Smart Graphics: Text and UIs

Lecture „Smart Graphics”
Andreas Butz,
8.2.2011
Topics today

- Freeform UIs, Igarashi 03
- Smart Text Arvo 00
- Fluid Documents, Chang 00
- SCWM, Badros 00
Some more Freeform UIs

[Takeo Igarashi, SG03]
Path drawing for VR

- Interpretation of pen strokes by projection onto the ground in 3D
- Observation of additional constraints in 3D world
- „smart“ interpretation filters out unwanted input
Flatland

- Whiteboard application for informal activities
- Interpretation of strokes
- Spatial constraints between objects
Flatland
Characteristics of Freeform UIs

• Stroke-based Input
  – Richer than mouse-based dragging, since intermediate states make a difference

• Perceptual Processing
  – Humans perceive much richer information in drawings

• Informal Presentation
  – „imprecise“ visual representation suggests that also the computation is not precise
Smart Text

[James Arvo, SG 2000]
Motivation

• Character input on pen tablets and tablet PCs visually unsatisfying:
  – Pen strokes show jittery hand writing
  – Recognized characters are displayed abruptly and in different location
  – Visual interruption of the process

• Wanted: smooth transformation between pen strokes and recognized characters
  – No visual interruption in the process
  – Touching up recognized chars for correction

• Metaphor: self-organizing virtual ink
Recognition process

• Input: Sequences of strokes
  – Temporally distinct
  – Spatially overlapping

• Find groups of strokes
  – Queue all strokes and lag behind
  – Find most promising matches from the queue
  – Remove the corresponding strokes and continue

• Recognize stroke groups
  – Nearest neighbor matching
  – 50-dimensional feature space
  – Features: stroke length, slope, curvature, gap between strokes, scale invariant!
Morphing process

• Assign recognized strokes to lines in the recognized symbol
• Morph strokes to lines (stroke font)
  – Move if necessary
  – Scale if necessary
• Morph lines to character shapes (outline font)

Figure 1: Each morph has two conceptual stages. In the first stage, lines are blended into lines. In the second stage, lines are expanded to fill in all the font features.
Properties of the stroke font

• **Containment**: Each stroke character is entirely contained within its corresponding outline character.

• **Clarity**: Each character of the stroke font should be aesthetically pleasing as well as easily recognizable.

• **Correspondence**: The strokes comprising each character in the stroke font should correspond as closely as possible to the strokes of a typical hand-drawn rendition.
Design of the stroke font

- Skeletonization of the outline font
  - Containment OK!
  - Recognizable
  - Contains unwanted details from serifs etc.

- Pruning of the resulting skeleton
  - Better, but...

- Hand-drawn font
  - Aesthetically most pleasing

Figure 2: A skeleton versus a hand-designed stroke character for the symbol “T” (top row) and a close-up of a serif region (bottom row). The raw CAT skeleton on the left is pruned, resulting in the automatically generated stroke character shown at center. On the right, a hand-designed stroke character is shown. (Lines are overlaid on the filled outline character for reference.)
Post-processing strokes

(a) Splitting

(b) Joining

Figure 3: To create a one-to-one correspondence between strokes, the strokes of a character may be (a) split at the sharpest bend, or (b) joined where they are most nearly collinear.
Matchking strokes to stroke font lines

- Connect points on stroke to points on the line
- Evaluate energy function on connecting lines
  - Sum of the squares of distances
- Typically only few strokes $\rightarrow$ try all combinations
- Retain the match with minimal energy
Stage 1 morph

Figure 6: Three examples of the Stage-1 metamorphosis, which maps user-drawn characters to corresponding characters of a stroke font.
Stage 2 morph

• For each point on the outline font, find closest point on the stroke font
• Linearly interpolate points from stroke font to the outline font
• Intermediate shapes seem to gradually „grow“ from the stroke font to the outline font
Fluid Documents

Bay-Wei Chang
Motivation

• Annotate primary text with secondary information
  – Footnotes
  – Hyperlinks
  – Literature references
  – Index references

• Problem with current techniques
  – Disrupt the reading flow

• Solution in dynamic media
  – Place the secondary material close to the primary text
  – Different techniques to do so…

• Transitions are animated
When in the Course of human Events, it becomes necessary for one People to dissolve the Political Bands which have connected them with another, and to assume among the Powers of the Earth, the separate and equal Station to which the Laws of Nature and of Nature's God entitle them, a decent Respect to the Opinions of Mankind requires that they should declare the causes which impel them to the Separation.

We hold these Truths to be self-evident, that all Men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty and the Pursuit of Happiness -- That to secure these Rights, Governments are instituted among Men, deriving their just Powers from the Consent of the Governed, that whenever any Form of Government becomes destructive of these Ends, it is the Right of the People to alter or to abolish it, and to institute new Government, laying its
Compress

When in the Course of human Events, it becomes necessary for one People to dissolve the Political Bands which have connected them with another, and to assume among the Powers of the Earth, the separate and equal Station to which the Laws of Nature and of Nature's God entitle them, a decent Respect to the Opinions of Mankind requires that they should declare the causes which impel them to the Separation. We hold these Truths to be self-evident, that all Men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty and the Pursuit of Happiness -- That to secure these Rights, Governments are instituted among Men, deriving their just Powers from the Consent of the Governed, that whenever any Form of Government
Overlay

When in the Course of human Events, it becomes necessary for one People to dissolve the Political Bands which have connected them with another, and to assume among the Powers of the Earth, the separate and equal Station to which the Laws of Nature and of Nature's God entitle them, a decent Respect to the Opinions of Mankind requires that they should declare the causes which impel them to the Separation.

We hold these Truths to be self-evident, that all Men are created equal, that they are endowed by their Creator with unalienable Rights, that among these are Life, Liberty and the Pursuit of Happiness -- That to secure these Rights Governments are instituted among Men, deriving their just Powers from the Consent of the Governed, that whenever any Form of Government becomes destructive of these Ends, it is the Right of the People to alter or to abolish it, and to institute new Government, laying its
How is this achieved?

• In normal reading mode, just show a small visual cue that there is secondary material
• When selected (i.e., mouse over), material must become
  – Readable, i.e. bigger
  – Salient and distinguishable from primary text
• Primary text has different strategies for making space
  – Moving, shrinking, overlay, margin
• Supporting material has different display strategies
  – Text reflow, text & image layout
• Space and salience are negotiated primary text and secondary
  – Common protocol for characteristics
Negotiation process

1. Supporting object makes initial proposition
2. Primary text checks available space and characteristics and provides guideline
3. Supporting object chooses presentation strategy
   - May differ from original proposal
   - Must fit guideline
4. Primary object chooses space-making strategy
Examples of fluid documents (Video)

Figure 1. Excerpt of *Romeo and Juliet* with underline cues indicating annotations.

Figure 2. An animation expands the annotation fluidly, moving the surrounding text apart.

Figure 3. Margins can also be used for supporting material.

Figure 4. When space is at a premium, supporting material can overlay the primary material.
Fluid Documents

KING MAKES IT THREE
By Doug O’Harra and Craig Medred

NOME, AK — Wednesday, March 18, 1998

Pounded by fierce coastal winds, Jeff King of Denali Park saw his chance for a record Iditarod Trail Sled Dog Race blow away on Tuesday, but his team persevered to claim a third victory in 9 days, 5 hours, and 52 minutes.

Compare with Doug Swingley’s record set in 1995:
9 days, 2 hours, and 42 minutes
Click to see all yearly statistics.

Only miles away from the Nome finish line, King and his dogs were caught in a ground blizzard that cut visibility to almost nothing. He later said the weather was the worst he’d witnessed in six Iditarod races.

The wind was the kind of blow “I’ve only heard described by people. I could barely see Red (his lead dog) from my sled. It was the longest couple hours of my life.”

Almost four hours moved between King’s race against the wind.
SCWM - Scheme Constraints
Window Manager

[Greg Badros, SG 2000]
Motivation

• Window managers allow window positioning only by direct manipulation.
• Users might want to specify window placements on a higher level
  – examples: tile, cascade
  – ...but more elaborate relations needed..
• Approach: specify spatial constraints between windows
Example
Types of constraints

- **Constant Height/Width Sum** Keep the total of the height/width of two windows constant.
- **Horizontal/Vertical Separation** Keep one window always to the left of or above another.
- **Strict Relative Position** Maintain the relative positions of two windows.
- **Vertical/Horizontal Maximum/Minimum Size** Keep the height/width of a window below/above a threshold.
- **Vertical/Horizontal Relative Size** Keep the change in heights/widths of two windows constant (i.e., resize them by the same amount, together).
- **Vertical/Horizontal Alignment** Align the edge or center of one window along a vertical/horizontal line with the edge or center of another window.
- **Anchor** Force a window position to stay in place.
Application of constraints

- Click on toolbar to select constraint type
- Click on windows to be constrained
  - Middle of the window: constrain middle (e.g., alignment)
  - Edge or corner: constrain edge or corner

<table>
<thead>
<tr>
<th>NW</th>
<th>N</th>
<th>NE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>W</td>
<td>C</td>
<td>E</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>SW</td>
<td>S</td>
<td>SE</td>
</tr>
<tr>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>
Managing constraints

• Constraint investigator window
• Visual overlay on the actual window
• Compositions (programming by example)
  – Record the composition of n windows
  – At playback, ask for n other windows
• Implicit constraints
  – Snap-dragging: near windows snap together and a constraint is added.
  – Scheme code can be written to automatically add constraints when a window is created
Implementation

• Based on fvwm2
• Extended by Scheme programming language
• Integration of a constraint solver written in C++, wrapped in scheme

• …ends in 2000 with version 0.99.6.2
Smart graphics: Overview of lecture content
Goal: 4 disciplines talking to each other

- Designers have produced graphics forever
- Psychologists tell us how humans perceive and process
- AI provides the tools to use this knowledge
- Computer Graphics provides the medium
3 main parts of the lecture

• Motivations
  – Graphics & Perception
  – Graphics & Design
  – Graphics & Communication

• Methods
  – Representation & Reasoning: A collection of AI tools and formalisms
  – Rendering: How they can be applied to graphics

• Milestones
  – Examples from various fields
Graphics & Perception
Knowledge acquisition pipeline
[W. Bradford Paley, SG 2003]

Simplified model of human sensemaking processes, useful for designing visual representations
Graphics & Design
Color theory acc. to Johannes Itten (1961)
Graphics & Communication
Structure of Graphics

1) Title: Bouquets in a basket with living flowers

2) There is a gardening revolution going on.

3) People are planting flower baskets with living plants.

4) Mixing many types in one container for a full summer of floral beauty.

5) To create your own "Victorian" bouquet of flowers.

6) Choose varying shapes, sizes and forms, besides a variety of complementary colors.

7) Plants that grow tall should be surrounded by smaller ones and filled with others that tumble over the side of a hanging basket.

8) Leaf textures and colors will also be important.

9) There is the silver-white foliage of dusty miller, the feathery threads of lotus vine floating down from above, the deep greens, or chartreuse, even the widely varied foliage colors of the coleus.

Graph: Scatter Plot of the Price/Mileage Data of Cars. The graph depicts a relationship between car price and mileage for 1979.
Methods
Some typical elements of SG systems

- Strong simplification and generalization
- Often only some elements present
Representation & Reasoning
Suche und Constraintverfahren

• Suche:
  – (blinde) Tiefen- und Breitensuche
  – Algorithmus A + A*
  – Minimax- + Alpha-Beta-Verfahren
  – Hillclimbing
  – Bidirektionale Suche
  – Simulated Annealing

• Constraints
  – Formalisierung
  – Lösungsverfahren
A simple PFLP example

- total size of search space \( b^d = 4^5 = 1024 \)
  - \( b \) = number of possible labeling for a point feature
  - \( d \) = number of point features to be labeled
- if the search proceeds A, B, C, D, E with preference 1, 2, 3, 4 then since A1 conflicts with all E labelings, we know we’ll explore at least \( 4^4 \) labelings (256)
- we can examine how the heuristics and pruning techniques might affect this
Algorithm 1: layering

“layered drawings place vertices according to their depth from a reference node, typically this prescribes the y-coordinates of the vertices”

For example:
– set: \( y(v) = \text{distance from root} \)
– set: \( x(v) = \text{inorder rank of } v \)

_inorder traversal:_ defined for binary trees as the recursive traversal of the left subtree of the root, followed by the root, and then the right subtree.
Force-directed methods

- Hirsch formulated a successful solution technique for the PLFP problem using a force analogue, where the repulsion of a label position was estimated from the overlap regions
- Graph drawing can also be done by force-directed methods
Example (15/23 Objects)
AFLs at different levels

- AFLs can be used at different levels for different purposes
  - Example above is for language generation
- Assumption: the analysis process is perfect
- Problem if generation and analysis have the same bug

Questions answered:
- Is the text correct?
- No homonyms?
- Are the sounds correct?
- No homophones?
- Is the sound played correctly?
- Are the speakers OK?
Milestones
SG & 3D

- Aufriss
- Explosion
- Metagraphik
- Annotation
- Abstraktion
- Kameraplanung
Interactive SG Systems

• So far only: intelligent generation of graphics
• But also: analysis, matching and processing of graphics and input according to cognitive criteria
• → different meaning of „Smart Graphics“
• Querying
  – Bitmap images
  – Vector drawings
  – 3D models
• Sketching
  – Polygonal shapes
  – Organic 3D models
SG & Text

• Smart Text Arvo 00

Smart Text

• Fluid Documents, Chang 00

When in the Course of human Events, it becomes necessary for one People to *dissolve* the Political Bands which have connected them with another, and to assume among the Powers of the Earth, the separate and equal Station to which the *Laws of Nature* and of *Nature's God* entitle them, a decent Respect to the Opinions of Mankind requires that they should declare the causes which *impel* them to the *Separation*.

We hold these Truths to be self-evident, that all Men are created *equal*, that they are endowed by their Creator with certain *unalienable Rights*, that among these are *Life, Liberty and the Pursuit of Happiness* -- That to secure these Rights, Governments are instituted among Men, deriving their just Powers from the *Consent of the Governed*, that whenever any Form of Government

As unequal in many ways as humans may be, no one human or class of humans is superior to another human or class of humans.
SG & UI

• Freeform Interfaces (Igarashi)
• SCWM, Badros 00