Above and Beyond: Outer Space as a Metaphor for Document Browsing and Visualization

Daniel P. Gonçalves Luis Bilo Daniel Gonçalves Manuel J. Fonseca Joaquim A. Jorge
Department of Information Systems and Computer Science
INESC-ID/IST/Technical University of Lisbon
R. Alves Redol, 9, 1000-029 Lisboa, Portugal
daniel.goncalves@inesc-id.pt, mjf@inesc-id.pt, jorgej@acm.org

Abstract

Currently, any ordinary user has hundreds or even thousands of electronic documents stored on his computer. Usually, those documents are archived using an hierarchically-organized file system, making their retrieval at a later time a difficult task. In this paper we present a novel approach for document browsing and visualization based on the Outer Space metaphor. While users "travel" from galaxies to planets and their satellites, the search criteria become narrower eventually allowing users to find their documents. With our approach, users can find a specific file in no more than four clicks. We developed a preliminary prototype, using a user centered approach, through the development of low-fidelity prototypes and heuristic evaluations.

Keywords

User Interfaces, Heuristic Evaluation, Information Visualization

1. Introduction

It is nowadays common for users to handle hundreds of electronic documents. Unfortunately, the way in which those documents are organized makes this a cumbersome task. Indeed, documents are nothing more than files in a hierarchically-organized file system. When trying to retrieve a file, users can resort to little more information than the file's location in the hierarchy. However, such a classification is fraught with problems. When storing a document, where to place it is often not a trivial decision. More than one place in the hierarchy (or no place at all!) might seem adequate. Also, what seems a good classification at one point in time might not be the one remembered at a later time. As such, retrieving the document can become impossible.

The aforementioned difficulties result from the fact that while the users are handling documents, the computer handles files. A document is something a user remembers fairly well, as it was read or written for a reason, can have memorable contents, and was handled in a meaningful context. Files and hierarchical file systems have little relation with this, being more useful for the computer itself rather than for the users. To help users manage their files several approaches allow the visualization of the users' document collections in meaningful ways. Moving away from the file system hierarchies those approaches strive to convey an overall view of the users' documents.

Some approaches, such as, Treemaps [Johnson 91], Cone Trees [Robertson 91], Collapsible Cylindrical Trees [Dachselt 01] and Fisheye Views [Furnas 86] try to cope with the simultaneous visualization of a large number of elements. They use colors to classify information, 3D spaces to highlight relevant information, and allow the navigation through hierarchical parameters or distribution of information in 3D spaces. Other systems allow us to visualize and browse through information in more specific domains, such as the WebBook [Card 96], the DeepDocument [Masoodian 04] and the Perspective Wall [Mackinlay 91], which explore concepts like document transparency and the book metaphor, to show the information in a specific context. Approaches developed by Wise [Wise 95], for visualization of large text documents, and by Rennison [Rennison 94], for visualizing large quantities of news stories, use the term galaxy in the context of information visualization. However, they did not explore the outer space metaphor as we are doing. These authors use the term galaxy to only express a large set of "points" arranged spatially, ignoring completely the way galaxies are composed and organized.

The simple visualization of files, in whatever way, is not enough to help users retrieving them. To actually retrieve a file, a file browser or "explorer" must be used. Unfortunately, most such solutions, again, fallback to the file system's conventions, making it difficult to use other information when retrieving documents.

Our solution tries to make use of the advantages of both kinds of approach. It allows the visualization of the users' entire document collection, so that they might get an immediate feeling of its overall composition (numbers and types of documents, etc.). Documents are grouped by meaningful properties, such as their type or date, rather than a position in an arbitrary hierarchy. Outer Space is used as a metaphor for this representation. Different astronomical entities are used to represent documents and document collections. Rather than just allowing the visualization, users can navigate in this "document universe" searching for a particular document. As this is an interactive system, its interface takes a preponderant role. As such, a user-centered interface design approach was taken, ensuring the validity of the solution. On average, no document is more than four mouse clicks away.

In the following section we will describe in more detail how the Outer Space metaphor was used. Then, the low-fidelity prototypes that led us to our approach will be discussed, as will their heuristic evaluation. Next, we will present the system's architecture and a short description of the preliminary prototype. Finally, we will conclude with a mention of relevant future work.

2. Overview of Our Proposal

In our approach we use the metaphor of Outer Space. It is a domain the average user has become familiar with, due to exposure in games, literature and popular media. This familiarity will allow users to interact in a way such that the visualization itself will not interfere with the main tasks: finding documents. We focus on personal documents, with which the user has previously interacted.

The four most commonly known astronomical entities were used: galaxies, solar systems, planets, and satellites. The larger its real-world counterpart, the more documents it will contain. For instance, a galaxy might contain all song files, each solar system within can contain all songs from a single band, each planet a particular album, and its satellites are songs in that album.

At the beginning, the user is presented with the entire "universe": all galaxies (see Figure 1). It will then be possible to continuously zoom into the galaxies to reach the other entities. At each detail level, the documents are grouped according to some criterion. This can be chosen by the user using a menu. The different criteria reflect how users might remember their documents. For instance, each galaxy can contain all documents created in a year, or all documents of a certain type (music, images, etc.).

While users zoom in into the representation, document groups are shown with increasing detail. By being able to choose at each moment the criterion they feel more relevant, it is easy for users to conduct the browsing towards the desired documents. At no time are the users forced to choose specific criteria, being free to explore their document collections as they deem more appropriate for each document they seek. As the detail level increases, different criteria might become available. For instance, if at some point (as in the example above) the user is visualizing only

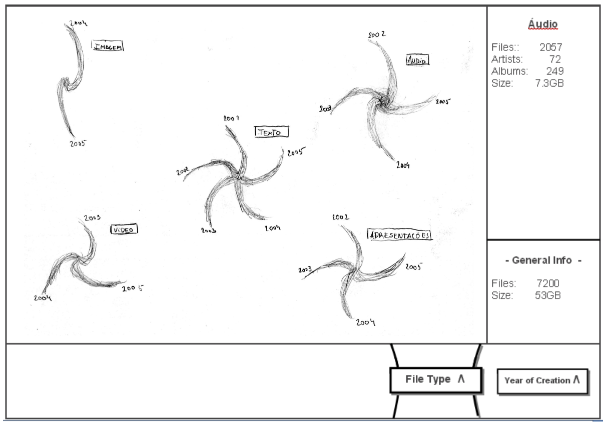

Figure 1. First low-fidelity prototype.

music files, it makes sense to group them by artist or album.

The data that underlies the documents' classifications according to the different criteria is automatically gathered beforehand, into a database. This is accomplished with the help of a sub-system that analyzes the users' hard drives' and collects not only information about the documents' names and whereabouts, but all meta-data it can glean from them. This includes actual meta-data in the documents (ID3 tags of mp3 files, for instance), but also keywords for text documents, generated with the help of the tfidf algorithm, etc. The goal is to gather a rich set of data about the documents with no need for user intervention, as few users would be willing to exhaustively classify all their documents in such a fashion.

The interface itself is generated based on that data. The different file types, dates, album names, etc. available to the user while browsing (and, even, the different criteria, such as file name, size, file type and so on) reflect those present in the database at the moment. The interface is, thus, flexible, adapting to each users' needs. It does not force them to deal with criteria and values they might find irrelevant, nor does it hinder them by preventing the use of relevant data.

At lower levels, when visualizing entities that might represent documents, we can use their properties to give them distinct visual appearances. Furthermore, we took care to ensure that those appearances and the location within the universe remain constant across sessions. This capitalizes on users' visual and spatial memories helping them to retrieve the same document a second time or related documents. Moreover, we take advantage of the several degrees of freedom to visually convey hints of the document's contents. For instance, if documents are planets, their size can represent the file size, the duration of a song or the number of pages of a text document, while their closeness to the star can symbolize the track order.

The actual visualization is generated from each particular document collection. For instance, if a galaxy contains documents from a particular year, each arm might represent a month or trimester. The actual granularity will be automatically decided by the system based on the number of documents to represent. If a galaxy representing audio files is organized by artist, and there are too many artists to represent each one as a galaxy arm then, the galaxy will appear as a sorted cloud of solar systems (an elliptic galaxy), rather than a spiral.

3. Low Fidelity Prototypes

The next step in our user-centered approach was to create a low-fidelity prototype using our Outer Space metaphor. Low fidelity prototypes are prototypes created in a short period of time (one to two hours), without writing a single line of code, using just paper, pencil and other low cost materials. Figure 1 presents an image of our first low-fidelity prototype, where we can see files organized by type in galaxies.

To validate our metaphor and our low-fidelity prototype, we performed a set of heuristic evaluations. We asked 4 usability experts (people who knew Nielsen's usability heuristics [Nielsen 93] and were proficient in there use) to evaluate our prototype. We started by presenting the prototype to evaluators, explaining the concept and goal of the application and the tasks they can perform on it. After that, one person took notes of the evaluators' comments while other person was playing the rule of computer, simulating the behavior of the application. At the end of the evaluation, evaluators gave us a report summarizing the usability problems found. For each usability problem, they mentioned the heuristic(s) violated, the severity of the problem and a possible solution.

From this heuristic evaluation we concluded that the majority of the problems, if not all, were related to the menu at the bottom. All evaluators considered that the navigation was very difficult: i) They were not able to associate the selected option with the content of the main window; ii) Users could not identify the result of selecting each option of the menu; iii) It was not clear how to go back one step.

Taking these usability problems into account, we designed a second version of the low-fidelity prototype, where the main improvements were on the bottom menu and its navigation. Figure 2 shows the second low-fidelity prototype, where we can see the new menu. Before starting coding the first functional prototype, we performed another heuristic evaluation to the second version of the low-fidelity prototype. This time we asked four experts to evaluate our prototype. Two of them were evaluating the prototype for the first time, while the other two already evaluated the first version.

This second evaluation revealed that our prototype had a better usability than the first one. Evaluators identified less problems and they were less severe. The navigation was easier and all evaluators were able to complete the set of tasks. However, there still were some problems related to the correspondence between a menu option and the desired result. Also about the consequences of selecting a specific

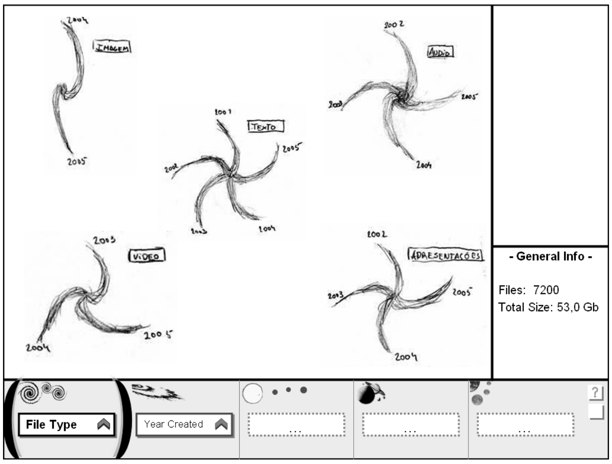

Figure 2. Second low-fidelity prototype.

option and finally, what are the areas in the main window that they could click on.

4. Architecture and Functional Prototype

Before starting developing the functional prototype, we defined the system architecture, depicted in Figure 3.

Our architecture is composed of three layers: Persistence Layer, Logical Layer and the Presentation Layer. The Persistence layer contents the database and the XML file with the configuration about the different attributes of files that can be used for the navigation and visualization of files. The Logical layer is responsible for creating and filling all the data structures according to the navigation steps performed by the user. Each time the user selects a type of visualization (by file type or by date) all data structures are rebuilt. In the Logical layer we have also all the elements from the Outer Space metaphor (galaxies, solar systems, etc.) filled with information. This way, when the system

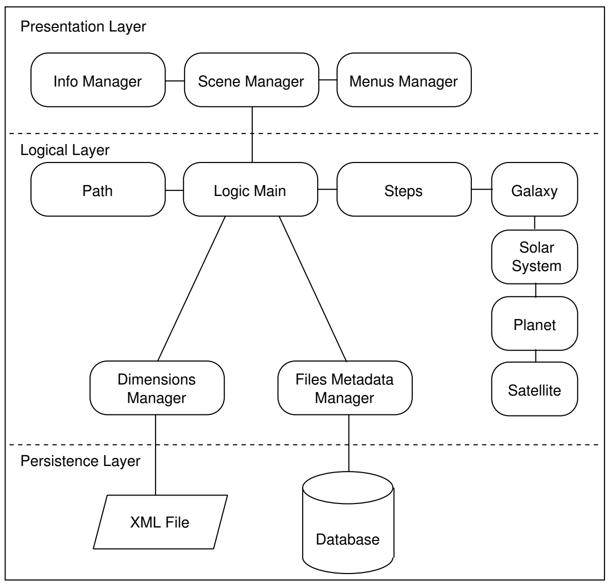

Figure 3. System Architecture.

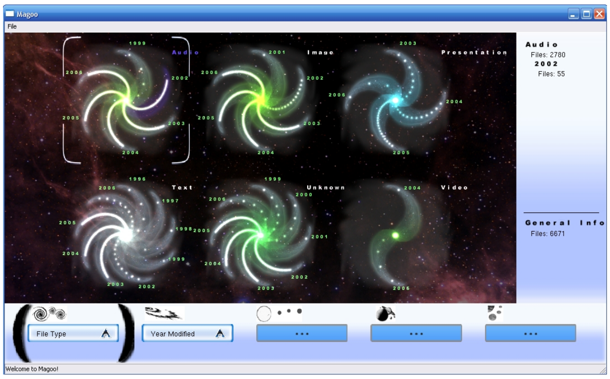

Figure 4. Functional prototype.

needs to represent one of the entities visually, only needs to access the information stored in the Logical layer. Finally, the Presentation layer is responsible for managing the navigation of the bottom menu, the scene graph and visually represent the different Outer Space entities.

We developed a preliminary functional prototype using this architecture, which at the time of this writing has very few functionalities (see Figure 4). In the near future we plan to conclude this functional prototype, submit it to another round of heuristic evaluation and improve the prototype by correcting identified problems.

5. Conclusions and Future Work

We have presented a new approach for document visualization and browsing based on the Outer Space metaphor. This solution has the advantage of allowing users to find a specific file in no more than four clicks. Moreover, users do not need to care about the directory where files were stored.

Currently, we have a very preliminary functional prototype that we are improving in terms of functionality and usability. To achieve this stage, we first created two low-fidelity prototypes, which were submitted to heuristic evaluations to identify usability problems.

After concluding the fully functional prototype, we plan to perform experimental evaluations with users, to measure its usability by comparing it to other "ordinary" file managers. In particular, we will measure the easiness that a particular file can be found, focusing on the number of mouse clicks and the time spent doing the task.

References

[Card 96] Stuart K. Card, George G. Robertson, and William York. The webbook and the web forager: an information workspace for the world-wide web. In *Proc. of the SIGCHI conference on Human factors in computing systems*, pages 111–ff., 1996.

[Dachselt 01] Raimund Dachselt and Jürgen Ebert. Collapsible cylindrical trees: A fast hierarchical navigation technique. In *Proc. of the IEEE Symposium on Information Visualization 2001 (INFOVIS'01)*, page 79, 2001.

[Furnas 86] George W. Furnas. Generalized fisheye views. In *Proc. of the SIGCHI conference on Human factors in computing systems*, pages 16–23, 1986.

[Johnson 91] Brian Johnson and Ben Shneiderman. Tree-maps: a space-filling approach to the visualization of hierarchical information structures. In *Proc. of the 2nd conference on Visualization '91*, pages 284–291, 1991.

[Mackinlay 91] Jock D. Mackinlay, George G. Robertson, and Stuart K. Card. The perspective wall: detail and context smoothly integrated. In *Proc. of the SIGCHI conference on Human factors in computing systems*, pages 173–176, 1991.

[Masoodian 04] Masood Masoodian, Sam McKoy, Bill Rogers, and David Ware. Deepdocument: use of a multi-layered display to provide context awareness in text editing. In *Proc. of the working conference on Advanced visual interfaces*, pages 235–239, 2004.

[Nielsen 93] Jakob Nielsen. *Usability Engineering*. Academic Press, 1993.

[Rennison 94] Earl Rennison. Galaxy of news: an approach to visualizing and understanding expansive news landscapes. In *Proceedings of the 7th annual ACM symposium on User interface software and technology*, pages 3–12, 1994.

[Robertson 91] George G. Robertson, Jock D. Mackinlay, and Stuart K. Card. Cone trees: animated 3d visualizations of hierarchical information. In *Proc. of the SIGCHI conference on Human factors in computing systems*, pages 189–194, 1991.

[Wise 95] J. A. Wise, J. J. Thomas, K. Pennock, D. Lantrip, M. Pottier, A. Schur, and V. Crow. Visualizing the non-visual: spatial analysis and interaction with information from text documents. In *Proceedings of the 1995 IEEE Symposium on Information Visualization*, page 51, 1995.