A comparison of 2D and 3D digital library visualisations for education

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Abstract

Protecting heritage sites in South Africa is a great concern and stewardship programs may be the answer to this problem. However, digital libraries, which might be used to educate prospective stewards, are focused on research and can be difficult for those without a background in this field to navigate. This paper looks at 2D and 3D implementations of visualisation techniques that provide intuitive navigation of digital libraries. It was found that while visualisations are often successfully used for such large information spaces, an important consideration is allowing the examination of detail without losing associated contextual information.

1 Introduction

South Africa has many historical sites containing ancient artefacts and artwork. These sites can often contain vast stores of knowledge and information but in many cases they can also be fragile and must therefore be protected (Pwiti & Ndoro, 1999). One manner in which this can be achieved is through stewardship, where local residents are educated about nearby sites and how to protect them without preventing access and the opportunity to learn from them (Pwiti & Ndoro, 1999). They are made stewards of the sites and the information about heritage stored there.

Education of residents of the community close to heritage sites is the key to stewardship programs, and digital libraries containing heritage and archaeological information that could be used for this task do exist (Ruther, 2007). Unfortunately, many are not easily accessible to those who have little to no research experience (Isaacman et al., 2005). In order to correct this, these libraries must be presented to users in a way which provides intuitive navigation of the information space. Therefore, visualisation techniques which could be applied to digital libraries must enable this.

Additionally, these libraries often contain information stored in a variety of different formats (Baldonado et al., 1997) or draw in information from multiple different sources (Rao et al., 1995). For this reason, potential visualisation techniques for large information spaces must also be able to handle multiple sources or formats in order to be considered suitable for application to digital libraries. This paper separates visualisation techniques into those that display the data in a 2D format and those that display it in a 3D format and analyses them with respect to navigational ability and the diversity of information formats handled.

2 2D Visualisations

Techniques for visualising and navigating large information spaces are not uncommon. Information Murals are one such technique. This technique focuses on condensing large amounts of information into a global 2D visualisation that is able to fit easily onto a computer screen (Jerding & Stasko, 1998). The visualisations preserve information on the context of the data being viewed in a way that supports analytical and navigational tasks that a user may want to perform (Wan, 2006). The goal of the software is to represent a large information space within the confines of a computer screen without losing information due to compression, while still allowing inspection of details without losing contextual information.

Macroscoping tools employ a variation on the pan-and-zoom technique of visualising large information spaces which are organised or can be visualised hierarchically (Lieberman, 1994). This technique use transparency to preserve a visual representation of the original context from which the current detailed view comes (Harrison et al., 1995). The main goal of macroscoping is to allow the user to zoom-in to get details, while

still being able to see the context that they occur in. This is achieved by changing the transparency of the original view and overlaying it on the zoomed-in view. This technique could be useful for navigating the GIS visualisations and maps contained in digital libraries (Wan, 2006).

ActiveGraph uses scatter-plot graphs to depict datasets of digital library documents. The service effectively handles user queries by filtering objects using predefined attributes and metadata. It is most notably useful for researchers who wish to query citation data (Wan, 2006). Built to enable collaborative projects, ActiveGraph also allows users to contribute to the digital library by editing the metadata of objects and storing the history of who edited the data and when (Marks et al., 2005).

The UC system for visualising and navigating digital libraries uses Treemap layouts to present collections of documents within the library (Good et al., 2005). Continuous and Quantum treemaps are used to provide an overview of documents in a set and then facilitate navigation amongst these documents. The system specialises in allowing the user to interact with the document instead of the tool and enables manipulation of documents as well as the ability to compare them. While it is designed for the visualisation of personal libraries (where the user has the right to use the data as well as local possession of it) it can be used for more public libraries (Wan, 2006).

To provide easier and more intuitive navigation, Information Murals and Macroscoping both preserve a visualisation of the context that details come from (Jerding & Stasko, 1998), (Lieberman, 1994). However, the transparent images used by Macroscoping to display this information could be misleading and distracting, obscuring the true information and making navigation difficult (Harrison et al., 1995). This idea of a preserved overview or global representation is not applied in the UC or ActiveGraph techniques, this could hamper a user's navigation of the information (Jerding & Stasko, 1998).

A drawback of both the Information Murals technique and the UC system is that only one type of information in the space can be viewed at any time (Jerding & Stasko, 1998), (Good et al., 2005). The Macroscoping technique suffers from the need for the information to be hierarchically connected or organised. These problems make these techniques inapplicable to visualisations of digital libraries that can contain many objects stored in different formats and related in different ways (Baldonado et al., 1997). In contrast, a dataset displayed by the ActiveGraph system can correspond to any objects in the library regardless of the format or medium in which they are stored and related (Marks et al., 2005).

3 3D Visualisations

LVis (Digital Library Visualizer) is a visualisation tool that extracts semantic relationships from data in a library and then uses a Boltzman algorithm to lay the data out in space (Borner et al., 2000). The system has both a 2D and a 3D user interface, with the 3D interface making use of the CAVE (CAVE Automatic Virtual Environment) virtual reality tool to create an immersive environment through which to display the information. Users of the 3D interface enter a virtual reality version of Easter Island and can choose to walk through gates that separate the information categories into rooms where the information is displayed on objects modelled in the space (Wan, 2006).

3D spacial metaphors are used in other digital library visualisation tools as well, such as the 3D Vase Museum developed at Tufts University that allows a user to change their view of the information as they navigate through it (Shiaw et al., 2004), (Wan, 2006). At a high level, the information is displayed as a birds-eye view of a museum room; this forms a visualisation similar to a scatter-plot with the walls as axis against which the vases are plotted. As users move closer to the objects, the view changes to be a perspective, eye-level view that allows examination of the physical details of the vases. As the user gets even closer, the view focuses on a vase and brings up metadata on it without the view leaving the room (Shiaw et al., 2004).

Projects such as LVis and the 3D Vase Museum raise the question of the use of virtual reality in information visualisation techniques. Guven & Feiner (2006) draws from projects such as FlyAbout (Kimber et al., 2001) and Movie-Maps (Lippman, 1980) to build a tool which uses augmented reality to display information. FlyAbout provides the spacial navigation through video, while Movie-Maps provides overlays of information on these graphics. Guven & Feiner (2006) focuses on visualising information in its actual location and context by overlaying it on pictures or videos taken from a camera. A Virtual Field of View is used to ensure the scale and positioning is correct in relation to the information from the camera as it moves.

The LVis system is an example of mapping a user's navigation of a 3D structure to their navigation of the information contained in the digital library being navigated (Borner et al., 2000). However, unlike the 3D Vase Museum and some of the 2D techniques described, it does not maintain a concept of the context that details come from (Shiaw et al., 2004). Guven & Feiner (2006) preserves context very well but suffers in that users must navigate to a different physical space in order to view information from the new space. However, it does allow the user to navigate the information at their own pace and leisure.

LVis again falls short when compared to the 3D Vase Museum since only information stored in image format is displayed (Borner et al., 2000), whereas the 3D Vase technique can be extended to incorporate other sources of information (Wan, 2006). Guven & Feiner (2006) benifits from the Movie-Map technique as it can display any information which can be viewed on a camera.

4 Conclusion

South Africa has a wealth of cultural heritage sites that contain fragile links to the rich past of the land. Some of these sites are in danger of degradation due to time, erosion and vandalism (Ruther et al., 2009). The protection of the sites lies in educating the residents living around them about their heritage and the importance of the information contained there and teaching them to become stewards of the local heritage.

Digital libraries can be used to prepare them and give citizens detailed information about their local heritage. Unfortunately, most digital libraries were built for the purpose of research (Isaacman et al., 2005) and users who do not have the research skills may find it difficult to navigate the large information spaces of these libraries and will therefore be unable to make full use of the resources contained in them. Additionally many digital libraries contain information from a variety of sources and this information can be stored in a variety of different formats.

With this in mind the paper looked at methods of visualising large information spaces, such as digital libraries, in both 2D and 3D environments before analysing the techniques with respect to navigation and variety of information that they can handle. An important factor noted throughout the research was the importance of allowing users to examine details without losing sight of the context from which the information is drawn. Systems such as ActiveGraph, the 3D Vase Museum were found to be strong with respect to navigation and compatibility with multiple information formats or sources.

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