ControlTree: Navigating and Selecting in a Large Tree

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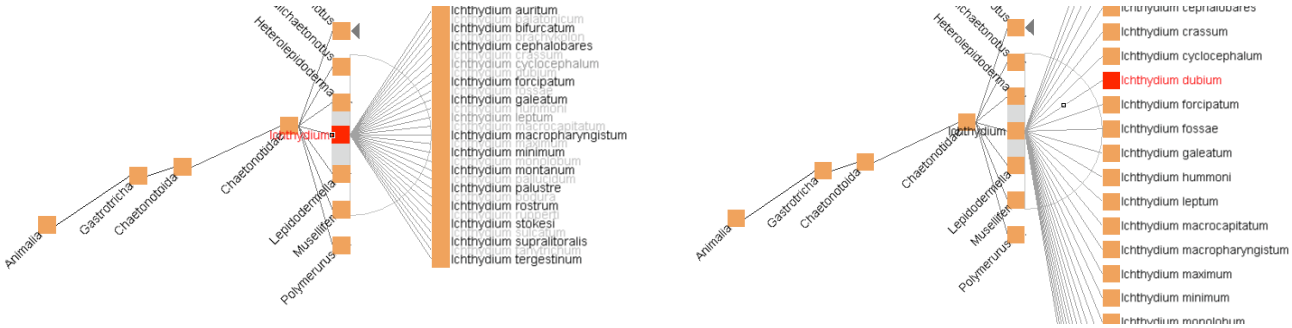

Figure 1:.The ControlTree Interface used for selecting a child in a large-degree node.

ABSTRACT

We introduce ControlTree, a novel interface using crossing interaction to navigate and select nodes in a large tree. ControlTree combines an optimized dynamic layout with interaction features to quickly reach a node in a node-link tree representation.

ACM Classification: H5.2 [Information interfaces and presentation]: User Interfaces. - Graphical user interfaces.

General terms: Design, Human Factors, Performance.

Keywords: Tree navigation, Tree selection.

INTRODUCTION

Navigating and selecting a node in a large tree has become a frequent task. Computer users frequently need to select a file in the file system or a command in a hierarchical menu. Similarly, biologists need to select a species in large taxonomic trees and library users need to find a book in a classification system.

Improving node selection in large trees requires coupling a representation for the tree and an interaction to navigate and select. As pointed out by Plaisant et al. [2]: the node-link "[…] representation of trees remains the most familiar mapping for users and still is universally used to draw simple trees."

This article describes a novel interface called ControlTree to navigate and select a node in a tree using a node-link representation (Figure 1). ControlTree introduces advanced interaction techniques to control a dynamic layout using a continuous interaction.

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CONTROLTREE

Tree visualizations try to provide an overview showing all the nodes. Selecting a node becomes a pointing task. However, as the tree becomes larger, the area dedicated to each node gets smaller and pointing becomes more difficult or impossible when the number of nodes exceeds the number of pixels. Solving this problem requires dynamic layout methods driven by navigation.

ControlTree uses a node-link representation of trees with a dynamic layout organized horizontally. Clicking the mouse button invokes ControlTree. Another click triggers the selection. The root node is initially displayed under the cursor with its children to the right. When the pointer is moved towards one of the children, this child is made current and its children are made visible. The layout is computed around the focus node. All nodes at the same depth level are aligned vertically to conform to the node-link representation and optimize label readability. At any time, there is a focus node *n* and the following visible regions (Figure 2):

- *left zone* or *parent zone* showing the nodes on the path from the root to *n,*
- *central zone* or *sibling zone*, showing *n* and its siblings,
- *right zone* or *child zone*, showing the children of *n.*

Navigation consists in moving the pointer to the different zones. Moving up or down changes the focus to the previous or next sibling. Moving left changes the focus to the parent. Moving to the right towards a child changes the focus to it. Each time a node *acquires the focus*, the node is smoothly animated to the cursor location and the layout of its surrounding nodes is updated. ControlTree only shows local pieces of information around the focus node assuming it is the most relevant way to traverse down the hierarchy level by level.

The horizontal layout that ControlTree uses helps perceive the relationships between nodes but also raises problems in

preserving label readability. Labels in the *child zone* are horizontal and aligned vertically to provide a good readability. However, displaying every label horizontally and avoiding occlusion consumes screen real-estate. To solve this problem, ControlTree changes its labels layout as the focus node changes as shown in Figure 2. Labels in the sibling and parent zones are displayed at a 45 degrees angle to minimize potential collisions. ControlTree also takes care not to clutter the interaction area between the focus node and its children: in the child zone, labels are on the right side of the icon nodes while in the parent and sibling zones, labels are on the left.

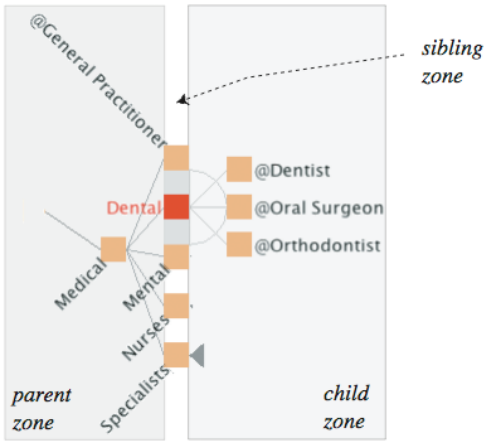

Figure 2: The three zones around the focus node ("Dental").

ControlTree is designed to allow a precise and fast control over node transitions using a continuous gesture to optimize navigation and selection time over a large tree. When a tree is large, several problems arise:

1. the number of children of a node can be arbitrarily large, making it hard or impossible to read their labels and select them precisely;
2. at a specified level, children may end up above or below the viewport and become invisible and unreachable;
3. when navigating on a deep path, nodes may disappear to the right of the viewport.

ControlTree offers interaction and layout methods to overcome these problems.

Interaction

With ControlTree, users just have to follow the successive nodes leading to the target node. ControlTree dynamically uses the direction of the user's trajectory and the cursor position to reach successive nodes.

Simple selections are simple. Since siblings are aligned vertically, their distances to the focus node vary. A *snapping* mechanism accelerates the selection and increases the number of levels that can be displayed by pulling the target node under the cursor before it is reached. However, this mechanism is appropriate when the chance to make a bad anticipation is acceptable, i.e. when the difficulty of selection is within a specified threshold. We now describe how ControlTree adapts its layout to keep the difficulty bounded.

Difficult selections are possible. There is no unique value of *tchild* that optimizes the efficiency for selecting each node in a given tree. With a fixed *tchild* value, the angular precision required to select a node increases with the degree of its parent.

To address this problem, we have adapted the OrthoZoom Scroller, a technique to efficiently navigate and select a target in large 1D spaces [1]. OrthoZoom Scroller uses the orthogonal direction to control zooming while panning is achieved along the collinear direction. ControlTree uses the distance from the focus node to the current point for controlling the spacing between nodes and the direction to choose the nodes that remain within the display area. Each time the mouse is moved we look for the potential target child *c* and adjust the space between nodes while taking care of preserving the position of *c*. *c* progressively repulses its siblings, making itself easier to reach (Figure 3). Thus, while interacting, the user only needs to look at the target node and follow its direction.

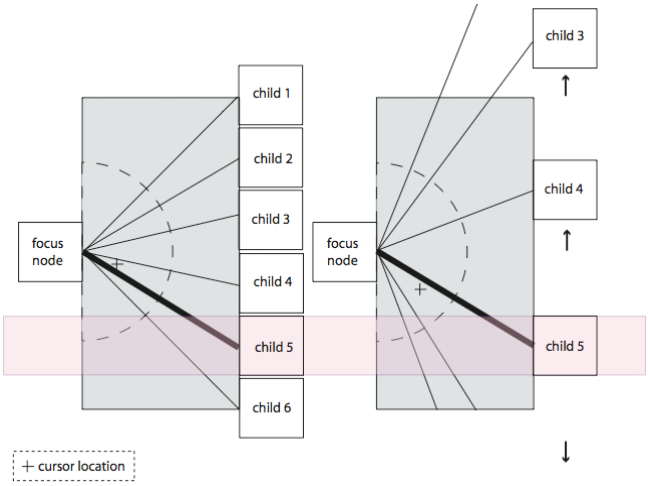

Figure 3: ControlTree strategy to ease a difficult selection.

We have designed an algorithm to dynamically adjust the distance between the focus node and its children each time the focus changes to improve ControlTree usability. This distance is a function of the number of children. Although we optimize the viewport real estate, the user can still reach the right edge of the display area. We provide a modal panning on the tree using a drag interaction. The user can also use the mouse wheel to scroll the children of the focus node while their spacing is kept constant.

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