Hypertext and Hypermedia: An Overview

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Abstract

The historical developments of hypertext (HT), which is non-linear text or non-sequential writing; hypermedia (HM) and multimedia; types of HT systems; their general charateristics, advantages, disadvantages and limitations are overviewed in this paper. It also lists important HT systems and HM products; their storage and distribution patterns. Problems like disorientation, cognitive overhead, lack of presentation, rhetoric and construction of default paths are also discussed.

1. Introduction

Information storage, retrieval and dissemination is a dynamic process. A number of technologies like radio, motion picture, telecommunications, computers, optical storage technology, etc have added strength in terms of sophistication, speed and accuracy. But, to retrieve the information quickly, especially when the size of information is large, is rather difficult and time consuming. So far there is no foolproof system to store all the information of human knowledge, and retrieve the same as and when required.

A record, if it is to be useful to science, must be continuously extended, it must be stored; and above all it must be consulted (1). At present only 10% of the information published is in electronic form and the rest is in printed form. It is a big problem to access the 90% of non-electronic information which mainly comes from magazines, newspapers, R&D reports, reference manuals, personal communications, etc. Above all, information doubles every few years (period varies from field to field). To store all the literature published in the world and make it easily accessible to users is a

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gigantic task. This problem has drawn the attention of pioneers in information field since the second world war.

Vannevar Bush identified this problem as far back as 1940s and gave a serious thought to overcome this situation. In 1945, he invented a technique which was later called 'Hypertext (HT)' (2). He foresaw the problem of information explosion in future and developed a mechanical recording device called 'Memex'. He described it as 'a device in which an individual stores all his books, records and communications, and which is mechanised so that it may be consulted with exceeding speed and flexibility. It is an enlarged intimate supplement to his memory' (ref 1, p 106-7). This can be considered as the first seed of the concept of HT.

In 1960s, Engelbart designed the first hypertext system named as 'on Line System' (NLS), for the knowledge workers to augment the human intellect. A number of concepts and items related to HT like mouse, windows, editing text on the screen, links between the chunks of information, teleconferencing, hypermedia (HM), office automation, outline processing, etc are some of his important contributions. Later, NLS (popularly known as Engelbart's system) was named as AUGMENT (text processing multi-user system)(3), and was distributed commercially.

Theodor Nelson defined and coined the term hypertext in 1965 (2). His book (4) can be considered as a treatise on HT and HM. According to him ordinary writing is sequential for two reasons. First, it grew out of speech and speech-making, which have to be sequential. Second, books are not convenient to read except in a sequence. But structures of ideas are not sequential. They tie together in every conceivable way. And when humans write, they always try to tie ideas together in non-sequential ways. The footnote is a break from sequence, but it can be extended (ref 4, p. 29). So hypertext is non-sequential reading and writing. When other media elements such as graphics, images, sound, video and animation are added to the HT, the resulting form is called hypermedia. In 1960s he started a project called 'Xanadu'—a global literary system (5,6) aimed as instantaneous repository and delivery system for the published works like text, graphics, audio, video, etc so that any user may rapidly get any frame or whole work. The system has automatic royalty facility to avoid copyright permission problem. Nelson had also foreseen 'computer teaching' (7).

Van Dam designed FRESS, a File Retrieval and Editing System (8) in late 1970s by incorporating the best ideas of Engelbart's NLS and some of the best features from his Hypertext Editing System. Later, under his guidance another hypermedia system 'INTERMEDIA' (9,10) was designed by Meyrowitz at IRIS, Brown University for conducting research on 'use of hypertext for teaching'.

From the mid-eighties, a number of people started working on various projects of hypertext. Presently there are more than fifty HT/HM systems designed for specific purposes like conducting research, commercial purpose, in-house use, etc.

2. What is Hypertext and Hypermedia ?

Text is an assembly of words, formed out of letters organised according to a set of principles. We use text to communicate our ideas to others either by speech/talk or in written/printed form. Though we do not think linearly, while writing we try to join or link all those ideas in a logical manner. All written communications like books and other printed publications are linear, in which text is arranged sequentially. For example, traditionally text of a

book is arranged linearly from page 1 to page X. At the end there may be an index through which one can retrieve the information easily and quickly.

When text is converted into hypertext, all the individual ideas instead of being joined sequentially, will be linked in non-linear fashion with some logic. The information is stored in the nodal points, joined through machine-generated links. This is considered to align more closely with human thinking than conventional computing.

HT consists of chunks or fragments of text, linked associatively. Nodes are the basic units of information in an HT. So, HT is creation and representation of links between discrete pieces of information (text or data). In HT, instead of continuous flow, text breaks into units or modules or fragments of information which will be linked in non-sequential manner. In HM, more than one media are arranged in HT linking pattern.

Hypertext can be simply defined as non-sequential writing (2) or as the text in electronic form that takes advantage of the interactive capabilities (11).

HM is simply the extension of HT that incorporates other media elements in addition to text. With HM systems, authors can create linked corps of materials that include text, static and animated graphics, video, sound, music, etc (10).

HT document systems allow authors to link together any information blocks created with a text editor, while HM document systems provide linking capabilities between heterogeneous blocks created with different applications such as a painting program, chart package, or a music editor.

3. Multimedia

Now-a-days multimedia is probably an over-used phrase in the personal computer (PC) world. Every new product, which involves any type of media, say sound, graphics or even text, is described as a multimedia product. Multimedia can be defined as a process that can handle text, still images, video, sound, and animated graphics (12). TV, video tapes, video disks, etc are some of the commonly available multimedia products. The advantages of TV multimedia communications and the widespread dissemination of information can then be combined with intelligent capabilities of the PC. Multimedia manufacturers are making these more attractive, but the viewer/user cannot interact with the program in the same way as in the case of HM because of the former's sequential organisation of information. Despite the feeling of being in control, the user can only watch the program but cannot interact. Some of the multimedia products like compact disk-interactive (CD-I), digital video interactive (DVI) are having some level of interaction because of their development using HT technique or some other pattern which allows the machine to generate links between information blocks. When a multimedia program is developed in HT environment, the resulting product is called Hypermedia. So, HT is a part of an interactive multimedia environment. All HM products are multimedia but not *vice versa*.

Multimedia is a general term which includes HM. The basic difference between HM and multimedia is the organisation and the linkages of the information fragments. Multimedia products are organised linearly whereas, HM products are organised non-linearly linking all the information chunks. There are quite a few companies making multimedia hardware systems. Apple's Macintosh is one of the best machines for developing multimedia applications.

One of the first and useful multimedia packages is Farallon Computing's Mediatracks which could be used to record a series of screens and use the

sound hardware to record a step-by-step guide for using any Mac software. Two multimedia projects from Europe are to be mentioned here: (i) Nordic Life Today, a full multimedia publishing platform for schools, colleges, libraries and other cultural institutions of Scandenavia, and (ii) 55 Anos Despues, tourist information multimedia system.

4. Characteristics of HT and HM Systems

- In hypertext, information (text and data) is represented in discrete chunks. The information may be a paragraph, diagram, graphics of image or a combination of any of these items.
- An HT database is formed by interlinking chunks. A chunk could be linked with another or many chunks forming a network in the HT database.
- Any document written by using HT technique is called a hyperdocument. In HT environment, the information chunks or frames will be linked within and in between the hyperdocuments.
- In HT systems, the user can navigate rapidly in either directions between nodes of the HT database. An HT user to access information by both associative and intuitive routes, irrespective of the actual location of information, or for any visible database structure.
- Users can create, edit and rearrange the chunks according to their needs. HT databases can have changeable structures which can be changed according to the author's or designer's addition, deletion or editing of the text, graphics, images, etc. It does not have a clear structure like a conventional book in which the length, breadth, etc can be defined. Moreover the arrangement of information in HT databases can change according to the user's interaction.
- At any time, a reader/user is able to see only a small fragment of information from a large HT database.
- There are no page boundaries as in a conventional book.
- To a large extent, HT leaves control of information in the hands of users.
- Unlike a printed book, HT is multifaceted, with many entry points to add or retrieve information according to the need/requirement, level of interest and learning style of the user population.

5. Types of HT

Ted Nelson has classified (ref 4, p. 32) Hypertext into five types:

(a) *Chunk or discrete style HT*: It consists of separate pieces of text called 'chunks' which are connected by links and represented in the form of footnote markers. When the user interacts with the chunks, they come out with a response and present an entirely new fragment of information related to the previous one. Using these 'jumpable connections' one can provide detailed explanations for a word, phrase or topic. This is an entirely different way of presenting information compared with traditional sequential form. While constructing this type of database, one has to provide these links logically, artistically and also according to the subject relevance through which a reader can grasp, understand, and assimilate the knowledge easily.

(b) *Collateral HT*: For two types of data structures, creation of collateral HT is possible. It may be useful to compare collateral equivalents of two tables of contents, writer's notes, etc. Creation of multiple viewable links in between any two data structures is called 'collation' and the structures are called 'collateral structures'. When comparing two definitions or laws on the same screen, it is

very easy to draw conclusions. Moreover, the user absorbs quickly by seeing those definitions or laws simultaneously on the screen.

(c) *Stretchtext*: Here all the related prose is written closely. It is very easy to use and has advantages of descreteness and looseness. In stretchtext, the screen will show two 'throttles', the first one moves the text forward and backward, up and down on the screen; the second throttle causes changes in the writing itself. This is completely controlled by the user. The text can also be changed with the throttles connected to the computer. Stretchtext can be made longer/shorter by adding and substracting words or phrases respectively. The gaps between the phrases can be used to pop-in new words and phrases like a cartoon picture. It is read by the user/students from the computer screen.

(d) *Grand HT*: It consists of 'everything' written about a subject or relevant to it, tied together by editors, and the users can navigate in all the directions and read the information according to their choice. There are different pathways of thinking. Ted Nelson's Xanadu is the best example of grand hypertext system, in which one can read 'everything' and also write on the screen.

(e) *Specific HT*: It is specifically written for a particular purpose in a specific area, consequently the usage also will be limited to a specific type of clientele. For example, Anthological HT, where all the materials are brought together and arranged like in an anthological book.

6. Classification of HT and HM Systems

We can classify the Hypertext and Hypermedia systems according to broad classification, environment or generations.

6.1 Broad Classification

Conklin has classified (13) all the available hypertext systems into four types under the broad classification.

(a) *Macro Literary Systems*: These systems are similar to very large size outline libraries in which all types of information on every topic will be stored and can be retrieved. The broad based systems like Memex, Augment, Xanadu and Textnet were designed for the multi-user environment, where one can store all types of published information. They could also be used for various purposes like publishing, reading, collaborative works and criticism.

(b) *Problem Exploration Systems*: These systems are basically issue-investigation type, designed to support high interactivity and unstructured thinking. They are developed to assist the members of a team in creating and structuring of information. These systems have built-in ability to handle large unstructured chunks of information and allow the user to focus, browse and organise the concepts. These systems assist the users with such mechanisms by providing information lenses to filter the various levels of details. They also permit the user to see differing views of the same information. Examples include PIE, IBIS, Synview, WE and Outline Processors.

(c) *Structured Browsing Systems*: These systems are almost like systems described at (a), but smaller in size and are being used for computer-aided teaching, reference, and public information. They are simple, user-friendly, and very easy to use. Examples include KMS, Info, HyperTIES and DE. Normally these systems are read-only type and will not allow the user to add new information because they are meant for providing information only. They are being used in museums (14) for information displays (HyperTIES), com-

puterised information management systems (15) for aircraft carries (KMS/ZOG) (15), and online computerised help systems (INFO) (16). These systems can be used at any place where well-defined information has to be provided.

(d) *Modified Database Management Systems (DBMS)*: Now-a-days a number of DBMS packages are coming with simple HT linking features. To make DBMS software useful and attractive, the designers incorporate the flavour of HT technique, but they are not real HT systems. Normally we find such features in the currently used software for information retrieval purposes where data pointers merely increase text retrieval facilities. They are retrofit systems rather than true HT systems.

(e) *General Experimental Systems*: There are a number of systems developed for experimentation of reading, writing, collaboration, etc aspects of HT such as Intermedia, NoteCards and HyperCard. Even though they are strong in some aspects of HT, they are very general in nature and could be used for any work.

6.2 HT and HM Classification with Reference to Environment

(a) *Distributed Systems*: Normally these systems are very powerful and are able to handle very large volumes of information. Since they are multi-user systems, they allow a number of users to work at a time in doing collaborative work. Intermedia is a good example for this type and is being used for computer-aided instruction at the English and Biology Departments of the Brown University for the past three years. Other examples include NoteCards, Neptune, and KMS.

(b) *PC-Based Systems*: These are single user systems, comparatively small in size and could be used to design personal HT applications. The most popular example of this kind is HyperCard. Others include Guide, HyperTIES, and LinkWay.

6.3 Classification based on Generations

Despite the commonality in the basic architecture of the HM systems, they are classified into two generations (17). All the first generation HM systems originally developed on mainframes, mainly focussed on text nodes and user display technologies with little or no graphics capabilities. However, they were developed to support work of a team, sharing a common HM network. These systems were developed prior to 1980 and include NLS/Augment (18), FRESS (8) and ZOG (19).

Those developed after 1980 are second generation systems—which include various workstation-based, research-oriented, and PC-based systems. The first category systems include NoteCards, Neptune, Intermedia, PlainText and KMS. These systems have got advanced three-dimentional graphics interface, strong support of graphics, animation, composite multimedia nodes, sophisticated navigational displays and interface tailorability. They were basically designed for single users or small teams of workers. Later, PC-based HT systems Guide (20), HyperTIES (21), LinkWay (22), HyperPAD (23), HyperDOC (24) etc have emerged.

7. Advantages of HT and HM Systems

HT is a pervading concept in the present computer world. The most important advantage of these systems is the ease and speed of browsing through greater volumes of information. One can also add personal annotations (25), without altering the original information of the document. The information in these systems may be viewed in varying degree of details. In case of larger HT

systems, greater economy of information storage could be achieved. Normally in very big databases, there will be a lot of information duplication at many places due to the inaccessibility of same information. In HT databases all the information is stored in basic units. The inter-linked information is easily accessible, so one can eliminate the repetition of same piece of information at more than one location which ultimately saves a lot of storage space of the computer. These systems encourage highly collaborative work environments (26,27) (for example, Augment (28), Intermedia (29), KMS (30), Neptune (17), NoteCards (31), and WE (32). Hyperdocuments are always dynamic and encourage the users to contribute their knowledge and ideas. The advantage of this function is that both users and authors can refine and also add new information to the system all the time, with a result the information in the system will always remain updated when compared to traditional databases. It is possible to provide comments, criticism, discussion, etc on a concept or topic by various people which ultimately lead to development of critical thinking in the users and are very useful for any research.

8. Applications of HT and HM Systems

These systems find applications in the following areas:

- Technical documentation, for example, DE, ThothII
- Help systems, for example, Emacs, INFO, HyperCard, Guide, askSam
- Museum exhibits, for example, Kings Herald's Dream, Jewish Heritage, HyperTIES
- Religious studies, for example, The Bible Library
- Problem solving and idea processing, for example,IBIS
- Software engineering, for example, CASE, Neptune
- Authoring and designing tools, for example, Hypercard, Guide, HyperDoc
- Collaborative writing, for example, Intermedia, WE
- Writing aids, for example, WE, Notes
- Instructional aids, for example, Hypercard, HyperDoc, LSM InfoMaster, etc
- Computer-aided training/teaching, CSILE, IRIS's INTERMEDIA
- Presentation aids and information kiosks, for example, Boston MacWorld, LITA Conference Information Disk, Metacatalog (multilingual information kiosk)
- Information and retrieval systems, for example, HIRS, HyperDoc, KRS, IBIS
- Library and information handling sources/services:
  - Dictionaries, for example, OED, Webster's Dictionary
  - Encyclopedias, for example, Grolier's Electronic Encyclopedia, Compton's Multimedia Encyclopedia
  - Medical text books, for example, Dynamic Medical Handbook
  - Product catalogues, for example, The Savings Zone Club Disk
  - Online user manuals, for example, HyperCard
  - Electronic maps, for example, HyperMap, Business Class
  - Travel guides, for example, Glasgow Online.
- Literary collections, for example, Xanadu, Textnet
- Electronic document publishing (considerable cost reduction in publishing, reproduction, and distribution)
- Expert Systems (+Hypertext), for example, KnowledgePro, Plus, HyperBridge, MacSmarts, 1st Class HT

A number of American libraries are already using HT for providing library and

information services to their users. Apart from special and university libraries, a number of public libraries also started using Hyper Card and other HT systems for providing services to the users of their libraries.

8. Drawbacks and Limitations

8.1 Superficial Problems

Temporary in nature, these are implications or technological drawbacks, that are common to any new technology. These include problems related to the structure of HT, learner control, integration of and synthesising information, retrieval of information, processing strategies of HT, retrieval of iconised nodes, copyright, compatibility, etc.

8.2 Deep Problems

These problems are more stronger which may take long time to solve and sometimes they may not be solved at all. Presently there are four such problems which overlap each other.

(a) *Disorientation*: The tendency of users to get lost in a HT database is termed as disorientation. This tendency depends on the size of the database; the bigger the database, the easier to get lost. Inspite of page numbers, chapter headings, sometimes we loose the sense of location while reading a book which is normally very small in size when compared to an HT database. In an HT database, the information is neither sequential nor it has the pages to flip through. So, it is easy to get lost. In case of multimedia environment, this problem is more severe because each medium may have its own cycles. Some of the HT systems are providing aids to overcome the problem of disorientation, for example, Find and Goto commands, bookmarks, database maps, location indicators, etc. But these are not permanent solutions. Research is underway to develop solution to this problem. (33-35)

(b) *Cognitive Overhead*: Even though users familiar with a particular network do not experience any disorientation, working in an HT knowledge base curtails some extra 'cognitive overhead' (36). An additional effort and concentration is required by the user to maintain several tasks or trails at the same time. Psychologists have found that a normal human being can maintain at the most five to nine thoughts in his memory at one time, whereas HT and HM systems require occasionally more. If the information is not properly organised and linked between the related chunks, the nonlinear representation leads to greater risks of potential intellectual digestion, disorientation and cognitive overhead.

(c) *Lack of Presentation Rhetoric*: Landow has discussed (37) the need for a rheotoric of linking in HM. Indication of the destination of a link, and inviting the user to that destination are the two problems according to him. He has formulated nine rules for creating meaningful links in HT database to have logic or relationship among nodes. HT systems are useful only when there are balanced number of linear and nonlinear links, otherwise they lead to more distortion. The number of linear or nonlinear links will depend on the knowledge/information being stored, the objectives of documentation, and sophistication of the user population. Large size databases, have more links to integrate the chunks which leads to 'nodal or linkage explosion', i.e., distortion. In second generation HT systems, this problem was taken care by aggregating sub-networks into composite nodes which have chunk material on a higher level of abstraction. But creating another dimension of hierarchy complicates the representational architecture and, unless implemented in a manner

transparent to users, may increase disorientation and cognitive overload (17, p.99).

(d) *Construction of Default Paths*: This problem is also related to rhetoric experienced in the construction of very big HT databases. Construction of required links itself is a time consuming task and creating default paths requires more time. Thus this becomes a major constraint in designing a sophisticated HM system.

9. Storage and Distribution of HT and HM Documents

The main problems in storage and distribution of HT and HM systems are their size and multimedia nature. Since these have graphics, photographs, animation, sound, etc they normally require very large disk space, which often exceeds the memory of large computers also. For a simple HT system, memory of a microcomputer is adequate whereas the same will be inadequate for HM. In general, most of the HM systems require an external storage device for storing and usage. Some of the storage and distribution devices include magnetic disks, video disks , optical disks, and online networks or bulletin board systems.

10. Conclusions

There is no doubt that HT has created a new revolution and opened a new way of presenting the information. At the same time, many people, especially computer scientists, believe that HT concept is a breakthrough in the computer world; something comparable to the invention of printing machine. Research is in progress to add new strengths and facilities to HT and to overcome the problems. HT is overwhelmingly accepted by many of the computer users in almost all areas. No valid and verified guidelines are available for designing the HT materials. Effective guidelines are necessary to assist in creating useful materials. Empirical studies in all the related fields of HT could be conducted to develop appropriate guidelines to make use of this technology optimally. The speed in which the research is going on, one can expect that they will be available very soon.

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