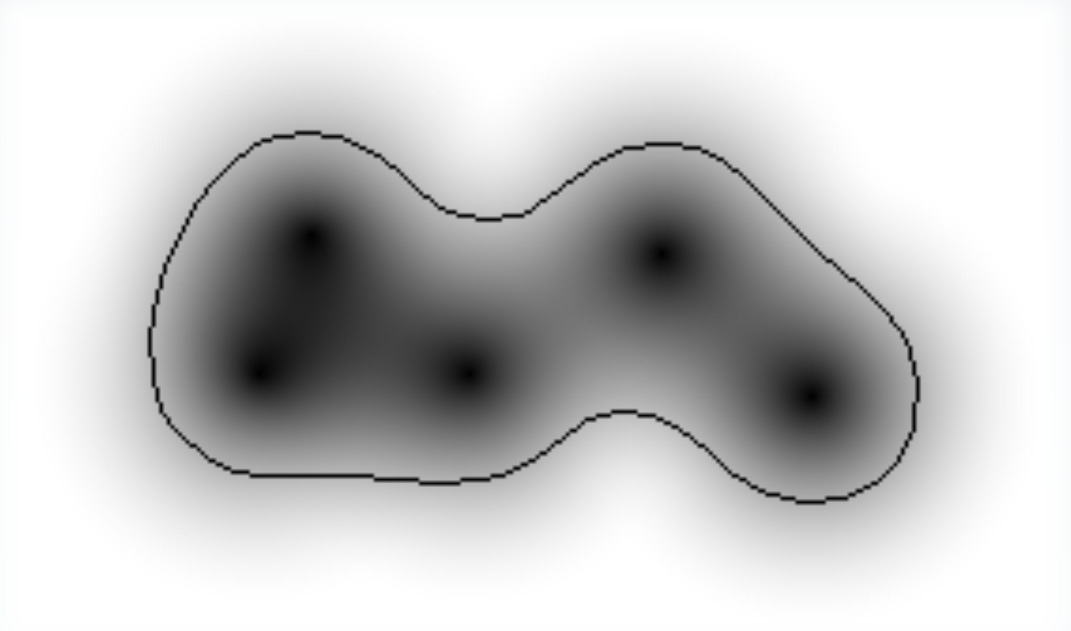



small value if $c(o_i) \neq c(o_j)$
large value if $c(o_i) = c(o_j)$
in previous step

Bubble Visualization

2D Implicit Surface



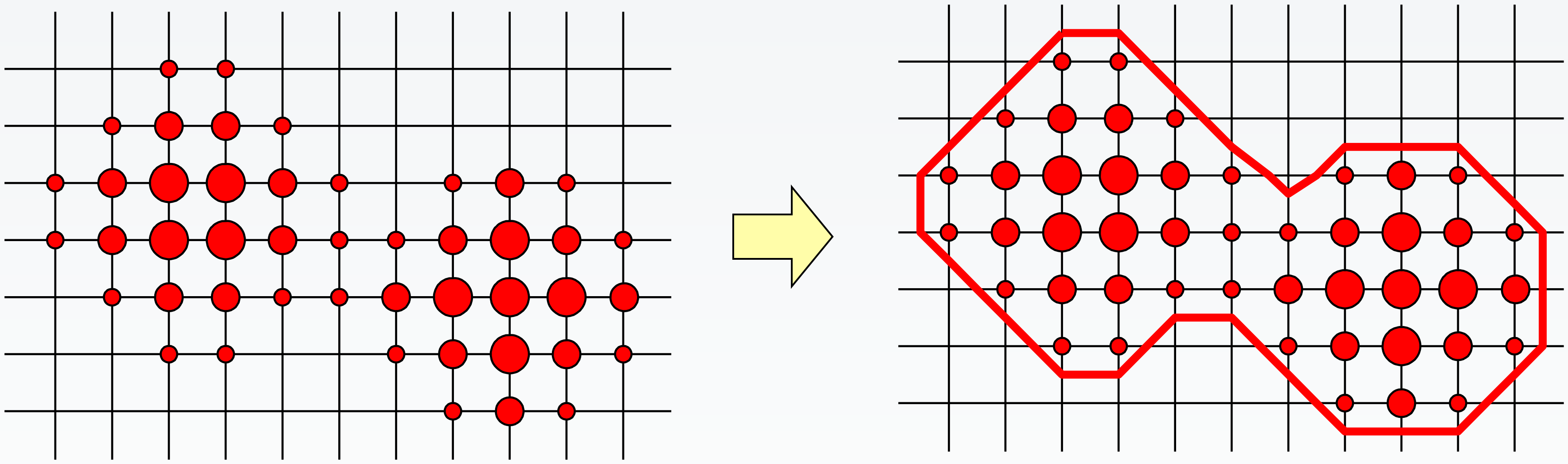


Potential field around each element.
Trace the iso-surface of the field.

opengl

Isosurface Extraction

Process each cluster independently.



Evaluate potential field at grid points

Extract isosurface by Marching Cubes

[Lorensen 87]

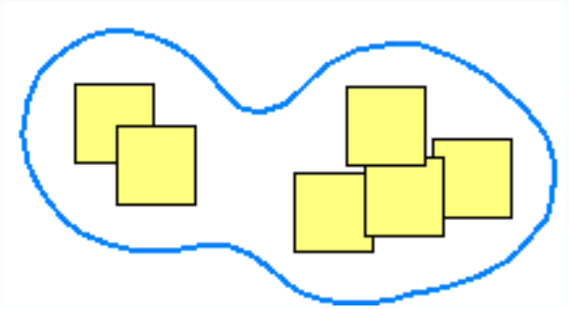
Summary

Problem:

Management of spatially organized icons on a desktop.

Solution:

Automatically cluster nearby icons as a bubble.



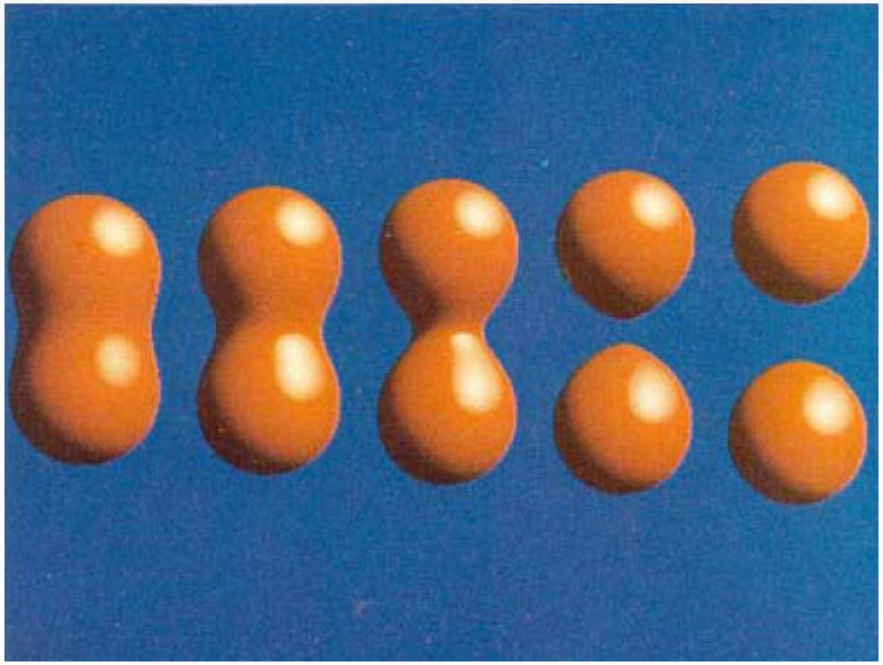
To Learn More…

The original paper:

- Watanabe, et al. Bubble Clusters: An Interface for Manipulating Spatial Aggregation of Graphical Objects. UIST 2007.

Implicit surfaces:

- Blinn. A generalization of algebraic surface drawing. SIGGRAPH 1982.
- Lorensen and Cline. Marching cubes: a high resolution 3D surface construction algorithm, SIGGRAPH 1987.



[Blinn 1982]

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Graphical User Interfaces

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- Pointing
- Digital Ink
- Voice Interaction

Ninja Cursors:

Using Multiple Cursors to Assist Target Acquisition on Large Screens

Masatomo Kobayashi
Takeo Igarashi

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Problem

It is difficult to point to a distant object.

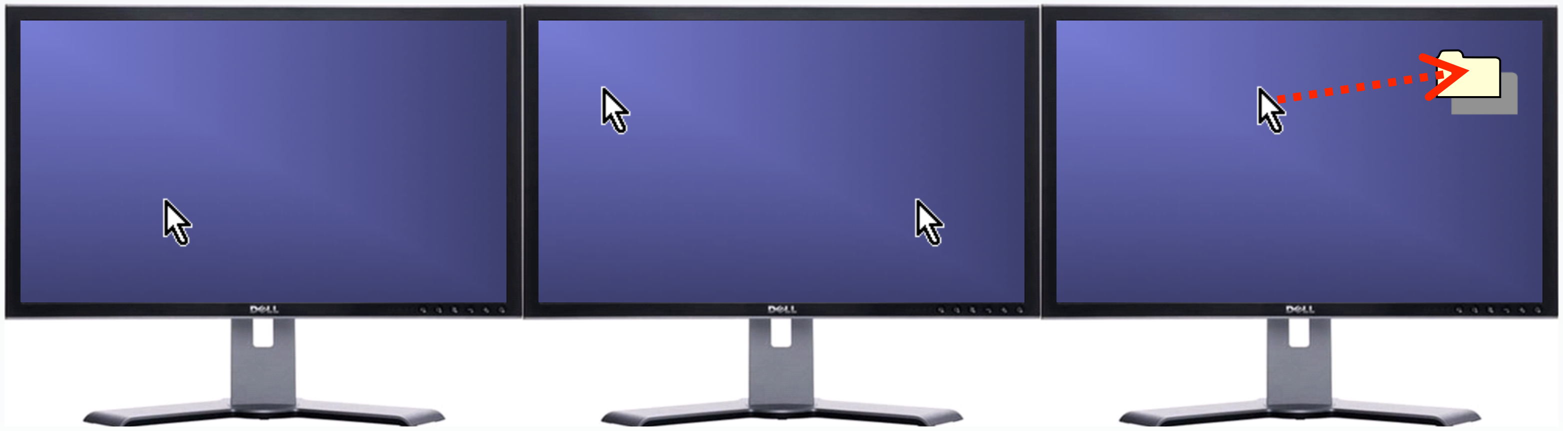
Introducing “ninja cursors”

Video

ninja_cursors.mov

Basic idea of “ninja cursors”

Cover the screen with multiple, synchronously moving cursors.

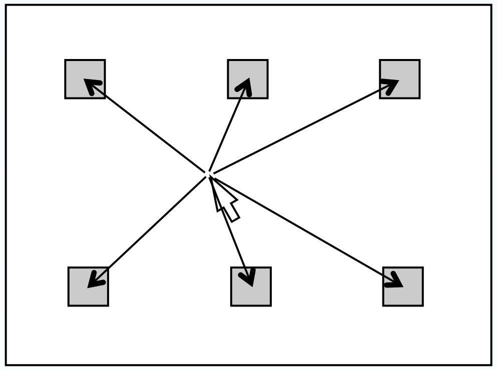


→ The user can use the nearest cursor.

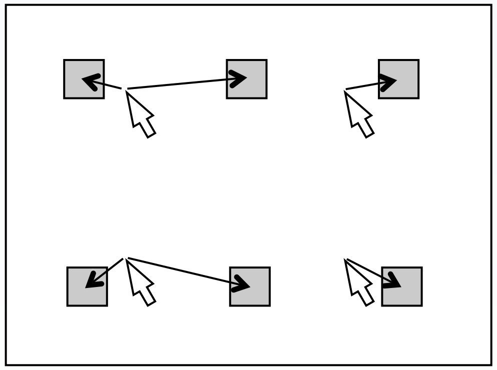
Reducing the distance

Average distance from the nearest cursor:

$$D \rightarrow \frac{D}{\sqrt{n}}$$ (***n*** : # of cursors)



n = 1

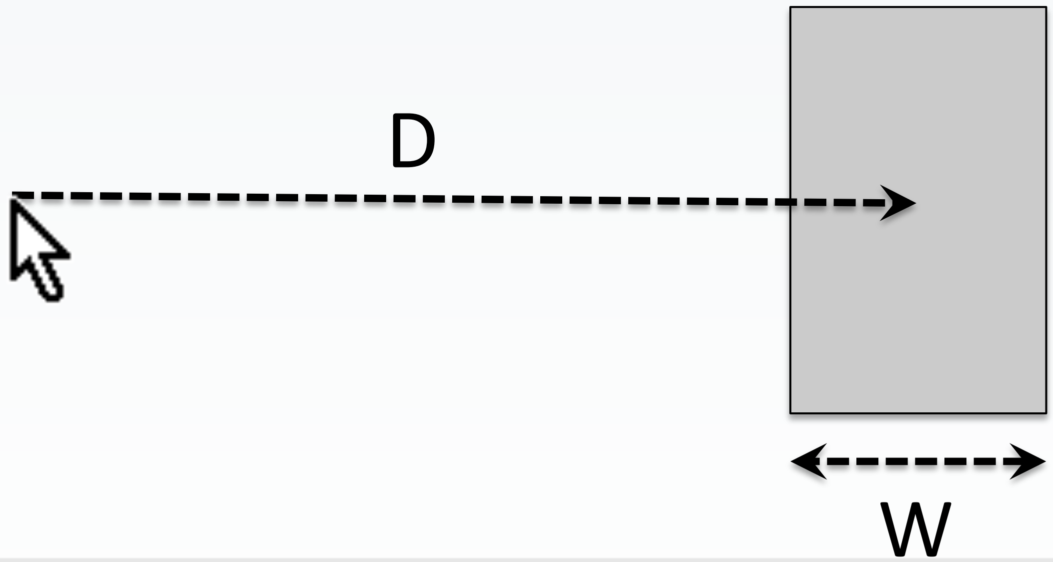


n = 4

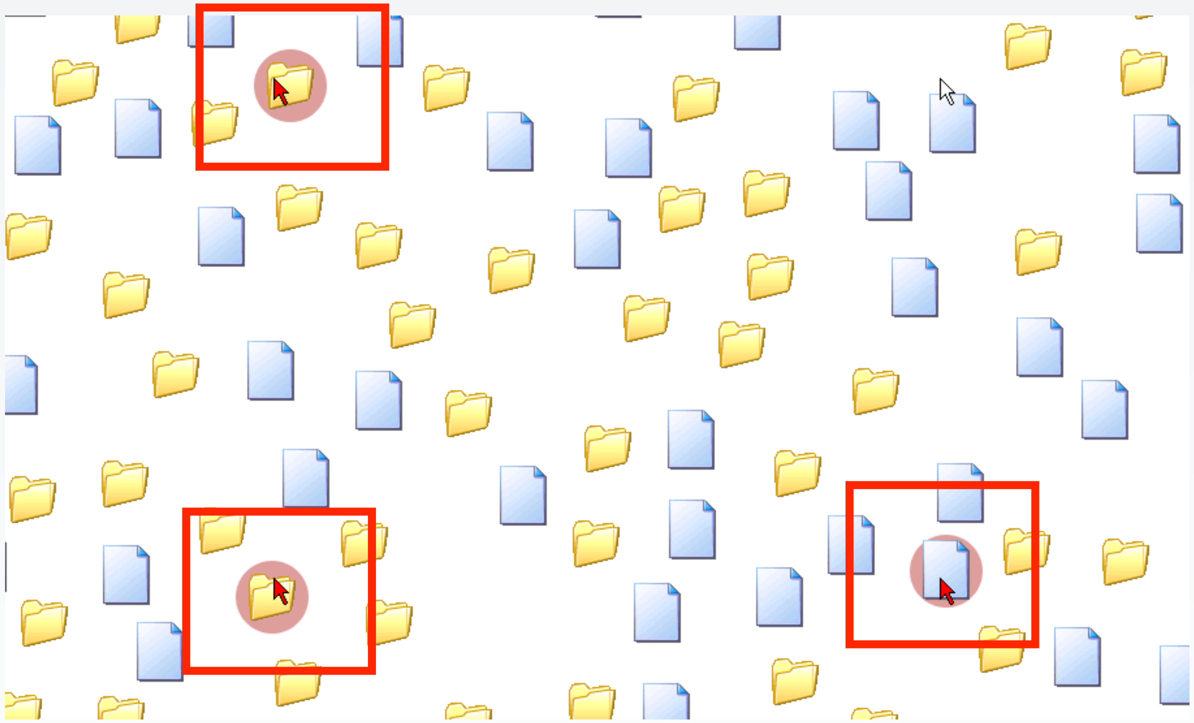
Fitts's law

A model of target acquisition:

$$T = a + b \log_2 \left(1 + D/W\right)$$



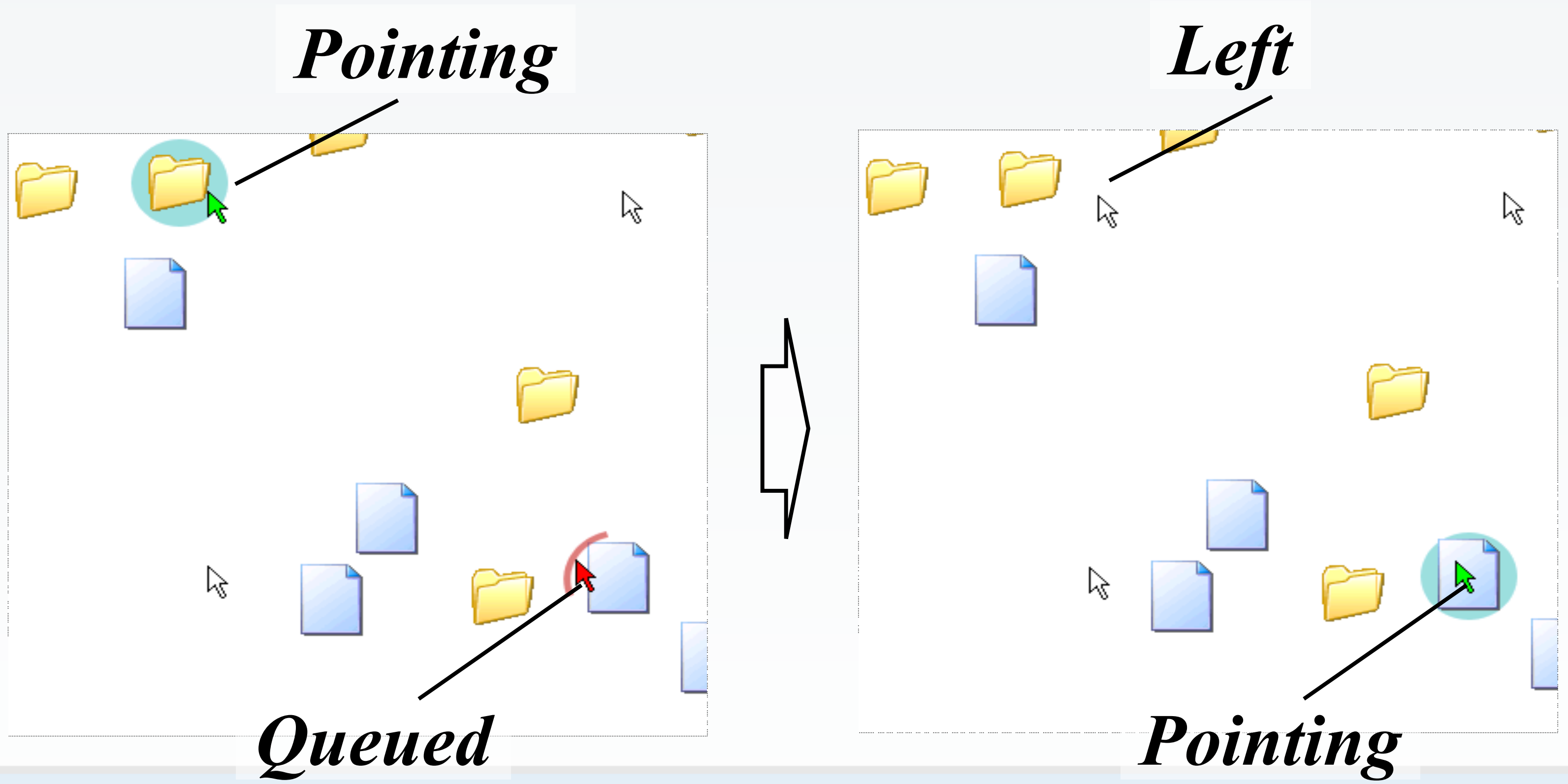
Ambiguity problem



What happens if multiple cursors point to multiple targets simultaneously?

Resolving ambiguity

Only one cursor can point to a target;
others are blocked and in the waiting queue.



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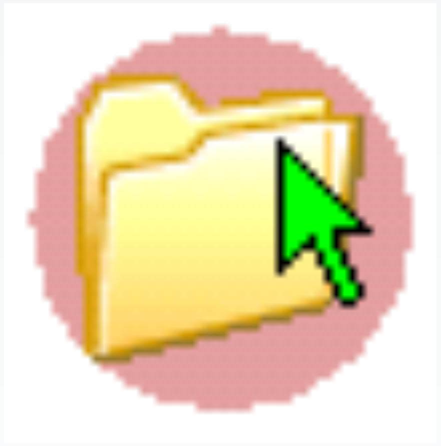
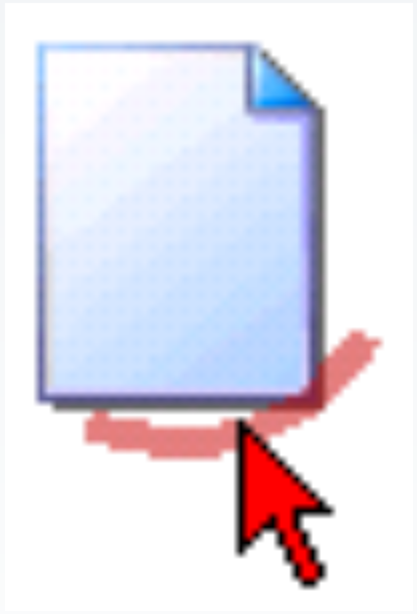
Visual feedbacks

Normal

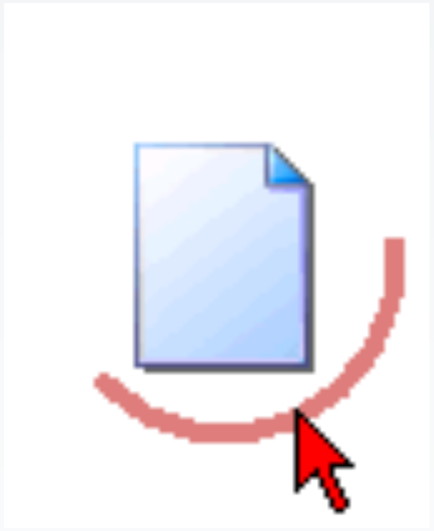


Pointing

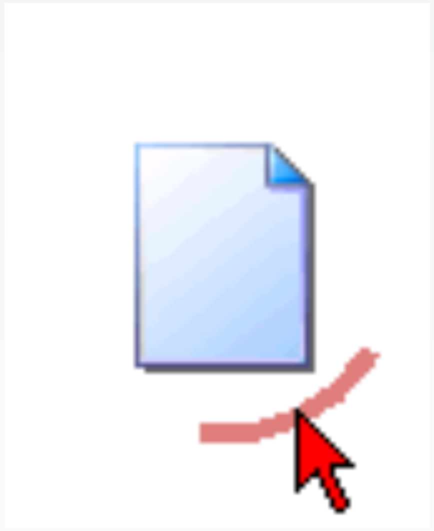


Blocked

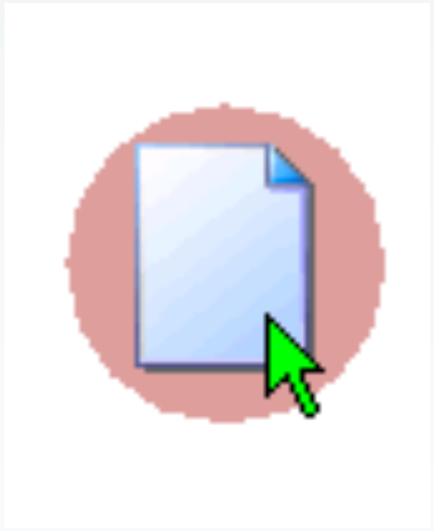
Visual feedbacks



Long waiting



Short waiting



Pointing

Summary

Problem:

Pointing a distant target on a very large display.

Solution:

Show multiple cursors and use the nearest one.

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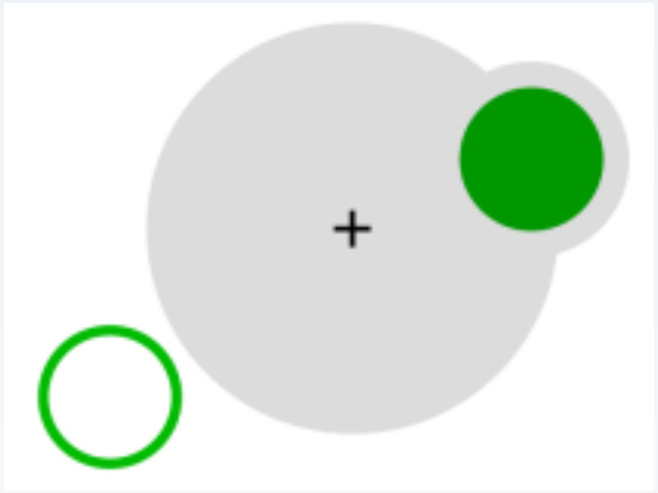
To Learn More…

The original paper:

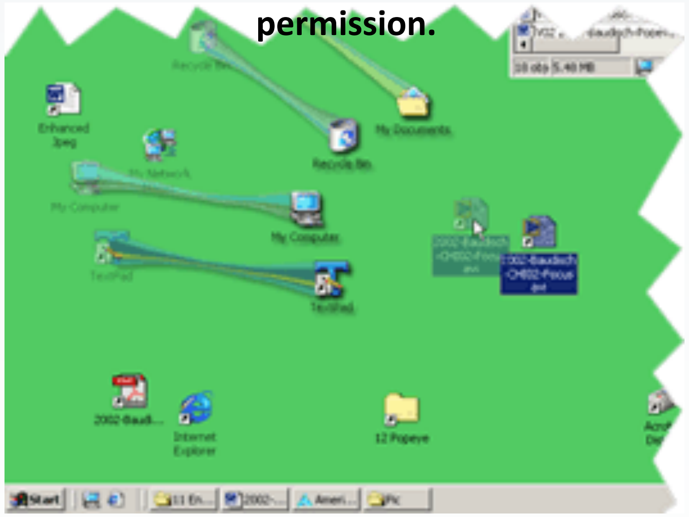
- Kobayashi and Igarashi. Ninja Cursors: Using Multiple Cursors to Assist Target Acquisition on Large Screens. CHI 2008.



[Grossman and Balakrishnan 2005]
Copyright 2005 ACM. Included here by permission.

Pointing:

- Grossman and Balakrishnan. The bubble cursor: enhancing target acquisition by dynamic resizing of the cursor's activation area. CHI 2005.
- Baudisch, et al. Drag-and-drop and drag-and-pick: Techniques for accessing remote screen content on touch- and pen operated systems. Interact 2003.



[Baudisch, et al. 2003]
(Figure obtained from http://www.patrickbaudisch.com/projects/dragandpop/index.html with permission)

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- Digital Ink
- Voice Interaction

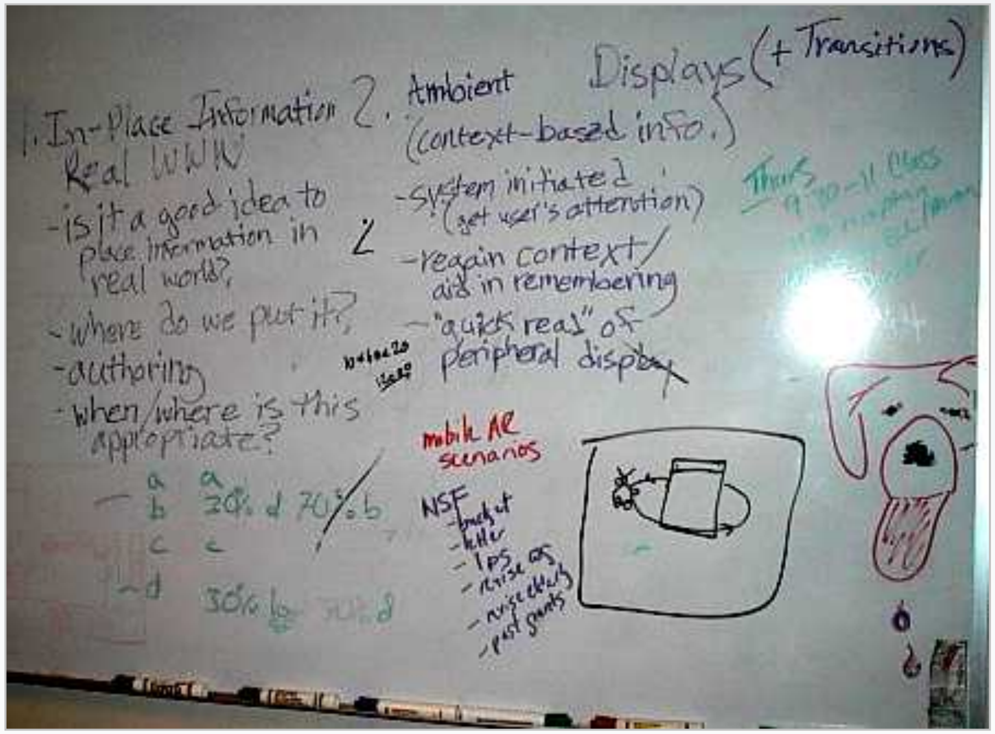
Appeared at
CHI'99

Flatland: New Dimensions in Office Whiteboards

Elizabeth D. Mynatt, Takeo Igarashi
(Georgia Tech.) (Univ. of Tokyo)

W. Keith Edwards, Anthony LaMarca
(Xerox PARC) (Xerox PARC)

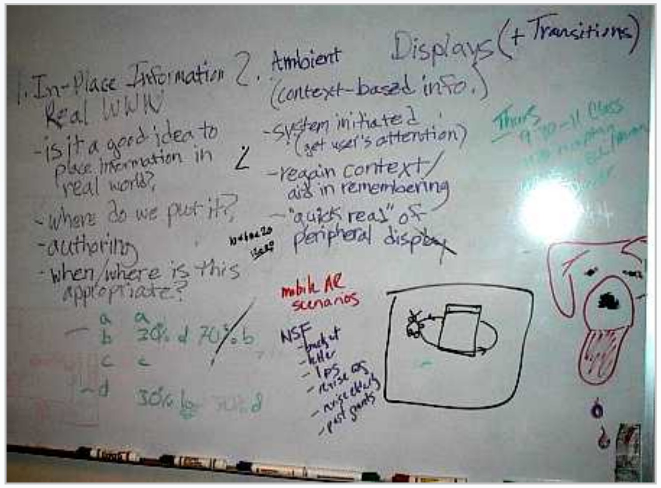
Research Goal


1. In-Place Information
Real WWW
-is it a good idea to place information in real world?
-where do we put it?
-authoring
-when/where is this appropriate?
2. Ambient Displays (+ Transitions)
(context-based info.)
-system initiated (get user's attention)
-regain context/ aid in remembering
-"quick read" of peripheral display
mobile AR scenarios
NSF

Designing computationally augmented office whiteboard

Observation

Office whiteboards are used for informal, pre-production activities.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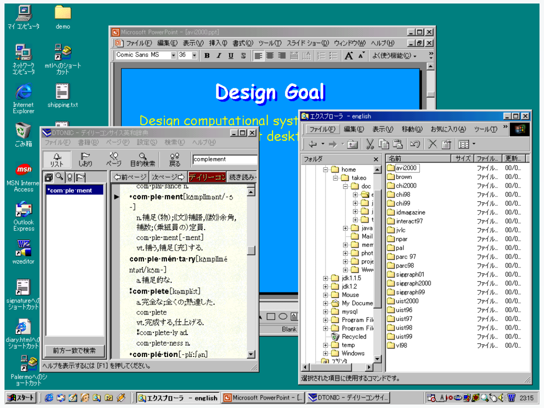
mobile AR scenarios
NSF

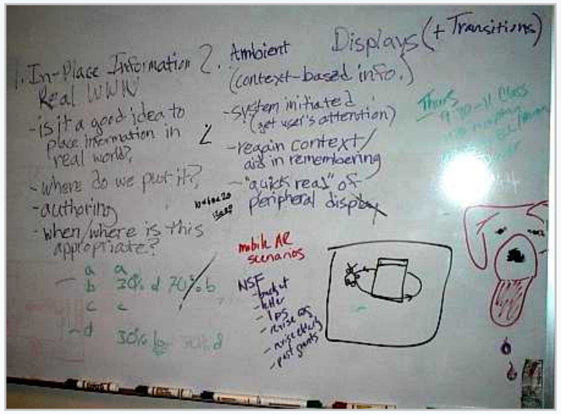
Examples:

- Note-taking over a phone.
- Organizing to do list.
- Sketching paper outlines.
- Discussing with office mates.

Design Goal

Design a computational system that complements current desktop computers.





1. In-Place Information
Real World
-is it a good idea to place information in real world?
-where do we put it?
-authoring
-when/where is this appropriate?
2. Ambient Displays (+ Transitions)
(context-based info.)
-system initiated (get user's attention)
-regain context/ aid in remembering
-"quick read" of peripheral display
mobile AR scenarios

Goal-oriented	Pre-productive
Tedious, complicated	Light, simple, easy
Formal, typed	Informal

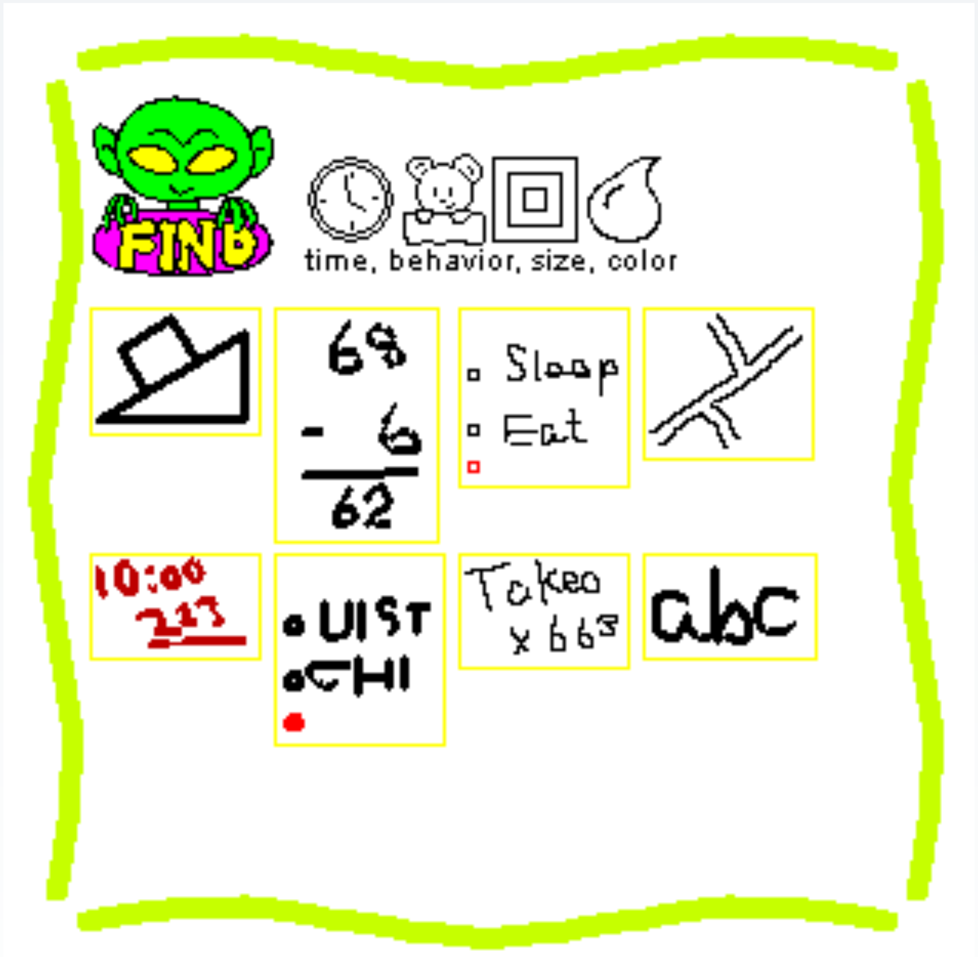
Features

1. Managing Space
2. Behaviors on Surface
3. History Management

Demo!

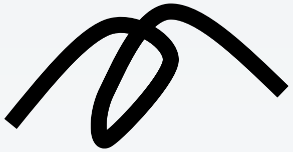
flatland

Context-based search



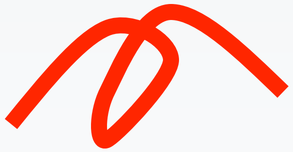
User Input

Primary input – ink strokes.



Always inking!

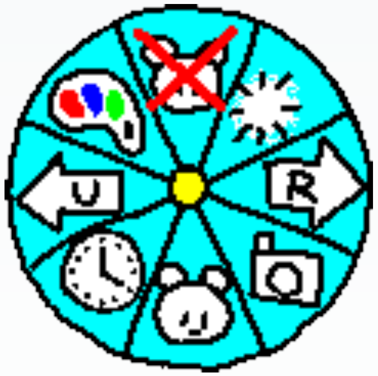
Secondary input – control strokes.



Erasing, Dragging,

Splitting,

Pie & marking menu

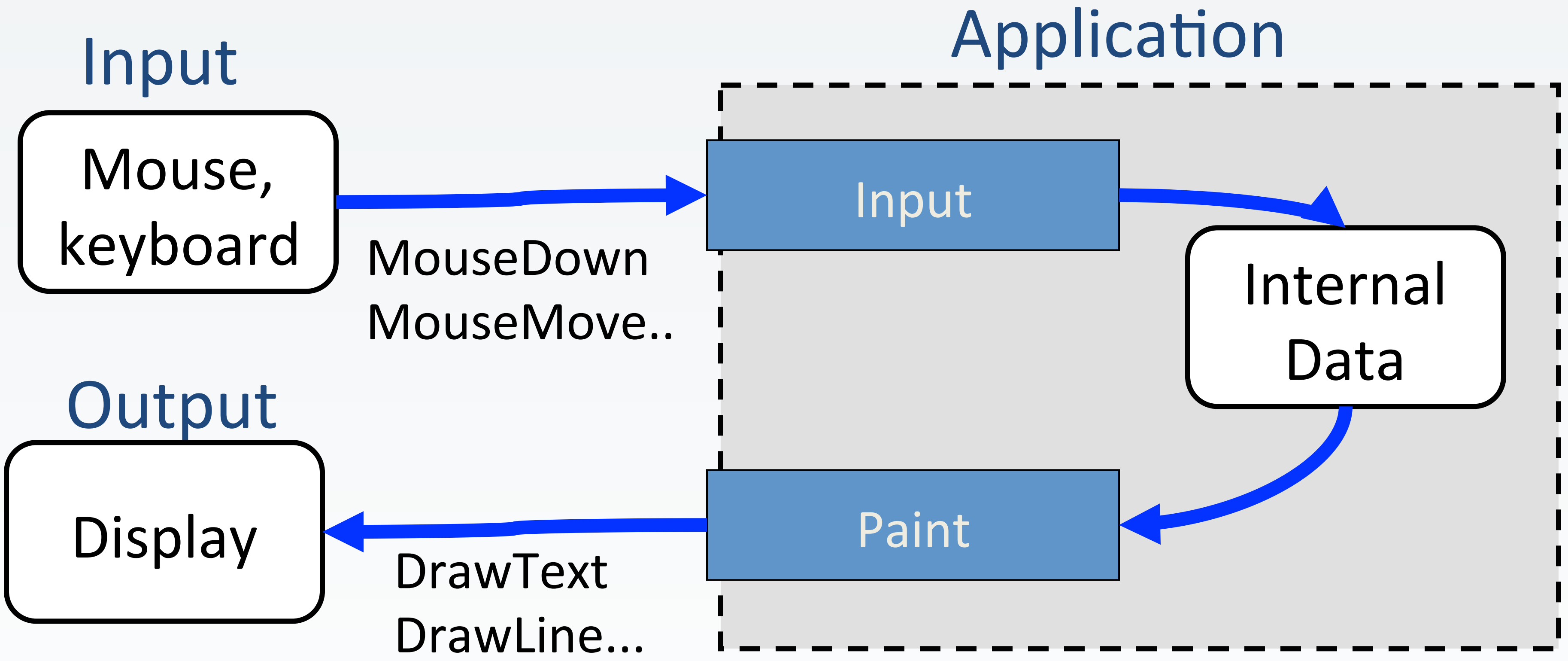


Flatland architecture

A pen version of GUI-based window system.

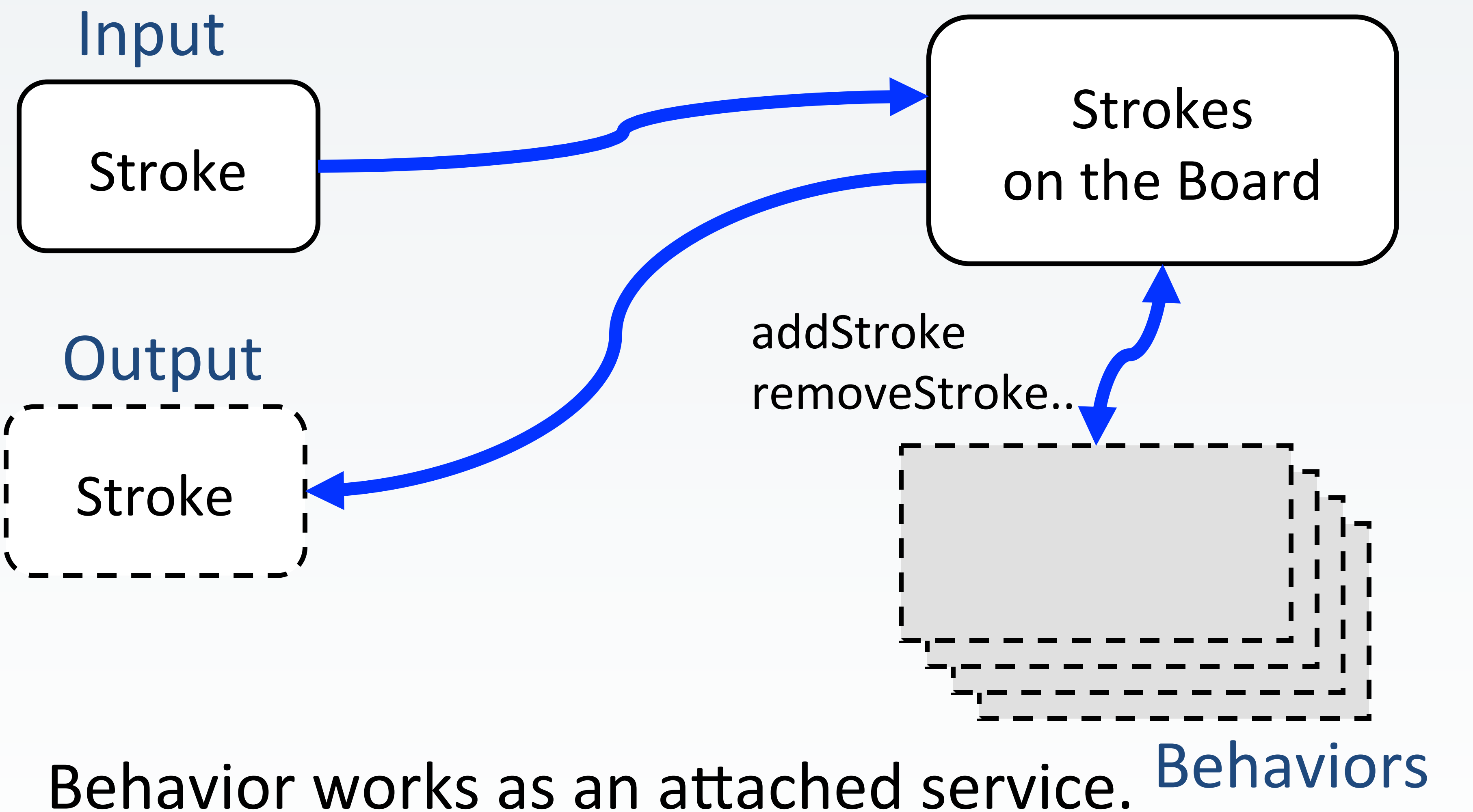
Standard GUI	Flatland
Mouse	Pen
Widgets and pixels	Strokes
Windows	Segments
Applications	Behaviors

Standard GUI applications



An application encapsulates the data.

Behaviors in Flatland



Behavior works as an attached service.

Code example

```
PlainDrawingBehavior

    void addInputStroke(Stroke stroke){
        segment.addPaintedStroke(stroke);
    }
```

Code example

```
 MapBehavior

void addInputStroke(Stroke stroke){
   ….
   segment.addPaintedStroke(left_stroke);
   segment.addPaintedStroke(right_stroke);
}
```

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Summary

Problem:

Multiple informal tasks on a electronic whiteboard.

Solution:

A window system for digital ink.

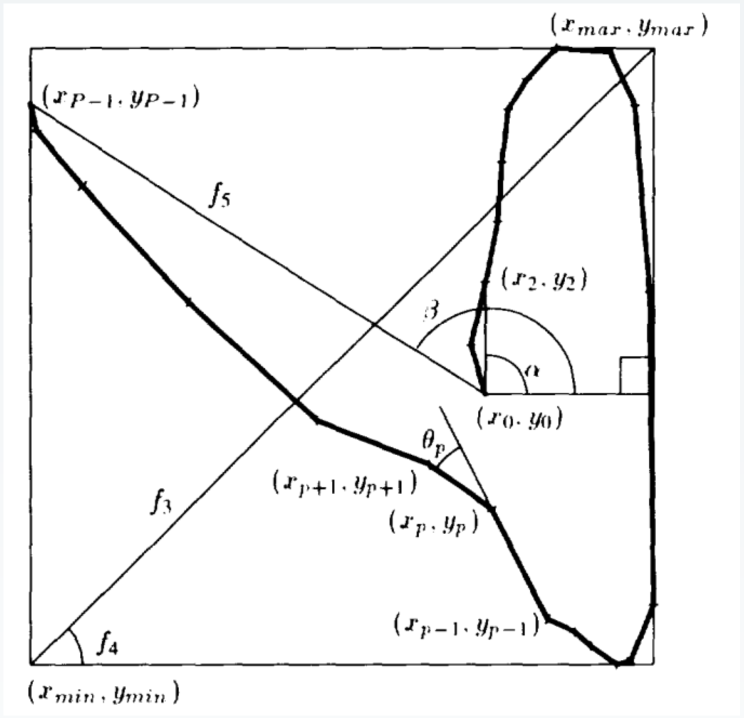
To Learn More…

The original paper:

- Mynatt, et al. Flatland: New Dimensions in Office Whiteboards. CHI 1999.

Gesture recognition:

- Rubine. Specifying gestures by example. SIGGRAPH 1991.
- Wobbrock, et al. Gestures without libraries, toolkits or training: a $1 recognizer for user interface prototypes. UIST 2007.



[Rubine 1991]
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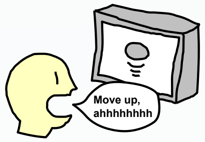
Pie and marking menus:

- Kurtenbach. The design and evaluation of marking menus. University of Toronto. 1993.

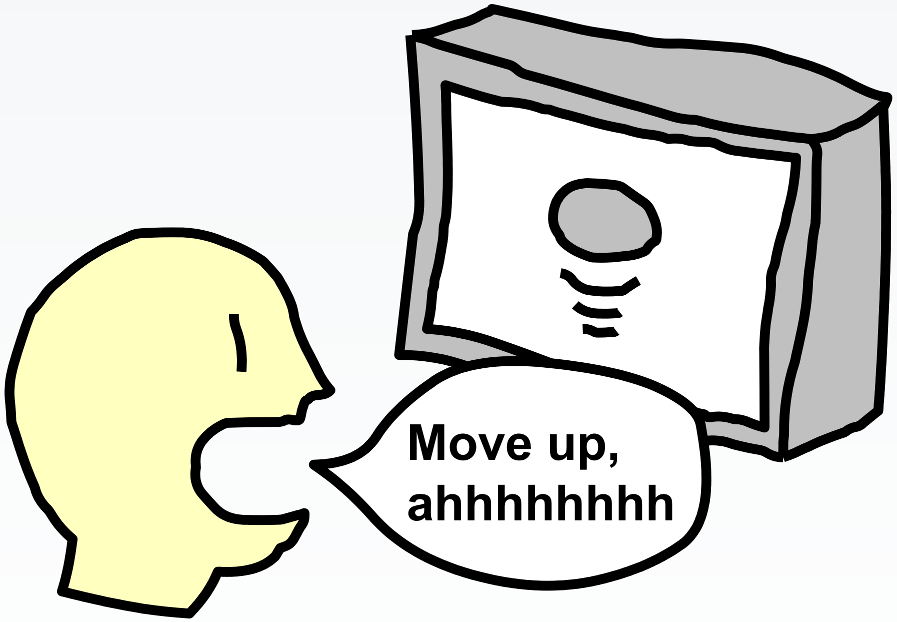
Graphical User Interfaces

- Scrolling Interface
- Desktop Icons
- Pointing
- Digital Ink
- Voice Interaction



Voice as Sound: Using Non-verbal Voice Input for Interactive Control

Takeo Igarashi
John F. Hughes
(Brown University)



Two Aspects of Voice

- Verbal information

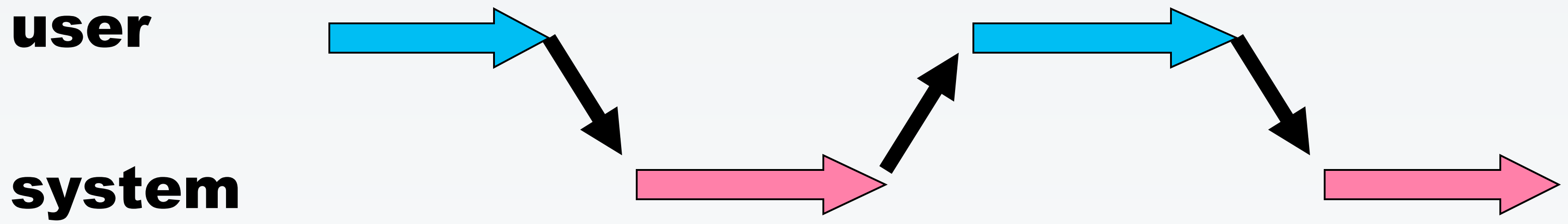
  → Speech recognition

- Non-verbal information

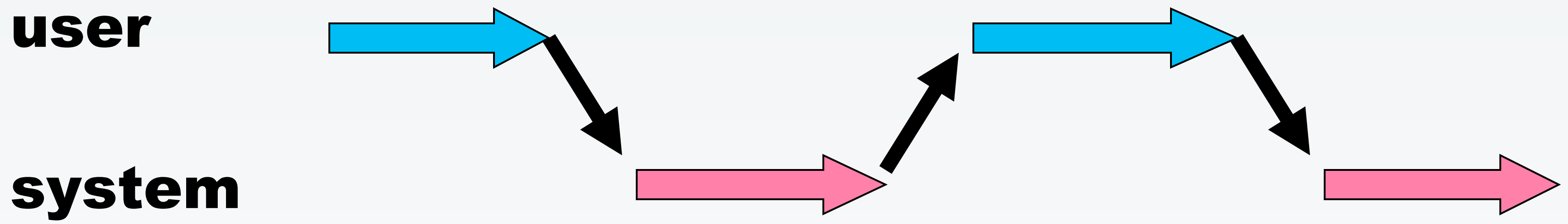
  (pitch, volume, speed, etc)

  → Voice as Sound techniques

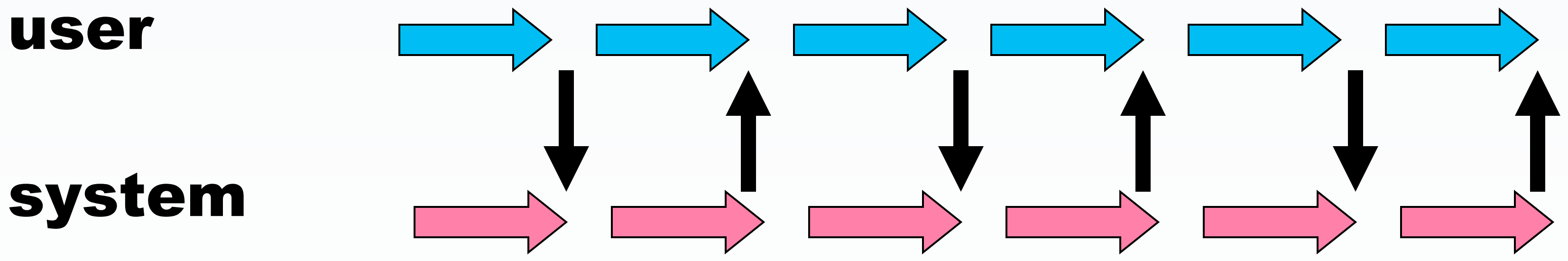
Interaction turn-around is long in voice recognition.



Interaction turn-around is long in voice recognition.



Voice as Sound achieves more immediate control.



THE UNIVERSITY OF TOKYO

Video

voice

Implementation

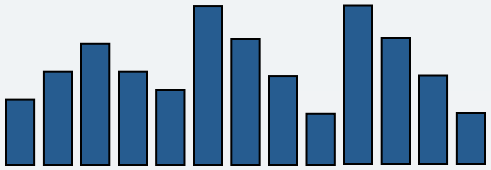
- Signal Processing (FFT) – C++
- Application Control – Java

On/off ... total volume > threshold

(ignore low frequency part)

Pitch ... detect change in frequency

Pitch Detection



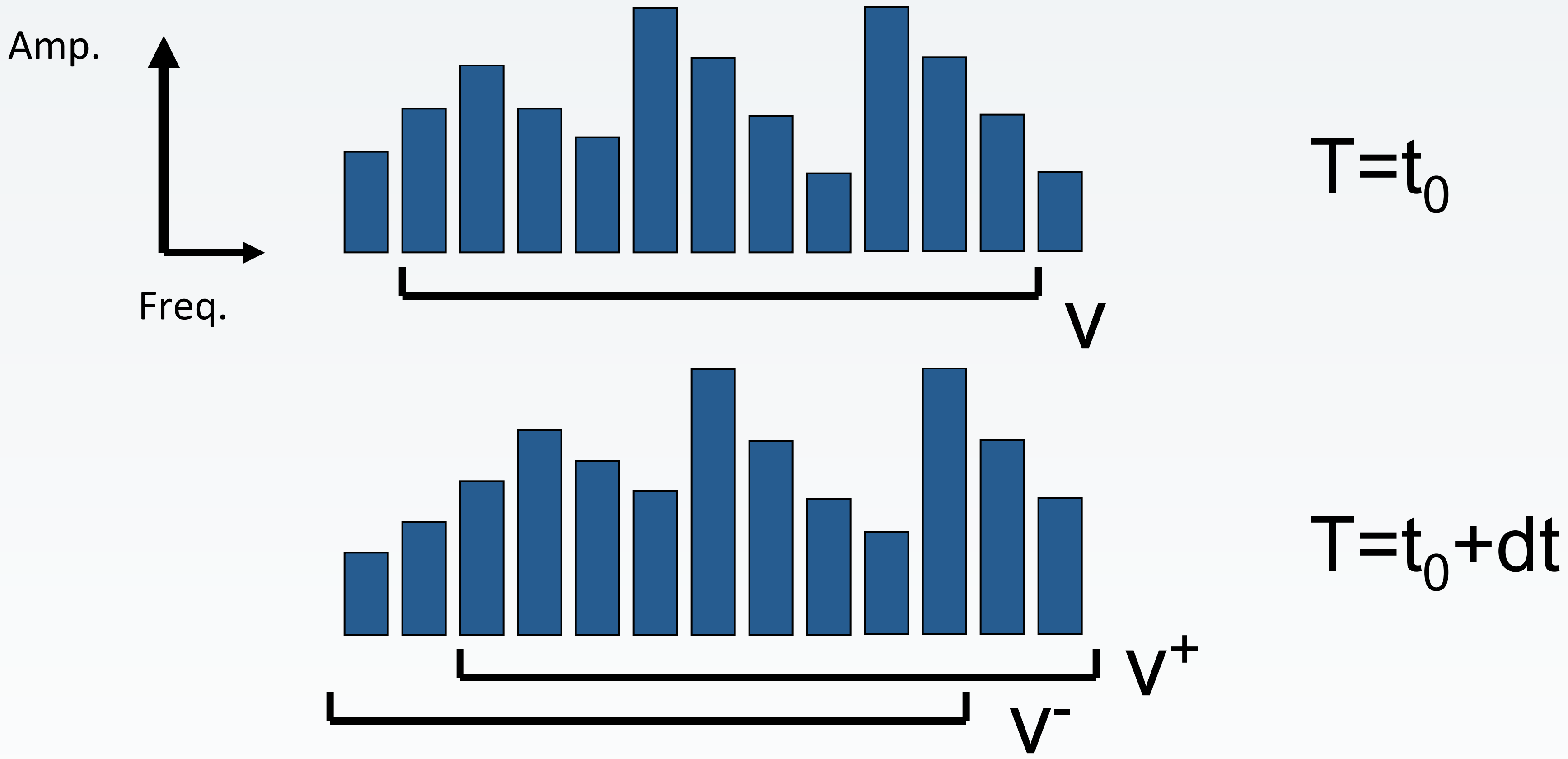
Naïve approach: identify absolute pitch

→ **Ambiguous, noisy, unstable**

Our approach: up or down at each frame

→ **Reliable and stable**

Pitch … comparing spectrum



$v \cdot v^- \;>\; v \cdot v^+$ … pitch gets lower

$v \cdot v^- \;<\; v \cdot v^+$ … pitch gets higher

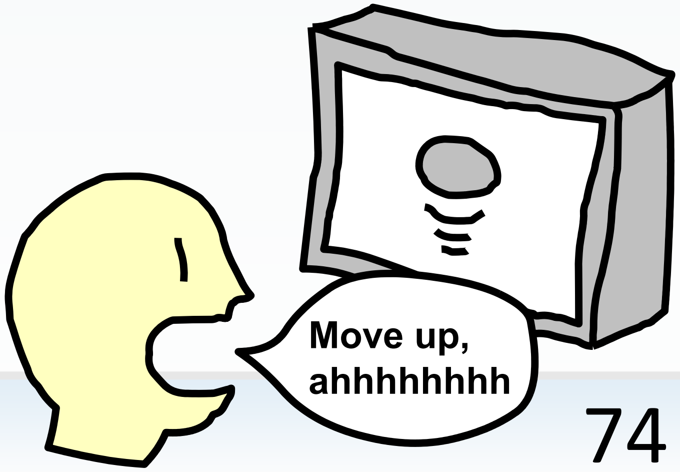
Summary

Problem:

Continuous control using voice.

Solution:

Use non-verbal aspect of voice.



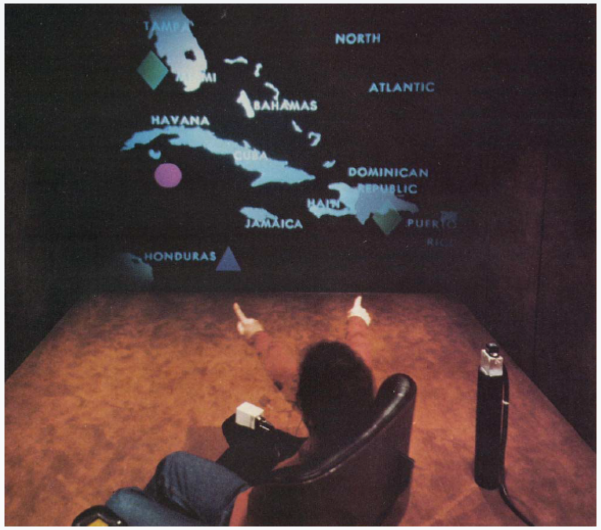
To Learn More…

The original paper:

- Igarashi and Hughes. Voice as Sound: Using Non-verbal Voice Input for Interactive Control. UIST 2001.

Multi-modal interface:

- Bolt. Put-that-there: Voice and gesture at the graphics interface. SIGGRAPH 1980.
  http://www.youtube.com/watch?v=RyBEUyEtxQo



[Bolt 1980]
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Voice completion:

- Goto, et al. Speech Completion: On-demand Completion Assistance Using Filled Pauses for Speech Input Interfaces. ICSLP 2002.
  https://staff.aist.go.jp/m.goto/SpeechCompletion/index.html

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