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ABSTRACT: *Today's digital libraries are extreme complex information systems, which run on the Internet [1]. The facilities of digital libraries are increasing daily as the technology advances with a motive to provide the appropriate information to its users. The very purpose of the digital libraries is to provide the required information to its users in a convenient and fashioned manner.*

Since the digital libraries are running on the Internet and the users are from different psychological, educational and social backgrounds, the usage of digital libraries is varying from user to user which entail the need of best user interface.

Hence, this paper proposes some design principles for user interfaces for digital libraries for its effective implementation.

Keywords: Digital Libraries, User Interfaces, Human-Computer Interaction

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1. Introduction

The contemporary technologies like XML databases; Internet and Web 2.0 are providing an excellent environment to disseminate the multi-media information to the common man by breaking the physical boundary barriers. These modern technologies have enabled global connectivity of computers and the development of various tools and technologies for networked information provision and access.

Digital Libraries (DL) provide an infrastructure for creating, structuring, storing, organizing, processing, retrieving, and distributing multimedia digital information [2] via Internet. Digital libraries are not used in isolation, they are built up with many components – User Interface is one of the major components that affect its use.

The user interface system, has gained much deliberation due to the fact that it affects the usability, which is a key factor for the success of a product. The commercial and technical importance of the user interface is now well established in the computer science research community, and many conferences and projects all over the world deal exclusively with human factors and user interface issues. Still open problems exist in this area, and they are increased when developing for digital libraries.

This paper proposes some design principles for designing of user interface for digital libraries.

The paper is organized as follows. Section 2 highlights the need of effective user interface for digital libraries; section 3 proposes some design principles of user interface for digital libraries. Finally, section 4 presents the conclusion.

2. Need of Effective User Interface for Digital Libraries

A digital library may provide a single point of access to a huge quantity of multimedia information that is available to a variety of kind users with a different psychological, educational, social backgrounds and information needs over Internet. Huge sum of money have been spent on building useable digital libraries. However research has shown that digital libraries are under utilized [5].

Digital libraries are inherently interactive systems with a constant growth of the number of end-users. They must not only rely on effective and sophisticated retrieval mechanisms but also provide efficient interaction with the end users [4].

From last two decades, several information scientists have paid attention to Human Computer Interaction (HCI) and the user interface design for information retrieval systems as well as a digital libraries [6], [7]. In order to enhance the usability and the accessibility of digital libraries, it is needed to show how theories and models from the domain of HCI can be applied to the user interface design of digital libraries.

3. User Interface Design Principles for Digital Libraries

Designing an interface for digital libraries is a complex process that is oriented towards demonstration of the system's potential capabilities [11]. Careful consideration of both system and user characteristics is the key to success for effective design. A design is considered universally usable when it addresses typical features relating to users, such as computer literacy, physical disability, competence in a foreign language, age group [9], or proficiency in the field of digital library content.

By considering the different user requirements and technical feasibilities, we propose the following user interface design principles for digital libraries for an effective user interaction and implementation.

I. Simple

[12] Uni-dimensional judgments span (the span of immediate memory) is usually somewhere in the neighborhood of seven, \pm two. This essentially means that humans have a very small (5-9 chunks of unrelated information) short-term memory load. So, the DL User Interface should be simple and straightforward. Basic functions should be immediately apparent, while advanced functions may be less obvious to new users. A well-organized interface that supports user tasks fades into the background and allows users to work efficiently. Functions like Copy, Print, and Save etc should be included only if a task analysis shows need/necessity for them. The best interface is one that is not noticed, and one that permits the user to focus on the information and task at hand instead of the mechanisms used to present the information and perform the task.

II. Support

The DL User Interface should provide users to control over the DL; it has to enable the users to accomplish tasks using any sequence of steps that they would naturally use. UI should not limit them by artificially restricting their choices to system notion of the "correct" sequence. It should be more on event driven rather than menu driven.

The user interface of a system should support for different tasks [3]. Most users perform a variety of tasks and may be expert at some and novices at others. Besides providing assistance when requested, the system should recognize and anticipate the user's goals and offer assistance to make the task easier. Ideally, assistance should improve user's knowledge that will allow them to accomplish their tasks quickly. Intelligent assistance is like the training wheels on a bicycle - at some point, most users will want to take them off and go forward on their own. The assistance should allow them to become independent at some point when they choose to be so.

III. Familiar

The UI of DL should be familiar to its users by allowing them to build on prior knowledge, especially knowledge they have gained from experience in the real world. Users should not have to learn new things to perform familiar tasks. The use of

concepts and techniques that users already understand from their real world experiences allows them to get started quickly and make progress immediately.

IV. Informative Feedback

The UI of DL must provide informative feedbacks to its user. As a general rule, there must be user feedback for every user action. As to the extent and form of feedback, it is dependant on the task that is performed. For minor and frequent actions, the feedback could be subtle, for instance a change of the content of the page or a soft sound will suffice. For major actions, for instance the changing of passwords or error messages, the feedback should be more obvious in the form of pop-ups and/or jarring noises to alert the user of the situation [16].

V. Design Dialogues to Yield Closure

Informative feedback at the completion of a series of actions will give operators a satisfaction of accomplishment and to prepare for the next group of actions [15].

VI. Prevent Errors

The system should be designed in such a way that user cannot make serious errors. Any avenue of making errors should be minimized. Another way is to make the system insensitive to errors. [13] The UI of DL should provide a mechanism to detect the user errors and offer simple, constructive and specific instructions that users can understand.

VII. Multimedia Support

Today's information is not only the textual information but also a variety kind of data such as maps, photographs, audio and video etc. Digital Libraries are providing this kind of rich multimedia information. So, the UI of DL must support the multimedia information.

VIII. Profile Based Support

Digital Libraries are maintaining the user profiles in order to provide efficient services. The UI of DL must act according to the settings specified in the user's profile and the settings should be changeable from time to time by the users.

IX. Lithe and Simple

Most of the DLs are accessible to users through Internet only. Possibly normal/home user's connectivity of Internet is less in speed and research has shown that for most of the computing tasks, the threshold of frustration is about ten seconds. Hence the user interface of the digital library must be lithe and simple without having heavy and unnecessary graphics which causes burden on network traffic and unnecessary delay.

X. Pan and Zoom Support

User interactions are based on the familiar ideas of pan and zoom. A user can zoom out and see the whole collection but with little detail, zoom in part way to see sections of the collection, or zoom in to see every detail. This spatial approach makes extensive use of research in human perception. Since people have good spatial memory, the system emphasizes shape and position as clues to help people explore information and to recall later what they found. So, the UI of DL has to support the Pan and Zoom features, and this should also be profile based.

XI. Accuracy

Poor display of information, spelling errors and grammatical errors display poor maintenance and it affects the site's credibility. [8] So, UI of DL should provide accurate information as much as possible to the user in a proper display mode.

XII. Efficient Searching with NLP support

Most of the users visit digital libraries for getting the required information on searching and browsing it. Digital Library has to provide the efficient search mechanisms with excellent search interface support. In order to search the DL most of the user quires are in natural language only. The emergence and ever increasing importance of end user searching provides challenging opportunities for the integration of sophisticated natural language analysis and processing techniques in user-friendly interfaces. Natural language interface technology represents a major break-through in "user friendly" computer systems [14].

XIII. Support of Semantic approach and Resource Description Frame Work (RDF) Technologies

Semantic approach and RDF technologies are providing easy and efficient way of searching to the user [17]. By enabling these technologies in designing of UI of DL will give more benefits to users in their interactions with the DL.

XIV. Sharing and Reusing of Information

The interface needs to support sharing and reusing the information processing knowledge. In a computerized environment, the searches of users can be easily recorded and re-used. The following are the mechanisms for using this information to improve future searching efficiency.

- Collaborative filtering.
- Social filtering/recommending.

XV. Multilingual Support

At present most of the digital libraries are portals. The availability of knowledge and information is not only in one language; hence the user interface of digital library must support the multilingual support [10].

XVI. Platform Independent

Since the digital libraries are running on Internet, the user's environment may not be the same; hence the user interface of digital library must be platform independent and adoptable to all types of environments.

XVII. Future Plug-ins Support

Development in technologies and ever increasing human needs are providing new types of information access. To support future information needs the UI of DL must be capable and adoptable for future developments.

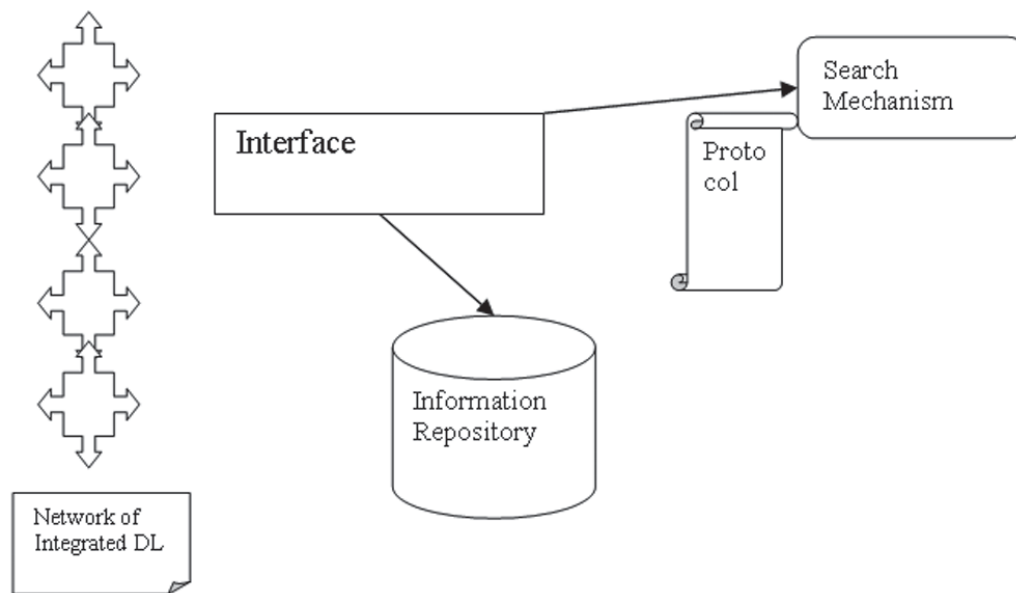


Figure 1. Architecture of the proposed User Interface

We have presented the proposed architecture of an ideal user interface for digital libraries. The search mechanism should follow protocols. To access to the information repository, the user interface works as a prime mechanism. The main benefit of the proposed architecture is the availability of the digital libraries scattered and gets integrated here for unified access. Again protocols bring together all possible unified schemes and access mechanisms. The design and implementation of the proposed system conformed to the design principles stated earlier and thus provide an extensible framework for future

expansion. Initial responses tracked through the pilot measurements are encouraging and the studies sample users expressed good signals for using such a system.

We believe that the results of the proposed interface framework will add to the way people introduce user interfaces in building Digital Libraries. The evaluations and feedback received from the initial target users strengthen the case for building on the various protocols to support high-level services, and composition of those services into complete Digital Library systems.

We are mindful to bring the scalability and extensibility of the user interfaces which will provide more insights and understanding. It will enable to bring closer the information repository, and ultimately making information more accessible to more end users.

4. Conclusion

The increasing usage of digital libraries poses a new challenge for user interface development. Designing a user interface involves many professionals such as software engineers, graphic designers, human factor specialists, and technical writers, and also very often statistical consultants, all of whom cooperate to meet the project goals.

The principles presented in this paper are not only consistent with target user needs, but it is also content-dependent and complete for normal digital libraries. Although the model refers to digital libraries, it can be extended with additional features to other cross-language information systems on the Web and special purpose digital libraries (medical, legal, geographical etc).

These user interface design principles are changeable in future expansion of technology and information needs.

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