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An Architecture of a User-Centred Digital Library for the Academic Community

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Abstract

An architecture of a user-centred digital library, designed to lead users of an academic community to the required information resources based on their tasks, is proposed. Information resources include full-text articles, databases, theses and dissertations, e-journals, e-books, multimedia databases, and so on. Other information resources such as university course calendars, university statutes, course registration, thesis and dissertation guidelines, style guides, and so on, are also needed by users. A prototype has been designed and developed using the School of Computer Engineering at Nanyang Technological University (NTU) as an example of such an environment to provide access to these information resources which are spread across different servers and in different home pages This prototype provides links to various information resources according to users' needs, as well as a personal work space to record/store his/her publications, frequently used or favorite hyperlinks and references or notes. Various stages of the prototype design and development are described and future works on this line are highlighted.

Introduction

The proliferation of digital libraries in the last few years have led to the development of various digital library collections and services. There are many on-going digital library projects in different parts of the world. A review of twenty working digital libraries from different parts of the world shows the diversified collection of information resources(Meyyappan, et al., 2000). Apart from the various information resources that are currently managed, provided and access by digital libraries, there are many other information resources such as course calendars, university statutes, various course offering, course registration, thesis and dissertation guidelines, laboratory facilities, availability of software, hardware, equipment, course materials, reserve book/handout collections, publication databases, and so on. Currently digital libraries do not manage or provide access to these diverse but yet extremely useful collections of information.

Problems of Users in an Academic Community

User requirements from a digital library are influenced by their nature of work, affiliation, educational background, accessibility to technology, and so on. The nature of work of staff, students and researchers vary according to their tasks in an academic setting. In the Internet era, the problems faced by the users of a digital library are manifold. First of all, they do not know which information source may be appropriate to accomplish a particular task or to resolve a particular problem. Secondly, they may not know where and how to locate it, and finally how to retrieve the information. Current digital libraries, and the Web as well, expect users to know what they want and also expect them to formulate a query to represent their information needs, or to map their query onto the, often unknown, knowledge structure (subject directory). This is not an easy job. Moreover, users information needs are related to their tasks, and current digital information systems, such as those obtained from digital libraries or the Web, are not organized

to match the various tasks that users perform. As a result, users may often use trial and error methods by frustratingly moving from one Web page to another or from one information resource to another resulting in a waste of time and energy.

Review of Related Work

Some recent research efforts have been directed to build personalised digital library environments. Adams, Wilkins, and Zhang conducted user needs assessment study in digital environment (Adams, et al., 1995; Zhang, 1998). Marchionini reviews literature on user interfaces particularly in digital library environment and suggested to have task based digital library(Marchionini, et al., 1998). Michelle discusses about a user-centered interface for information exploration in a heterogeneous Digital Library (Michelle, et al., 2000).

Zhao discusses the Personal Digital Library (PDL) (Zhao, 1998). Barry discusses the creation of personal digital libraries(Barry, et al., 1999). The North Carolina University Library (NCSU) developed MyLibrary@NCState as a portal application to the NCSU Library's information resources (Mylibrary, 2000). *MyLibrary* is a Cornell University Library initiative to provide personalized library services to their patrons(Suzane, et al., 2000). At the NTU Library in Singapore, the Gateway to Electronic Media Services (GEMS, 2000) serves as a vehicle to deliver a range of information resources to all staff and students in the campus. HeadLine is one of the eLib programme's Phase 3 projects, Personal Information Environment (PIE), uses portal-type technology to present an information environment (Gambles, 2000). The MyLibrary and HeadLine projects are designed to provide users with links to information resources.

However, none of these research projects have adequately resolved the users' problem of the need to have a one-stop environment to meet their information needs in totality. This paper describes the general architecture and function of the proposed system, and reports on the development of the prototype DWE at NTU, Singapore. The system is based on an analysis of the various tasks of users in an academic institution. The basic tenet is that the users need not know about the existence (or non-existence) of a particular information source nor do they need to formulate a query to look for an information source. In an academic environment, the major tasks of the user community are more or less fixed and therefore, a system based on tasks rather than individual users, will be more stable and portable.

Objectives and Functions of the DWE

The main objective of the proposed DWE is to provide access to the local digital library collections, to remote digital libraries, as well as to the traditional libraries, and, most importantly, to the vast information resources on the university Intranet. The first phase of our research work on DWE based on a pilot user study conducted at Division of Information Studies (DIS), School of Computer Engineering at NTU is reported here. The proposed DWE is designed to perform the following functions:

- To take the users, as and when necessary, to traditional library resources and information resources such as school and office web sites, databases, folders, etc;
- To take the users, as and when necessary, to Internet resources and commercial databases;
- To take the users, as far as practicable, directly to the information source;
- To provide users personal space to record or store collected information or notes or favorite links or publications;
- To filter out irrelevant information resources for a particular task;

- To provide user and usage statistics to the management for future planning.

Basic Architecture of the System

Figure 1 shows the basic architecture of the DWE. The system consists of a User Interface module that is linked to the Task Maintenance, Resource Maintenance, Information Resource organisation, Statistics and User Authentication & Management modules for carrying out the various functions of DWE. The environment relies heavily on the Information Resources that are interfaced to the system to provide the input information to meet users needs. These resources are available in different forms and formats and are placed at different locations such as traditional libraries, digital libraries, web pages, databases, folders, and other locations.

The *Information Resource Administrator* is responsible for collecting information about various categories of users, various tasks that are accomplished by each category of users and information resources that are required to accomplish these tasks, as well as the necessary URLs and access information to these various resources. The administrator is therefore responsible for the creation, periodic update and maintenance of the *Task database, Resource database*, and to link the various tasks to the necessary information resources.

The *User Manager*, as the name implies, overall manages the collection of user-related information, creation of user accounts, maintenance of the User database and users personal space data in the personal database.

The *users* of DWE include all types of users of the academic community. They interact with DWE to obtain information to accomplish particular tasks that are specific to their vocation. Thus, specific user groups of users needs to be identified, along with their typical tasks and information resources in order for DWE to fulfill its role of being a one-stop centre for information to meet the varying information needs of these users.

The main modules of the DWE are briefly outlined:

User Interface/Control Panel The design of a user interface (UI) is a crucial and critical element for the success of any digital library. The Control Panel that is seaminglessly integrated with the UI provides the necessary activation of the relevant modules in supporting the functions of the DWE.

Information Resources Organiser Module This module responses to the users request through the user interface and interacts with servers in the Intranet, library home page, databases, folders and Internet resources, to bring back the needed information resources to users.

Task and Resource Maintenance Modules These modules are used by the Resource Administrator to append or update the respective tasks and resource databases. The aim is to provide a convenient means to update such information when the need arises. At the same time, it will also check and ensure the integrity of data in the databases prior to any updates.

Statistics Module This module basically keeps a log of the operational statistics of DWE to provide useful information for the administration and management of the system. Examples of statistics that can be kept and inferred include the number of users using the system during any

defined period, identification of frequent or inactive users, frequently used information resources, when individual information resources was last accessed, and so on.

User Authentication and Management Module   This module identifies user when a user login to the DWE through the user interface and interacts with user category database for displaying tasks related to that category of user. This module is used by the User Manager to append or update the respective user and category databases. The users personal database is also maintained through this module.

DWE Prototype Development

A DWE prototype based on the aforementioned architecture has been developed in a web environment in the Division of Information Studies, School of Computer Engineering, NTU. This section reports on a number of issues addressed in the development of the prototype system.

Identification of Information Resources

The NTU library is a major information resource centre for the NTU academic community. The NTU library provides links to various information resources for staff and students through its home page. Centre for IT Services (CITS) provides and manages the central IT infrastructure and services to support the teaching, research, administrative and social needs of the campus community. The MS Exchange message system, available to all staff and students through CITS, facilitates academic community to exchange information on computers, software, societies, religion, music, hobby, and so on. The various information resources such as databases, folders and intranet resources of NTU available in various offices, schools, research centres and divisions are identified for the prototype development.

Identification of various user categories

The NTU Calendar provides information on various courses such as undergraduate, graduate, research and short-term courses. The NTU Library Handbook provides information about the various categories of users. These identified categories of users are verified with a number of faculty, student, and library staff (Figure 2).

Identification of Various User Tasks

The various tasks associated with each categories of users are identified on a detailed study of the NTU calendar, University's Intranet, School of Computer Engineering home page, DIS home page, and the various brochures of the School and Division (Information Studies, 2000). The various categories of users and their tasks are identified and shown in Figure 3. The various information resources needed to perform each task and for each category of users are identified through discussions with 2 faculty members, 5 research students and 69 graduate students. During the discussion, participants were shown the various tasks and information resources collected from various sources in the university. Faculty members and students were also invited to suggest additional information resources for each task during the discussion.

Implementation of DWE

All users (Resource Administrator, User Manager and Users) interact with the DWE through a unified web interface via a URL. This section briefly describes the main issues in the implementation of DWE, namely, UI/Control Panel development, and design and maintenance of the various databases of the system.

User Interface/Control Panel Development

The Tango Enterprises application software was used for the development of DWE interactive user interface (Everyware, 1999). The DWE interface is frame-based as shown in Figure 4. The interface is divided into four frames: *Task*, *Resource Group*, *Resource* and *Display*. The *Task frame* displays the institution name, institutions' logo, a personalised welcome message, link to user's personal folder, and various tasks associated with the users' category alphabetically. The user selects the appropriate tasks from a drop-down list. This will activate the related resources associated for the task in the *Resource Group* frame. Thus, the *Resource Group frame* is used to display the various resources by group for each selected task alphabetically. Upon selecting an appropriate resource group, the *Resource frame* displays the various information resources that can either be arranged based on users' preferences or by the frequency of usage of the information resources. The final *Display frame* is used as the main information browsing window to display the content of the selected resource.

Design of the appropriate databases

The identified user categories, user tasks, and the information resources are organised in a suitable form for easy and effective retrieval. MS Access was used at the backend for creating, maintaining and updating of tables and data. Resource Administrator module includes routines to create a new category of users, to delete a user category, to update data in the resource table, to update the task table and to provide links to the resource table whenever a new task needs to be added.

Process of Using DWE

Using DWE is intuitive, simple and straightforward. A user enters the DWE URL on the web browser to be prompted to enter the user identification and password. Upon successful authentication, a personalised greeting message is displayed to the user. The user will navigate and activate the various frames of the DWE interface to select tasks, information resource groups and information resources. As an example, Figure 5 illustrates the step-by-step process of a research student using DWE on research task to get access to guidelines for writing dissertation. Although not immediately obvious in these figures, a number of information resources that are not needed for research work, for example, examination papers, course information, seminar information etc., are automatically filtered out from the display list.

Personal Folder

The DWE also incorporates a personal workspace for user to store and access various information at a later point in time. Three options are presented to the user when the 'Your personal folder' hyperlink is activated, namely, *favorite links*, *publications* and *personal space*. The *favorite links* option is used to store a user's favorite or frequently used URLs, This basically provides a convenient bookmark facility for users to revisit stored URLs, or to update or add new URLs. Links to full-text paper is stored under the *publications link* option. User can make notes on important quotes, texts or other annotations and store them in the personal space. This information is indexed using a full-text retrieval software, dtSearch, that is integrated with the DWE to support subsequent query and retrieval (DT Search, 1998).

Conclusion and Future Work

This paper reports the first phase of our DWE research and development of a working prototype for an academic community. In this phase, we have identified the user categories, their tasks and

the information resources needed to perform the identified tasks using the domain of the Information Studies Division at NTU. In the ever-increasing amount of information resources that are available over Internets and Intranets, the user-centred approach in developing a usable digital library is especially important to overcome the information overload problem by only presenting relevant information resources to meet user needs. New users who are unfamiliar with the relevant information resources for specific activities will also find DWE particularly helpful since it automatically lists these resources needed for that activity. This DWE differs from others since users have access to a myriad of information resources that are directly task-oriented accordingly to their needs. The system architecture is flexible and is designed to be adaptive in order to accommodate changes or addition in the number of users, number of tasks as well as any number of information resources, databases, folders that can be added or deleted in the information resource database. The proposed model is designed to be portable so that it can be implemented in an academic institution with minor modifications.

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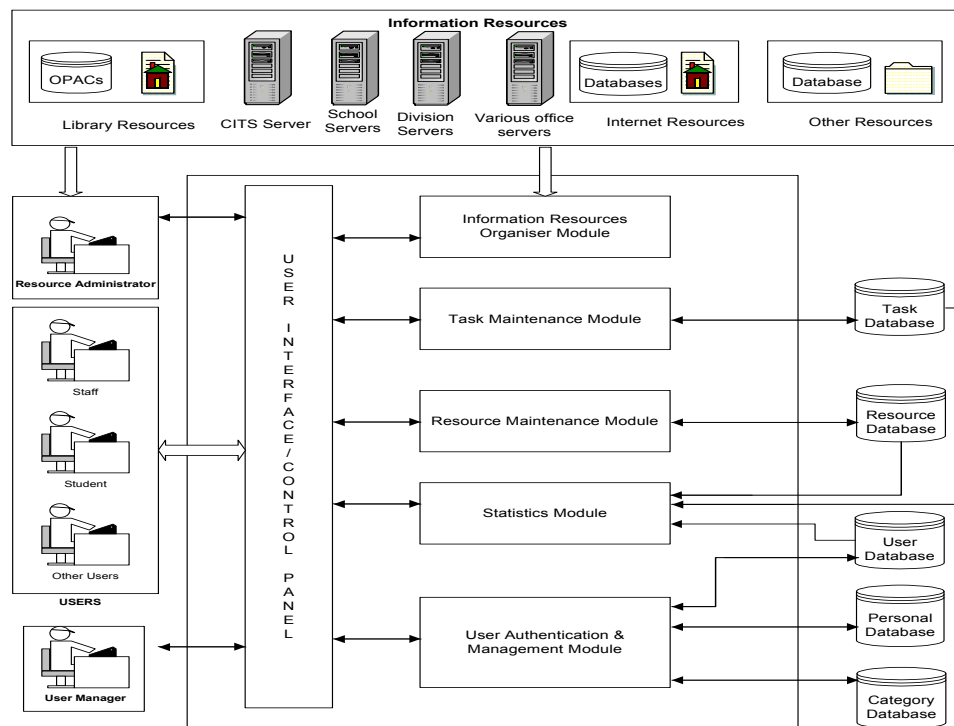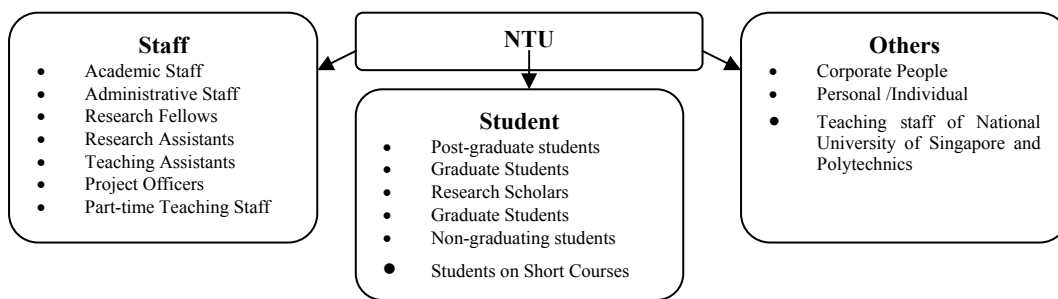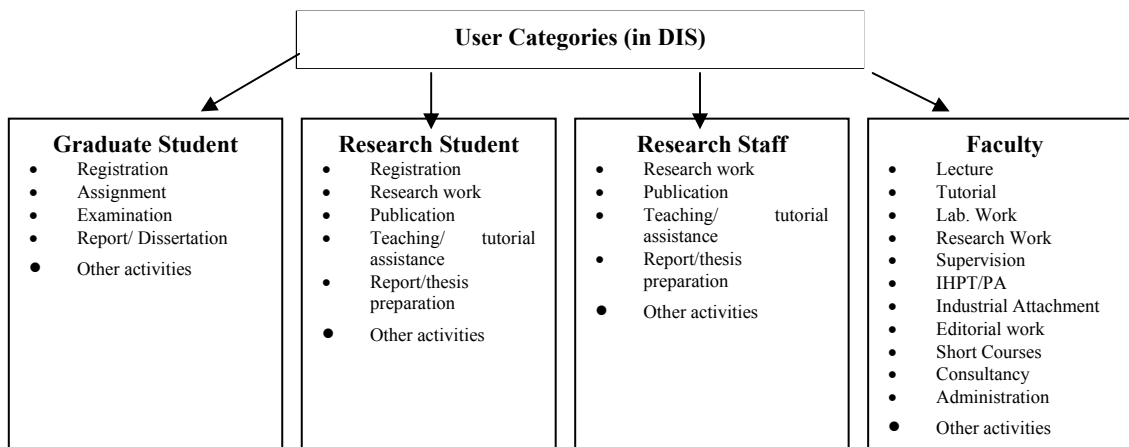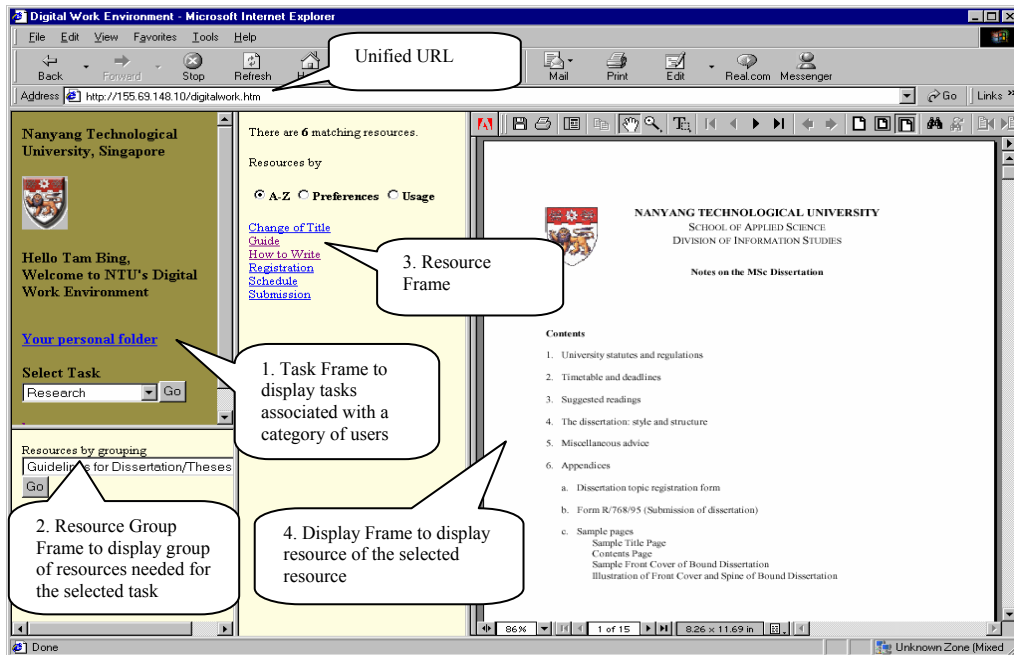
Figure 1: Architecture of DWE

Figure 2: Various Categories of Users at NTU

Figure 3: User Categories in NTU

Figure 4: DWE Interface

S.No.	STEPS
1	User enters unified URL
2	User login to DWE by giving UserId and password
3	DWE displays welcome message
4	DWE displays various tasks for that category of the user
5	User selects Research task from the drop-down list
6	DWE displays information resource grouping for the selected task
7	User selects Dissertation from the drop-down list
8	DWE displays list of information resources for the selected task alphabetically
9	User selects dissertation guidelines for display
10	DWE displays dissertation guidelines for that category of user
11	User can select any other resource or task for his/her requirement or logout from the system

Figure 5: Process of using DWE

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