Magic Lenses and Two-Handed Interaction

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Spot the difference between these examples and GUIs

- A student turns a page of a book while taking notes
- A driver changes gears while steering a car
- A recording engineer fades out the drums while bringing up the strings

- [Examples ref. Buxton]

Quick Motivation

- The desktop paradigm does not demand much (physically) of its user.
- Then again, it doesn't take advantage of the physical abilities of the user either.
- Many tasks are handled more easily with multiple hands.

Two-handed Interaction

- Not just two hands on a keyboard...
  - Discrete actions from both hands (hitting keys)
- More often, either:
  - Continuous action -- both hands in motion
  - Compound action -- one hand moves to target and the other performs an action
- Takes advantage of how we naturally work
  - Drawing/drafting
  - Lab work
  - Surgeons, dentists, ...
  - etc.

Quick Quiz

- What was the first use of two-handed input with a computer?

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- Douglas Englebart in 1968
  - Point with mouse
  - Operate chord keyboard

Next Quiz

- Why has the PC so committed to having a single pointing device?

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- Why has the PC so committed to having a single pointing device?

- Lots of historical baggage
  - Technical: Early systems couldn't keep up with multiple continuous devices
  - Experimental: Fitts Law has only two parameters, target distance and size; performance studies typically focus on just a single hand

Lots of Recent Interest

- N. Matsushita, Y. Ayatsuka, J. Rekimoto. Dual touch: a two-handed interface for pen-based PDAs. UIST 2000, pp. 211-212.
  - Coordinated pen-and-thumb interaction without any additional technology on contact closure PDA (e.g., Palm or PocketPC device).
- A GUI Paradigm Using Tablets, Two Hands and Transparency. G Fitzmaurice, T. Baudel, G. Kurtenbach, B. Buxton. Alias/Wavefront, Toronto. CHI 97
- K. Hinckley, M. Czerwinski and M. Sinclair. Interaction and modeling techniques for desktop two-handed input. UIST '98 pp. 49-58.
- T. Grossman, G. Kurtenbach, G. Fitzmaurice, A. Khan, B. Buxton. Creating principle 3D curves using digital tape drawing. CHI 2002
- S. Chatty. Extending a graphical toolkit for two-handed interaction. UIST '94, pp. 195-204.
- MID: Multiple Input Devices
  - http://www.cs.umd.edu/hcil/mid/

Toolglasses and Magic Lenses

- GUI interaction technique meant to capture a common metaphor for two-handed interaction
  - Basic idea:
    - One hand moves the lens
    - The other operates the cursor/pointer
  - “See through” interfaces
  - The lens can affect what is “below” it:
    - Can change drawing parameters
    - Change change input that happens “through” the lens
- For the purpose of this lecture, I’m combining both of these under the term “magic lens”

Quick Examples

- Magnification (and arbitrary transforms)
- Render in wireframe/outline
- Object editing
  - E.g., click-through buttons: position color palette over object, click through the palette to assign the color to the object

- Important concept: lenses can be *composed* together
  - E.g., stick an outline lens and a color palette lens together to change the color of an object's outline
- Second important concept: lenses don't just have to operate on the final rendered output of the objects below them
  - Can take advantage of application data structures to change presentation and semantics

Reading:

Eric A. Bier, Maureen C. Stone, Ken Pier, William Buxton and Tony D. DeRose, "Toolglass and magic lenses: the see-through interface", *Proceedings of the 20th Annual Conference on Computer Graphics*, 1993, Pages 73-80.

http://www.acm.org/pubs/articles/proceedings/graph/166117/p73-bier/p73-bier.pdf

Note...

- These techniques are patented by Xerox
- Don’t know scope of patent, but its likely you would need to license to use them commercially

Advantages of lenses

- In context interaction
    - Little or no shift in focus of attention
        - tool is at/near action point
    - Alternate views in context and on demand
        - can compare in context
        - useful for "detail + context" visualization techniques

Detail + context visualization

- Broad category of information visualization techniques
  - Present more detail in area of interest
    - More than you could typically afford to show everywhere
    - Details may be very targeted
  - Present in context of larger visualization

Advantages of lenses

- Two handed interaction
  - Structured well for 2 handed input
    - non-dominant hand does coarse positioning (of the lens)
      - examples also use scroll wheel with non-dominant hand
        - scaling: again a coarse task
    - dominant hand does fine work

Advantages of lenses

- Spatial modes
  - Alternative to more traditional modes
  - Use "where you click through" to establish meaning
  - Typically has a clear affordance for the meaning
    - lens provides a "place to put" this affordance (and other things)

Examples

- Lots of possible uses, quite a few given in paper and video

- Property palettes
  - Click through interaction
  - Again: no context shift + spatial mode

Examples

- Clipboards
    - Visible
        - invisibility of typical clipboard is a problem
    - Lots of interesting variations
        - multiple clipboards
        - “rubbings”
    - Can do variations, because we have a place to represent them & can do multiple specialized lenses

Examples

- Previewing lenses
  - Very useful for what-if
  - Can place controls for parameters on lens
- Selection tools
  - Can filter out details and/or modify picture to make selection a lot easier

Examples

- Grids
  - Note that grids are aligned with respect to the object space not the lens

Examples

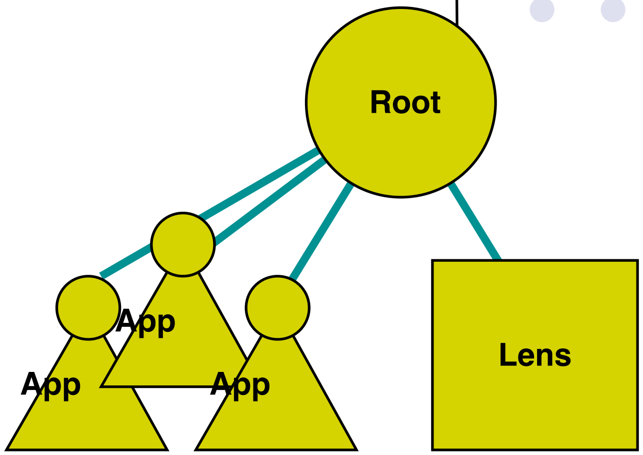
- Debugging lenses
  - Show hidden internal structure in a GUI
  - Not just surface features

- “Debugging Lenses: A New Class of Transparent Tools for User Interface Debugging,” Hudson, Rodenstein, Smith. UIST’97

Implementation of lenses

- Done in a shared memory system
  - All "applications" are in one address space
  - Can take advantage of application-internal data structures
    - Different than OS-provided magnifying glass, for example
  - Like one giant interactor tree
  - Also assumes a common command language that all applications respond to

Implementation of lenses



- Lens is an additional object "over the top"
  - Drawn last
  - Can leave output from below and add to it (draw over top)
  - Can completely overwrite output from below
    - can do things like "draw behind"

Implementation of lenses

- Input side
  - Changed way they did input
    - originally used simple top-down dispatch mechanisms
    - now lens gets events first
      - can modify (e.g., x,y) or consume
    - possibly modified events then go back to root for “normal dispatch

Implementation of lenses

- Input side
  - Special mechanism to avoid sending events back to lens
  - Also has mechanism for attaching "commands" to events
    - assumes unified command lang
    - command executed when event delivered

Implementation of lenses

- Output side
- Damage management
  - Lenses need to be notified of all damage
    - Lens may need to modify area due to manipulation of output (e.g. mag)

Implementation of lenses

- Output side
- Redraw
  - Several different types of lenses
    - Ambush
    - Model-in / model-out
    - Reparameterize and clip

Types of lens drawing

- Ambush
  - catch the low level drawing calls
    - typically a wrapper around the equivalent of the Graphics object
  - and modify them
    - e.g. turn all colors to "red"
  - Works transparently across all apps
  - But somewhat limited

Types of lens drawing

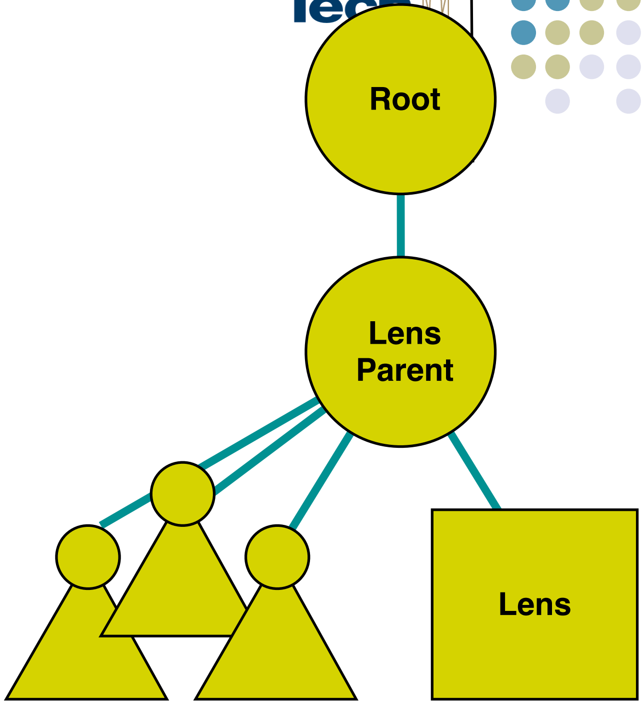
- Reparameterize & clip
  - similar to ambush

  - modify global parameters to drawing
  - redraw, but clipped to lens
  - best example: scaling

Types of lens drawing

- Model-in / model-out
    - create new objects and transform them
        - transforms of transforms for composition
    - very powerful, but…
        - cross application is an issue
        - incremental update is as issue

Lenses in subArctic



- Implemented with special "lens parent" & lens interactors
- Input
  - Don't need to modify input dispatch
  - Lens may need to change results of picking (only positional is affected)
    - in collusion with lens parent

Lenses in subArctic

- Damage management
  - Lens parent forwards all damage to all lenses
  - Lenses typically change any damage that overlaps them into damage of whole lens area

Lenses in subArctic

- Replace vs. draw-over just a matter of clearing before drawing lens or not
- Two kinds of output support
  - Ambush
    - Via wrappers on drawable
    - Extra features in drawable make ambush more powerful
  - Traversal based (similar to MIMO)

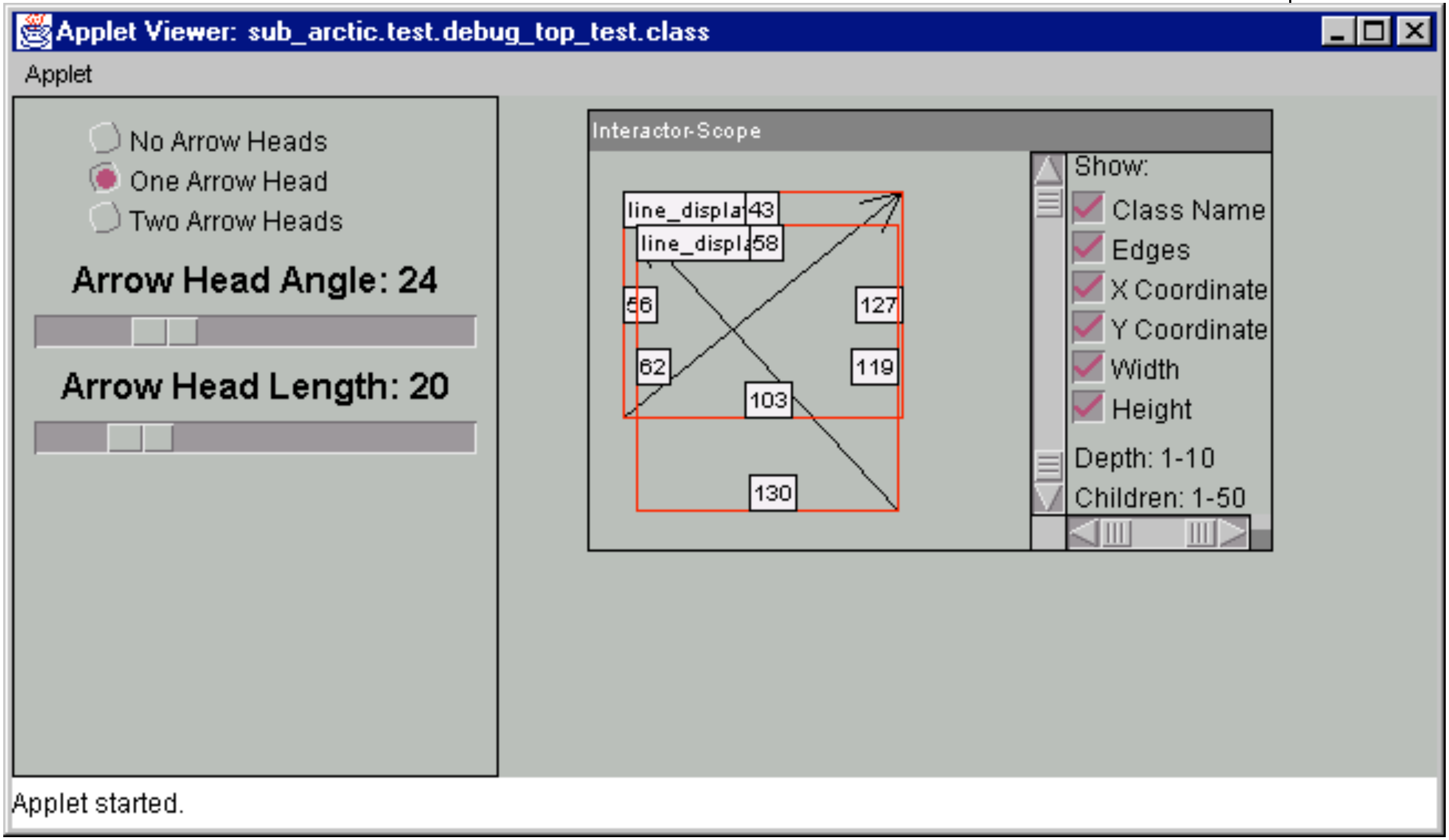
Ambush features in drawable

- boolean start_interactor_draw()
- end_interactor_draw()
  - called at start/end of interactor draw
  - allows tracking of what is being drawn
  - drawing skipped if returns false
- allows MIMO effects in ambush
  - isolated drawing
  - predicate selected drawing

Lenses in subArctic

- Also support for doing specialized traversal
  - walk down tree and produce specialized output
  - can do typical MIMO effects

Example: Debugging Lens



Applet Viewer: sub_arctic.test.debug_top_test.class

○ No Arrow Heads
● One Arrow Head
○ Two Arrow Heads

Arrow Head Angle: 24

Arrow Head Length: 20

Show:
☑ Class Name
☑ Edges
☑ X Coordinate
☑ Y Coordinate
☑ Width
☑ Height

Depth: 1-10
Children: 1-50

Applet started.

Lenses in Swing

- Two things to do:
  - #1: Make sure that your lens is drawn over other components
    - Easiest way: add a special component as the "Glass Pane" of a JFrame
    - GlassPane is hidden by default; when visible, it's like a sheet of glass over the other parts of your frame.
    - Generally, set a custom component as the glass pane with a paintComponent() method to cause things to be drawn
      - myFrame.setGlassPane(myNewLensPane)
      - myNewLensPane.setVisible(true)
  - #2 Create your lens class itself
    - Extend JCompnoent
    - Implement whatever listeners you want to get events for
    - Implement paintComponent so that when you draw yourself, you actually draw components under you (however you want to draw them) -- note that the lens itself likely won't have children

Swing GlassPane

- Hidden, by default
- Like a sheet of glass over all other parts of the JFrame; transparent unless you set it to be a component that has an implementation of paintComponent()
  - Don't actually have to *do* anything in paintComponent unless you want the pane itself to be visible
- Useful when you want to catch events or paint over an area that already contains components
  - E.g., deactivate mouse events by installing a class pane that intercepts the events

GlassPane Resources

- Tutorial on how to use the various panes in a JFrame:
  - http://java.sun.com/docs/books/tutorial/uiswing/components/rootpane.html
- Example of using glass pane:
  - http://blog.elevenworks.com/?p=6
- Another example of using glass panes for graphical overlay:
  - http://weblogs.java.net/blog/joshy/archive/2003/09/swing_hack_3_ov.html

Making a Lens

- Basically, a specialized component that's a child of the glass pane
  - Output:
    - The lens should draw itself (title bar, gizmo to make it go away, its borders)
    - Also draw the components in the frame that are under it, although perhaps not in their original form
  - Input:
    - Redispatch events to components in the content pane
    - May need to tweak their coordinates/details (transform to the new component's coordinate system, for example)
      - See SwingUtilities.convertMouseEvent(), SwingUtilities.convertPoint(), etc.

Lens Resources

- Swing Hacks, hack #56: Create a Magnifying Glass Component
- Blog entry on magic lenses in Swing:
  - http://weblogs.java.net/blog/joshy/archive/2003/11/swing_hack_5_a.html
- Lens details from an earlier version of this class:
  - http://www3.cc.gatech.edu/classes/AY2001/cs4470_fall/a4.html
- Passing events through to underlying components
- Tweaking component drawing
  - SwingUtilities.paintComponent
  - Lets you call a component's paint method on an arbitrary graphics object (e.g., one of your own choosing; can disable/reimplement certain functions, look at the call stack, etc., in drawing)
- Drawing the lens itself
  - Consider using JInternalFrame as the base class for your Lens, as you'll get some basic window decorations.