Implementing Accessibility to a Digital Library Using Virtual Reality Techniques

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Abstract. This paper describes an ongoing research project about the development of a digital library to house 3D graphical models of biomolecules, for educational applications. An important aspect of the digital library will be the implementation of its accessibility to people with visual disabilities. To achieve this, the information from the 3D models will be presented through auditory and haptic (using the sense of touch) information using virtual reality techniques, and the queries to the digital library will be done using voice recognition hardware. The objective of this research is to see whether virtual reality techniques are effective to improve accessibility to a digital library. This research project is being carried out at the Virtual Reality Laboratory of the University of Colima in Mexico.

1. Introduction

A digital (or electronic) library can be defined as a repository of electronic documents, digital video, audio clips, images, and graphics stored in a network server, as well as on CD-ROMs or DVDs [1,2]. Digital libraries also integrate services about information retrieving, search, and distribution. The access to a digital library can be done via a local intranet or the Internet almost from anywhere, either from a classroom, a computer center, a research laboratory, or from home, even from a conventional library. For instance, the University of Colima in Mexico is currently carrying out a large research project on storage and retrieving of electronic documents from Latin American and Caribbean libraries in a digital library [3].

Digital libraries for scientific applications make extensive use of visual information. Scientific information is often composed of large datasets, many images, video clips, and lately, three-dimensional graphical models, usually stored as VRML (Virtual Reality Modeling Language) files. That amount of information is sometimes difficult to present to a common user due to its complexity, and it is often difficult to understand because its abstractness. This can be partially alleviated by using scientific visualization techniques like color coding, depth, perspective, use of contours, semi-transparency, and others.

2. Problem Description and Objective of this Research

One of the problems that face people with visual disabilities (being total or partially blind, or experiencing other vision problems) is about accessing and perceiving scientific information from a digital library that originally was designed for users with normal vision, which make extensive use of information and scientific visualization techniques.
Most digital libraries do not offer accessibility features (or “adapted technology” [4]) to people with visual disability, unless they could use other senses than vision to perceive information from a digital library. A solution could be to use both auditory display (the use of sound in human-computer interfaces to convey information) and haptics (referring to the sense of touch) techniques, to allow users with visual disabilities to perceive information from the digital library through their senses of hearing and touch.

The proposed digital library could also serve to people without disabilities, because they could perceive and analyze scientific information by using three information channels (hearing, touch and vision), taking advantage of putative benefits of multimodality in human-computer interfaces [5], such as information transduction and complementation between senses.

The main objective of this research project is to see if virtual reality techniques are effective to enhance accessibility to scientific information stored in a digital library.

3. Test Bed for the Proposed Digital Library

One of the uses of digital libraries for education and research is the storage and management of scientific information, namely molecular biology. Graphical information of biomolecular structures are being stored in digital libraries for their access through the Internet. The structural information is codified in special file formats for 3D graphics, being VRML one of the most used formats on the Internet. Once retrieved from the digital library, generally using text search or icon selection, the VRML files are visualized in local computers using VRML browsers [6].

The virtual reality laboratory of the University of Colima is currently developing a repository of graphical models of biomolecules, to be used in local biochemistry courses. The graphical molecules are being made from PDB (Protein Databank) data files obtained from [7], and converted to VRML using a range of programs. We are currently testing a virtual environment browser called DIVE [8]. A virtual molecule displayed with DIVE is shown in Figure 1. We are planning to conduct a series of usability studies in this research project to test our proposed digital library.

![Figure 1. A virtual molecule of Alanine showed in DIVE browser.](image)
4. Accessing the Digital Library

Users will select a virtual molecule from the digital library using verbal commands, by means of a voice recognition hardware based on Voice Direct 364 (TM) voice recognition circuit kit [9], which is being tested at the Laboratory. It is shown in figure 2.

![Figure 2. The Voicedirect 364 (TM) kit.]

5. Perceiving the Information

Once the requested virtual molecule has been converted to VRML at the digital library server, some of the molecular information will be presented to the user in two ways:

- Presenting the molecular structure through haptics. The user will perceive the molecular structure using an input/output device for virtual reality called “Phantom” [10]. The Phantom provides force feedback that allows feeling of volume (among other features) of virtual objects (in this case virtual molecules) with great accuracy by holding a tip to manipulate and analyze the structure of the virtual molecule.

- Presenting molecular information through sound. It is possible to play loud each atom’s name of the molecule to be analyzed when the user selects each atom with the Phantom. The sound will be played in 3D, that is, it will be heard at approximately the atom’s spatial position in the molecule, this to allow user identify each atom and relate it to the molecular structure.

In this manner, the visually impaired users can perceive information from the digital library by using two sensory modalities (hearing and touch) at the computer interface. Figure 3 shows the complete system, including the digital library and its multimodal human-computer interface.
In addition, it is possible to display the virtual molecule, as well as presenting information through sound and haptics, to make future tests with people without disabilities.

6. Possible Users of the Proposed Digital Library

It is expected that our research project will benefit not only visually impaired students, teachers, researchers, and staff of the University of Colima, but people in general that study, teach and carry out research on biochemistry, by using their senses to perceive biomolecular information. This investigation can be applied to other universities and institutions as well:

- Other universities and educational institutions that wish to make use of the proposed multimodal digital library or implement a multimodal digital library of their own.
- Conventional libraries that want to diversify their services by offering access to a multimodal digital library.
- Institutions and laboratories that do research on biochemistry.

7. Acknowledgements

We wish to thank the University Center for Didactic Media Production (CEUPROMED) and Telematics School of the University of Colima, and E-media and VR Consulting, S.A. de C.V. for their support in this research.

References


