# A mobile interface for navigating hierarchical information space ☆

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## ARTICLE INFO

## ABSTRACT

This paper presents ERELT (Enhanced Radial Edgeless Tree), a tree visualization approach on modern mobile devices. ERELT is designed to offer a clear visualization of any tree structure with intuitive interaction. Such visualization can assist users in interacting with a hierarchical structure such as a media collection, file system, etc.

In the ERELT visualization, a subset of the tree is displayed at a time. The displayed tree size depends on the maximum number of tree elements that can be put on the screen while maintaining clarity. Users can quickly navigate to the hidden parts of the tree through touch-based gestures. We have conducted a user study to evaluate this visualization for a music collection. The study results show that this approach reduces the time and effort in navigating tree structures for exploration and search tasks.

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## 1. Introduction

Current market trends show strong rise in smartphones and tablets. Smartphones can now match the processing capabilities of laptop/PCs from a few years ago with a fraction of the power usage. With emails, contacts, documents, pictures and music all stored in the cloud, one no longer needs to sit in front of a personal computer to access data. There are, however, still many challenges in mobile computing, such as smaller screens and lack of separate input devices such as keyboard.

Although the screen resolution in mobile devices has been increasing, in terms of screen size they are still much smaller than laptops/PC monitors. This makes it difficult to present tabular and hierarchical structures in mobile device when a large proportion of application data are hierarchical in nature. For example, a file system is a hierarchical structure, and a file list within a folder is usually displayed in tabular format. A multimedia collection such as music, pictures, videos, etc. may exist in hierarchical structures, and is usually displayed in tabular form in laptops/PCs. Fig. 1 shows music hierarchy presented as a table in a PC media player.

Apart from the presentation issues, how we interact with these data structures on mobile devices is also challenging. Modern mobile devices are mostly equipped with touch screens, and soft keyboards. Any keyboards or buttons displayed on screen take space, which is already at a premium. Thus, it is necessary to come up with intuitive
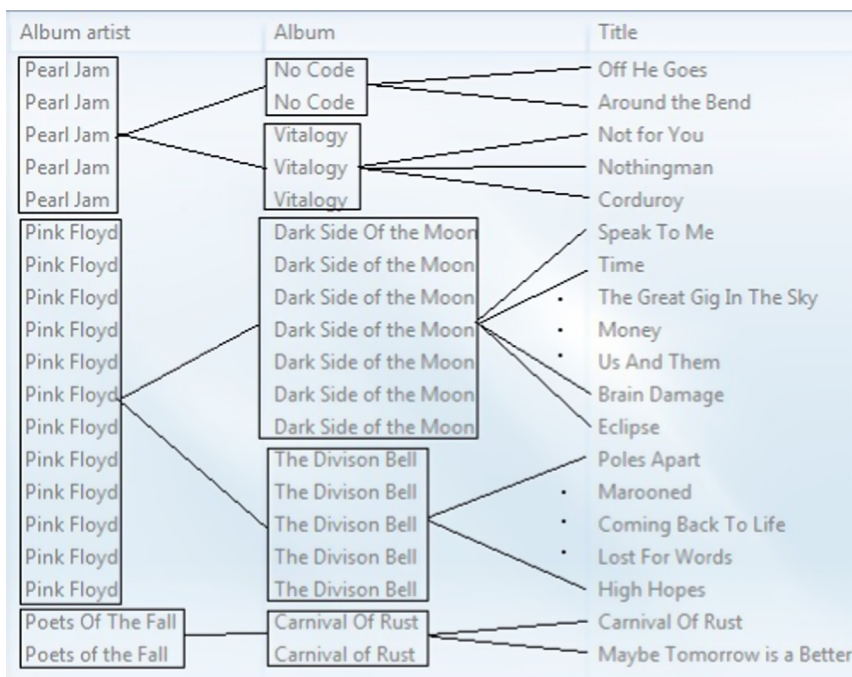
**Fig. 1.** Tabular display of artist/album/track in a media player (edited to show hierarchical division).

methods of interaction without sacrificing screen area for input. Most hierarchical structures are represented by lists in mobile devices, as shown in Fig. 2. Lists offer fast interaction but can only display one level of hierarchy at a time. This paper presents a technique for visualizing and navigating hierarchical structures on mobile devices that focuses on following two issues:

1. Maximal utilization of screen area to display hierarchical structures.
2. Intuitive interaction to allow rapid navigation and exploration of the structures.

The research aims to utilize the screen estate to display maximum possible information, without sacrificing clarity. The objective is to use touch technology in most modern smartphones to implement gesture based commands that are intuitive and mimic real-world object interactions. The paper presents further enhancement over our earlier prototype [1], and a user study using media player application utilizing ERELT. Our user study shows that ERELT supports faster exploration of tree structures than traditional list based interfaces.

To date, considerable research has been done in the areas of information visualization and human-computer interaction (HCI). While recent advances in visualization techniques for hierarchical structures have been promising, little previous work has focused on utilizing visualization as UI elements. Our contribution is a hierarchy visualization technique for small screens with a practical approach for user interaction. We extensively evaluate the ease of user interaction with the proposed ERELT visualization through a user study. Our results show that it takes significantly less time and fewer number of touches to

perform exploration and search tasks. In some cases, the number of touches is reduced by nearly 50%. This suggests that ERELT is a more appropriate interface for users for interacting with hierarchical data than the traditional list interface.

The next section reviews the previous research on the subject, including our own, and explore their short-comings and our latest improvements. Section 3 describes our visualization approach. Section 4 focuses on navigation and interaction details, followed by the evaluation of the research through user tests. Finally, Section 5 presents conclusion and ideas for future work.

## 2. Background and related work

### 2.1. Hierarchy visualization

#### 2.1.1. Implicit vs. explicit visualization

Hierarchy visualization techniques can broadly be classified into two types – implicit and explicit [2]. Explicit visualization techniques display the edges between the connected vertices of the hierarchy. In contrast, implicit techniques, also known as enclosure techniques, show hierarchical relations through shape, location and area of vertices [3].

Explicit visualization techniques are simpler to understand as each relation between nodes is explicitly displayed through links. However, the edges require larger area to draw and much display area around edges and between nodes is unused. There has been some research on explicit visualization for mobile devices, such as Magic-Eye view [5] and Space Manager [6].