Collapsible Cylindrical Trees:
A Fast Hierarchical Navigation Technique

Raimund Dachselt, Jürgen Ebert
Dresden University of Technology
Paper Presentation at InfoVis 2001, San Diego
Outline

- Motivation
- Related Work
- Collapsible Cylindrical Trees (CCT)
  - Navigation and Interaction
  - Tree Size and Presentation Aspects
  - Implementation
- Conclusion & Future Work
Motivation

- Hierarchies: important structure
  - Organizational and web structures, product catalogs, part hierarchies, table of contents…
  - Mostly trees (or convertible to trees)
  - Many medium-sized hierarchies
- Not only display, but fast navigation crucial
- CCT initially developed for web hierarchies
  - Focus on usable tree visualization & navigation
  - Comprehensible 3D navigation technique
Related Work

- 2D-Tree visualization
  - 2D Layouts, H-trees, radial & balloon views, tree-maps, onion graphs… [Herman et al. 2000]
  - Problems: performance, viewability, usability, screen space usage
  - Menus: long item lists, large mouse movements

- 3D-Techniques for larger hierarchies
  - Cone trees [Robertson et al. 91] & augmented solutions
  - Object occlusion, bad text readability, interaction
Related Work

- **Navigation Cones** in LyberWorld
  [Hemmje et al. 94], successor *visual trees*

- **Focus+Context** extensions to 2D and 3D visualization
  - Hyperbolic browser [Lamping & Rao 96], hyperbolic cone trees [Munzner 97]

- Problems: interaction, performance, usability

- **3D Web navigation techniques** [Benford 99]
  - Large hierarchies, structure vs. interaction, cognitive difficulties of 3D navigation
Collapsible Cylindrical Trees

- 3D Visualization and interaction technique for medium-sized hierarchies
  - First two tree levels plus chosen path
CCT - The Model

- Tree with finite list of nodes
  - Associated attributes: label, action, color, icon …
  - Intermediate nodes $p$ have set of children $C$

- Cylindrical Mapping
  - For every $p$ child nodes $C$ are mapped on facets of a rotating cylinder
  - Facets evenly spaced, unnecessary removed, not evenly distributed
  - Endless cylinder concept (if $\text{count}(C) > num_f$)
CCT - The Model

- Nested cylinders *Telescope Metaphor*
  - For every $p$ on level $l=i$ a smaller cylinder with $C$ of $p$ is constructed
  - All $l=i+1$ sub-cylinders are nested and hidden within the $l=i$ cylinder
  - $x$-axis for tree depth
  - Siblings of $C$ displayed along $y$-axis

- Parallel display of all $l=1$ cylinders
  - Squeeze or x-scale all other cylinders, same screen space
Navigating the tree structure without clicks

- Move mouse in upper or lower region → rotation
- Branch node facets provide tree expansion functionality, mouse rollover and movement to the right
- Short vertical & horizontal axis-aligned mouse movements

Performing an action on a node: 1 click
CCT - Tree Size and Presentation

- **Size**
  - Number of root children limited $num_{rc} \leq 7$
  - For $l \geq 1$ high branching degree (good: $num_f = 20$)
  - High tree depth (good: $d = num_{rc} - 1 = 6$)
  - Breadth instead of depth encouraged (except top)
  - Typical values: few hundreds to thousand nodes

- **Presentation Aspects**
  - Cylinder radius, width, color; scale; facet number
  - Facet color, icon, text, indicator for branch nodes
CCT - Tree Size and Presentation
CCT - Implementation

- Internal tree representation with XML

  ```xml
  <!ELEMENT NODE (NODE*)>
  <!ATTLIST NODE
    label CDATA #REQUIRED
    target CDATA #IMPLIED
    color CDATA #IMPLIED
    icon CDATA #IMPLIED>
  ```

- VRML97
  - Web-Prototype
- Shockwave3D
  - (Java3D)
Conclusion & Future Work

Main CCT Characteristics

- Tree visualization AND fast & intuitive interaction
- Useful balance of detail and context: dynamical expanding & collapsing sub-hierarchies
- Comprehensible layout, fixed sizes and viewpoint → maximum display quality and readability
- Resemblance with traditional menu systems → almost no training, intuitive interaction
- Restricted number of root children, medium-size
Conclusion & Future Work

- Research context
  - Example 3D Widget of Contigra Framework
  - Component-oriented 3D graphical applications
  - www.contigra.com

- Future Work
  - Enhanced implementations
  - Evaluation and usability testing (online course)
  - Investigate more complex hierarchies
References


