A GRAPHICAL BROWSER FOR HYPERMEDIA SYSTEMS

by

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DECLARATION

No portion of the work referred to in this dissertation has been submitted in support of an application for another degree or qualification of this or any other university or institution of higher learning.
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ABSTRAK

Kajian ini bertujuan untuk membina suatu pemapar grafik sebagai antaramuka bagi menjelajak dan memilih dokumen yang dikehendaki dari suatu sistem hipermedia yang besar. Hyper-G telah dipilih sebagai sistem hipermedia bagi tujuan ini. Hyper-G adalah suatu sistem yang berupaya menyimpan bilangan dokumen yang besar dengan selamat, dan pemapar grafik bertujuan untuk menghadkan pencapaian dokumen hanya ke atas dokumen yang berguna dan dikehendaki sahaja.


Bagi pencapaian document, satu program pelanggan Hyper-G diperlukan sebagai "jambatan" diantara pemapar grafik dan sistem Hyper-G. Dengan Peraturan Pembekal Pelanggan Hyper-G, satu program pelanggan Hyper-G telah dibangunkan. Dengan program pelanggan Hyper-G ini, pemilihan document yang dibuat dari pemapar grafik akan membolehkan pengguna untuk mencapai dokumen yang dikehendaki dari sistem Hyper-G.

Di akhir pembangunan, satu ujian penilaian antaramuka telah dijalankan bagi menguji kebolehgunaaan dan prestasi pemapar grafik ini. Kelemahan dan maklumbalas daripada pengguna tentang pemapar grafik ini akan dipertimbangkan dalam kerja-kerja peningkatan di masa depan.
ABSTRACT

The purpose of this study is to build a graphical browser as the navigation interface to navigate through a very large hypermedia system looking for relevant documents. Hyper-G is the chosen hypermedia system. It is a large system capable of holding a huge repository of documents, and the graphical browser aims to limit the document access only to the useful and relevant documents.

To give an overall view of the available data and to avoid users from being "lost in hyperspace", studies on suitable metaphors or a combination of some well-known metaphors have been taken into account in the interface design of the graphical browser. It is also targeted towards building an effective and efficient graphical browser for data navigation. For this purpose issues on GUI (Graphical User Interface) and navigational features have been studied. For the graphical browser, the horizontal cone trees metaphor has been selected for the interface design. Then, all the GUI and navigational features have been incorporated into the selected interface metaphor.

For document retrieval, a client program is needed to act as a "bridge" between the graphical browser and the Hyper-G system. With the Client Server Protocol, a Hyper-G client program is developed. With this client program, a document selection from the graphical browser will then enable a user to retrieve the relevant documents from the server.

At the end of the implementation, an interface evaluation test will be carried out to test the usability and performance of the graphical browser. The shortcomings of the graphical browser and user's feedback are taken into account for future enhancement.
1 INTRODUCTION

1.1 Introduction

The advanced and rapid growth of multimedia technology has had a great impact on human's daily life. This impact is seen in education, commercials, entertainment, knowledge learning and so forth. Many multimedia applications and CAL (Computer Assisted Learning) packages have been developed to assist knowledge learning, and all these are in the process of replacing the conventional lecturing tasks. Students no longer need to obtain knowledge from text books but they can get the same knowledge plus extras from computer texts that are enriched with multimedia features. As a result, the lecturing tasks of lecturers become easier, and the learning processes for students become more interesting with all the animation, images, audio and video presentation and delivery.

In addition, the phenomenal growth of world-wide networking and data communication technology have led to new approaches such as computer conferencing, electronic distance teaching and remote learning. All these will introduce a new learning alternate learning model, OL (Open Learning) as the new learning and lecturing style in near the future. Currently, there are many universities and “Virtual Campuses” putting their educational materials like course notes on WWW [WWW] which are accessible through the Internet. Many of these notes are organised as hypermedia documents where each document can be either in hypertext or media form and has the embedded links to access another document.

Hypermedia technology is the combination of multimedia and networking technology and it is defined as the philosophy of information representation and access of information. Its’ basic concept is a model of an information space where a graph of nodes are used to store information and links represent semantic relationships between nodes. To be claimed as a hypermedia system, it must consist a large number of document nodes and links.
Million of users navigate and access to WWW via Internet every day, and the degree of sophistication of the users vary. For example, hypermedia users can be a complete novice, with little or no knowledge of computer systems or a computer hacker who probably sits in front of the computer every day. For data navigation in most of the hypermedia systems, navigation tools such as navigators or graphical browsers are used. Most of the navigation tools consist of navigational features to ease users in navigating for data. However, due to the huge structure of the hypermedia system, hypermedia users might get lost in hyperspace without knowing how to navigate for relevant data or they fail to decide which link as a follow up. Today, disorientation and cognitive overhead [Ivan91] are the two main issues in most of the hypermedia systems and many studies on data navigation have been carried out.

To overcome the problems in data navigation and visualisation in large hypermedia systems, effective and efficient navigation tools are needed as navigation interface between the hypermedia systems and the users. By using the navigation tools, hypermedia users can browse and navigate through hypermedia system for data visualisation before making any access to the needed documents. In addition, navigation tools should limit the data navigation only on relevant data. Then, the navigation tools should also provide other extra navigational features to ease hypermedia users in IR (Information Retrieval).

In developing navigation tools, the effectiveness and efficiency of the navigation tool depend on how GUI (Graphical User Interface) features and design metaphors are incorporated in the interface design. By choosing the correct UI features and interface metaphor, a better data visualisation can be achieved thus users can avoid from getting lost in navigating for data. With proper studies on all these interface related issues, an optimise navigation tool as the UI (User Interface) can be developed to ease hypermedia users in navigating the hypermedia system.
1.2 Scope Of Study
To solve the problems such as disorientation and cognitive overhead in navigating hypermedia systems, implementation of a navigation interface is proposed. The proposed environment in “Graphical Browser For Hypermedia System” provides a framework for future OL (Open Learning) courseware. The system overview of the proposed environment is shown in Figure 1-1.

Figure 1-1 System Overview Of “Graphical Browser For Hypermedia System”
In the proposed environment, a large hypermedia system, Hyper-G [Kappe93] is selected as the server to keep all the courseware. Currently, for the courseware in the Hyper-G server, only documents in text form will be considered and included in data navigation. All the courseware materials must be in electronic form before navigation interface can be used for data navigation. Easy and effective ways to prepare and maintain the documents nodes and links are needed. To communicate with the Hyper-G server, a client program is needed to act as the “bridge” between the navigation interface and the Hyper-G system.

For the design and development of the navigation interface, some suitable GUI features and metaphors for data navigation and visualisation are chosen to ease users in navigating courseware materials in the Hyper-G system. The navigation interface is in 3-D effects for better visualisation and would be more realistic to users. Some of the common navigational features like zooming, search engine and others are included in the navigation interface to assist user in data navigation, visualisation and retrieval. The navigation interface will display organised data that are user friendly in data browsing.

1.3 Research Objectives

The main aim of this study is to develop a graphical browser as the interface to navigate electronic documents that are kept in the Hyper-G server. In achieving the main aim, the following objectives are identified:
- To analyse and review suitable metaphor(s) for the design of a graphical browser.
- To analyse some of the GUI (Graphical User Interface) and navigational features that can assist in data visualisation of a graphical browser.
- To analyse and identify the protocol commands for message sending and document retrieving between the graphical browser and the Hyper-G server.
- To design and implement a prototype of a navigation tool with graphical browser as the user interface which allows user to retrieve electronic document from the Hyper-G server.
1.4 An Outline Of The Dissertation

The research work of this dissertation are organised as follows :-

Chapter 2 Provides a background literature and introduction pertaining to the subject matter. The introduction introduces background on OL concept, hypermedia systems, Hyper-G system and GUI (Graphical User Interface).

Chapter 3 Provides a literature survey to the subject matter. The survey looks into some current papers and researches on education model, hypermedia issues, navigation issues and some existing navigation tools.

Chapter 4 Covers the methodology and related steps in developing graphical browser and Hyper-G client program. Suitable metaphor is stated for the graphical browser. It also provides software and hardware specification for development work and related development steps.

Chapter 5 Gives the description of the development work on a graphical browser. Covers all the data structures, functionality and navigational features of the graphical browser.

Chapter 6 Gives the description on how to prepare a Hyper-G document and the generation of Title File, input data file for the graphical browser. Besides, it also gives the description of the development work on a Hyper-G client program. It also illustrates all the protocol commands to communicate with the Hyper-G system and to retrieve document from it.

Chapter 7 Covers description and a conclusion as to conduct an evaluation test on user interface design.

Chapter 8 Concludes the study with an assessment of the work and suggestions for future work on this area.
2 BACKGROUND

2.1 Introduction

This chapter covers necessary background on Open Learning (OL) concepts and hypermedia systems especially about the Hyper-G system. Finally, it includes some background explanation on how metaphors and GUI features are used as a counterpart of a user interface design. This is geared to give an overall and general understanding of the themes surrounding the subject matter.

2.2 Open Learning Concept

Nowadays, terms for distance learning, remote learning and open learning are basically the same, and normally the use is interchangeable. There are some strong reasons why Open Learning (OL) concept is suitable as the learning and lecturing style in education today and in the future. First, OL concept reduces the education fees, especially cost of living expenses when away from home. Second, it provides flexible learning hours, where more and more people can follow OL programme at any time to obtain higher education without leaving their jobs or career aside. Lastly, it overcomes the learning problem due to the geographical or distance constrains.

As stated in Lennon's paper [Lennon93], in comparison to the previous ten or twenty years, learning process and lecturing style have changed radically where whiteboards, flip charts and overhead transparencies have been pushed to the background. If in the past, only texts and static charts were used as teaching materials, today, computer is used to display interactive graphics, sound, animation and other elements. To illustrate the advantages and disadvantages of each lecturing style, a brief comparison of lecturing techniques is shown in Figure 2-1.

Today, for most of the learning modules, hypermedia technology has been included to assist learning. The implementation of hypermedia in OL concept is more than just work being done in networking all the computers within a lecture room with a single hypermedia system running at the background. More
importantly, all computers are also networked beyond the lecture room with multiple hypermedia systems which are located all over the world, running at the background. For example, some of the modern hypermedia are WWW [WWW] and Hyper-G [Kappe93].

Finally, with the availability of world-wide web and telecommunication technology, OL concept might allow computer conferencing or discussion in a decision room session. With all the experience gained from groupware and computer conferencing systems, all these might turn the future education into a new era where OL concept will be one of the future educational solutions.

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Figure 2-1  Pros And Cons In Lecturing Technologies [Lennon93] (adopted and modified)
2.3 Hypermedia Systems

Both multimedia and hypermedia systems are the most talkabout issues in any of the popular computer magazines today. However, the terms for multimedia, hypertext and hypermedia often cause confusion [Davies91]. In most cases, computer-based multimedia and hypermedia systems are two terms which are often interchangeable. Besides, the term hypertext and hypermedia are subject to many interpretations and are often interchangeable too. Multimedia and hypertext systems should not be confused with hypermedia systems, although hypermedia systems can be viewed as the extension of a networked multimedia system. In comparison to hypertext, the term hypermedia is used when materials are not limited to static text as in a hypertext.

2.3.1 Multimedia Systems

HyperCard for the Mac and ToolBook for the PC are among some well-known multimedia application systems. Multimedia systems allow the integration of various types of hyperinformation (electronic documents) on a computer. In addition to traditional textual and numeric data, other types of information including graphics, images, audio and video can be handled in a multimedia system in digital form. Today, multimedia applications are used in many IT (Information Technology) fields. The main applications of multimedia systems are in the area of information presentation, simulations, education, "edutainment" (education entertainment) and computer games.

For example, multimedia information presentation applications are used to present companies and institutions, as a public information terminal and in exhibition counters which provide electronic guide. Besides, multimedia systems are also suitable to perform presentations for information kiosk and museums. In some cases, multimedia systems that are using book metaphor are widely used in the whole spectrum of electronic publishing (from computerised encyclopaedias to dictionaries).

In the process of providing a combination of various types of information, multimedia systems should provide and prepare convenient access to relevant information. Various mechanisms such as simple query languages, menus,
paradigm usage like “stack of information cards” are used in accessing for information. All these various mechanisms are always combined with the notion of “link to clickable buttons” and “hot-spots” that are distinguishable on a screen. The activation of various mechanisms will then lead “knowledge in the head” [Don88], of users to associate with related information.

Most of the time, human can verbalise ideas fairly well by speaking (i.e. human can convert certain ideas into a stream of acoustic signals easily) but cannot “picturize” ideas similarly (i.e. human cannot convert mental images into a stream of images visible to other people) because human do not have an “organ to produce pictures”. As addressed in Maurer H.’s paper [Maurer], since there is no organ for human to visualise picture, the author suggested that multimedia systems should be developed and achieved to a stage where they will provide users with a prosthesis to make up for this deficiency. This will close the gap between what human eyes can see and how human can consciously feed them with images that they want to communicate. Since human can see and feel all the multimedia features, it is undeniable that multimedia systems have a significant impact on how human live, think and work.

2.3.2 Hypermedia Systems
As defined by Ivan Tomek [Ivan91], hypermedia is the philosophy of information representation and access of information. Its' basic concept is a model of an information space as a graph whose nodes store information and whose arcs represent semantic relationships. Besides, hypermedia can also be referred to as a set of technologies that deals with a new way of organising and providing associations between related pieces of information [Chua91], [Kamran93]. It evolved so as to tackle the problems of organisation and access to multimedia information. Basically, hypermedia systems consist of nodes and links. Information is encoded into small self-contained unit called nodes and related nodes are linked together using machine supported links, giving rise to an associated information network.

The example of hyperinformation base is outlined in Figure 2-2. An addition of a new document can be easily included in an existing hypermedia system by
introducing a new link from the new document to the existing hypermedia system, as shown in Figure 2-3.

Figure 2-2  A Hypermedia Information Base [Chua91]

Figure 2-3  Rapid Expansion Of A New Hyperinformation Document By Linking It To A Large Existing Document [Kamran93]
Although many systems claiming to be hypermedia have been developed, the concept of hypermedia is still constantly being defined and revised. As mentioned in Maurer’s paper [Maurer], “… the hypermedia pioneer Ted Nelson says a hypermedia system must be a large (i.e. capable of holding giga-quantities of chunks of information) networked multimedia system …”. Besides “read-only” functionality, hypermedia system must allow a multiple user environment where users can annotate and customise the information and its paths in the system. This allows the possibility of delivery user freedom to the users in exploring large amounts of hyperinformation at their own pace and according to their interests. Based on the definition by Tel Nelson, Nelson’s Xanadu, the IRIS systems at Brown University, and the Hyper-G at the Graz University of Technology [Kappe93] are some of the qualified hypermedia systems.

2.3.3 Hypermedia Systems History

The following are the major points in the history of hypermedia given by Ivan Tomek [Ivan91] and Maurer H. [Maurer] in their papers. The term hypertext is sometimes used, particular when the multimedia aspect is small or absent.

Bush is usually credited as the first person who wrote in concrete terms about a technological system (not yet computerised) called Memex, which allows storage and access to large amounts of cross-linked information to augment the human intellect. However, the Engelbart’s NLS system was probably the first version of simple hypertext systems. NLS did allow storage of chunks of information and to navigate through them using “links” and other techniques.

Ted Nelson was certainly one of the early hypertext visionaries seeing hypertext as a new universal medium for general publication. Nelson’s 1965 Xanadu project went in several ways far beyond Bush’s intentions in anticipating a global “docuverse” (document universe) in which all information ever produced will be stored in a combination of local and global storage and kept forever.

The first hypermedia project using media other than text was developed at MIT in 1978. This system known as the Aspen Movie Map, implemented “surrogate travel” through the town of Aspen by giving the user access to a universe of left-
right-front-view photographs of Aspen streets and houses taken at regular
distances by a crew of photographers. A system user can take walks through the
town, look around, back up, make turns at street intersections and even select
between summer and winter pictures.

The first commercial hypertext system was the Document Examiner developed
in 1985 by Symbolics for the company workstations. This Document Examiner
provides a hypertext interface to an on-line copy of the user manual and contains
some 10,000 nodes and over 20,000 links. However, HyperCard with limited
computer environment but extensible multimedia features had the greatest
effect on the general public. It reached millions of users since it comes bundled
with the Apple Mac computer with no extra cost.

Other well-known developed hypertext and hypermedia systems as summarised
in Balasubramanian's report [Bala94] are Intermedia (Brown University),
NoteCards (Xerox's product), KMS (Knowledge Management System by
Carnegie Mellon University), HyperTies (University of Maryland's HCI
Laboratory), Guide (University of Canterbury, UK), Textnet (University of
Maryland) and WE (Writing Environment by University of North Carolina).
Other notable systems include Hypertext Editing System (HES), File Retrieval
and Editing System (FRESS) from Brown University and MCC's Group Issue
Based Information System (gIBIS).

Both North America and Europe have a number of "genuine" networked state-of-
the-art hypermedia systems that are in a prototype use. There are Hyper-G
[Kappe93], and Nestor/Hector as European examples. Lastly, WWW (World
Wide Web) [WWW] operated by CERN (Conseil Europeen pour la Recherche
Nucleaire), is tying together hypermedia systems in the whole world including
the Minnesota which originated from the Gopher system.
2.4 Introduction To Hyper-G System

The following sections give a brief background on Hyper-G system, HTF (Hyper-G Text Format) and the first existing UNIX/X11 based Hyper-G client system, Harmony system.

2.4.1 Hyper-G System

Hyper-G is a networked multimedia system developed at the Graz University of Technology, Austria. It is developed jointly by the Information Processing and Computer Supported New Media (IICM) of Graz University of Technology and the Institute for Hypermedia Systems (IHM) of JOANNEUM Research, Graz, Austria.

It is based on the extensive work on computerising and combining large amounts of encyclopaedia, instructional and pictorial information. Therefore, Hyper-G is targeted for mega-quantities of documents and tera-quantities of bytes. As a large hypermedia system, Hyper-G will provide a strong core database of general information that will support large special-purpose databases, particularly involving courseware, digitised pictures, and a variety of textual database.

When fully implemented, Hyper-G system will offer much more than relatively simple information services, it will also provide automatic link, rich annotational facilities, messaging and computer conferencing, the use of program packages from software libraries plus more unorthodox media such as synthesised sound, digitised sound and video clips.

Hyper-G can be accessed via Internet on all the standard platforms, particularly UNIX (X-Windows) and PC (MS-Windows). Like WWW, Hyper-G is built based on a standard client-server architecture. For example, information resides on UNIX based servers that can be reached via Internet, using WWW clients like Mosaic and Netscape. However, some of the more subtle and interesting points of Hyper-G can only be exploited using Hyper-G’s “native” viewers like Amadeus (for MS-Windows) or Harmony (for X-Windows). Compared to WWW, Hyper-G system is a second generation network hypermedia system [Kappe93], [Andrews95] that was based on experience gained from WWW. As
the reason, some of the shortcomings of WWW servers have been corrected in Hyper-G system.

2.4.2 Hyper-G Text Format (HTF)

Hyper-G Text Format (HTF) [Kappe94b] is the preferred text format for Hyper-G system, that means that all current and future Hyper-G clients will support this text format. However, other text formats will become available in some future versions of Hyper-G. HTF is defined in terms of the ISO Standard Generalised Markup Language (SGML) [ISO86]. HTML [Bernes93] is the markup language used for the World-Wide-Web (WWW), it is rather similar to HTF, although there are some substantial differences.

Because Hyper-G system (hence HTF) is designed to be used together with WWW clients, it is possible to translate HTF to HTML with only minimal loss of information. There is a stand-alone incarnation of the parser called “hgparser”, that is a part of the Hyper-G server distribution that allows users to use parser to verify the correctness of the SGML markup. Besides text correction, by giving an appropriate style sheet, “hgparser” is also used to convert HTF text format to other text formats.

2.4.3 Hyper-G Client: Harmony System

Harmony [Andrews94] is the first UNIX/X11 client for a Hyper-G system. Harmony Session Manager is the core of the Harmony client program. The snapshot of Harmony Session Manager is outlined in Figure 2-4. For data visualisation, Harmony Session Manager consists of some interesting navigation tools. Some of the navigation tools are Collection Browser, Search Engine, Local Map Browser and History Browser. Besides, Harmony also has some interesting features like hyperlinks between arbitrary document types, 3-D information landscape and multilinguality.

Different types of document in Harmony are displayed by different viewers. The existing Harmony’s viewers are 3-D Scene Viewer, Text Viewer, Image Viewer, Film Player and Audio Player. For example, to display image document, Harmony’s Image Viewer is used to display the image, as shown in Figure 2-5.