Design of Supporting Tools to Simplify the Learning Process over the Internet

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ABSTRACT

Virtual navigation through the Web has problems of positioning and space-temporal reference
design some computer-aided tools to help the user position him/herself in space and time during a navigation session. The user is provided with a map of visited sites, thus giving an explicit representation of virtual space. Various levels of visualization are set up to make the map more visible and less overloaded. A permanently displayed time indicator enables users to keep an eye on themselves and thus to optimize navigation time. To help users surmount the other difficulties faced during the use of the system, we developed a distance learning educational server.

KEYWORDS: Web, virtual navigation, hypertext, navigation maps, time indicator.

1. INTRODUCTION

The information and communication technologies, on which new training and learning media are based, have improved the transmission and access of data. But they did not facilitate enough the interaction between the user and the information. This interaction is very important factor for someone who is trying to learn. Until now the new Internet technologies are taught of to improve the speed of access and the quantity of information accessed. There is a need to develop tools to help the user interact with the huge information available on the Internet. In this context we propose a set of computer-aided tools to ease the process of interaction and understanding of the user who is absorbed by the web.

2. OBJECTIVES AND APPROACH

In a previous work [3] we conducted a survey to build an educated point of view among the general public about the use

opinion is developed and grows as they use the Internet, and measure how their opinion is affected by making the browsing simple. We are especially interested in the user interface for distance learning. We started our work with the following hypotheses.

1. A negative opinion about NTIC and a resistance to their use.
2. The use of NTIC is very limited.
3. A favorable opinion after their use.
4. The simplification of the browsing mode helps to spread the experience.

The data collected concern the user opinion about education in presence or distance; problem faced during the browsing, role of helpers in places where the general public can access the Internet, and the effect of the research team members. The concerned population is made up mainly of school children and adult pursuing professional education or just looking to improve their general knowledge.
We used the following methods: direct observations, queries, interviews, and examination of products and services used or rejected. The analysis methodology is based on time management (sequential or parallel), space representation and the usage strategy.

3. VIRTUAL NAVIGATION DIFFICULTIES

The Web is an open, evolving, heterogeneous and non-moderated space of information. It has problems related to any navigation in a large hypermedia system. Also it contains problems specific to choices and routing through heterogeneous information [1].

Problems faced while browsing the Web can be characterized as disorientation and cognitive overload [19].
Disorientation [17] is due to the fact of loosing the link between the subject being searched for and the information shown on the screen. Disorientation is caused by the absence of reference points that the users can use as they travel through the Internet. They need to know where they came from, where they are and how to move from one place to another. Three types of problems have been observed:

1. The users do not know what to do due the fact that they do not know how a hypertext system works.
2. The users are unable to understand the concept of the system.
3. The users have lost the navigation link.

The cognitive overload happens with a user who has only a screen to work with. This user has to know the information shown is associated with what. Many decisions have to be taken while going through a hypermedia: which link to follow, how to

retrieve the ones that are of interest among the links already visited or to be visited.

The user should be able to find the information being searched while moving from one page to another by following the different links. These tasks of searching for what is needed require accessing the information in smart way. This means that we need to have the capabilities to go from one place to another, identify the document reached, evaluate it, to save it or memorize its address, and relate to other documents and information.

It is very common to notice that during the use of hypermedia, the user, after few minutes of search, does not know where he really is with respect to the different notions he went through. We reach a point where we start to move from one page to another or from one site to another without gaining anything new even if some pages and/or sites may contain relevant information. This is not going to improve the knowledge of the learner [16].

Working with World Wide Web may lead the user, from one link to another, to a page that has very little to do with the subject being searched for. The information read, that is not related to a specific cognitive project is forgotten very quickly. Meanwhile we forget other pages that we have consulted earlier which contained information that is of interest to us. We activated a link that we taught it would lead us to more information about the topic. This action took us further away from the subject because we kept following other links. Before we noticed it, we lost track of the pages that interest us. After a half-hour (or so) of search, we turn off our computer with the impression that we went through a lot of material without learning any thing new.

Computerized Answers to the Difficulties Faced

The users have shown their unhappiness about Internet exploration. Especially about the time they spent and corrections of routing (links) to move from one server to another. They are aware that there is a limited knowledge of the use of computers locally. According to them, in order for this development to succeed, once the research team leaves, there must be a way to keep in touch with the experts. This point is very important, because it shows that the development of a local Internet culture depends on the capacity of the user to move from a situation where the experts are present to a situation where help is available but from a distance when needed.

This last point seems to be one of the most important things learned from this research because the use of NTIC will depends on it. The experts can not be present at all times in all places. Also the move from help in presence to help from a distance which is a particular form of groupware between one or many experts and one or many users is a necessary condition for the development of NTIC.

This is not limited to the use of a file or a Web site from a distance, because the notion of distance is transparent to the user. But it is extended to the case when the user realizes that he is physically alone and he needs someone to communicate with face to face to get help. Researchers in the area of distance learning have studied this problem few years ago. These researchers have shown two main factors: anxiety of loneness and the inability to organize the work [13]. But since than few more factors have emerged [15]. These mainly concern the individual abilities such as:

1. The ability to identify the communication tool being used from a distance
2. The ability to choose based on the situation the mode of communication, which can be synchronous or asynchronous, point to point or multi-points.
3. The ability to evaluate and manage the time while using the multimedia [8].
4. The ability to describe the problem very precisely and clearly in the communication language. This point is very important in the development of NTIC, which assumes that the users are very competent in the communication language.

We assume that these competencies are acquired by experience and/or by training. This will help to eliminate the two major handicaps mentioned above. Concerning our situation, our users consult with us very often while we are present and they will have our support from a distance when we leave their location.

4. NAVIGATION HELP

Navigation help can be of two different ways:

The first way is concerned with the construction of web sites. A construction method should be adapted to make it easy for the user to access and search the sites. In [16] for example, the author proposes to limit the depth decomposition of the page to four levels. This means, only three nodes can be active at the same time. In addition, each screen should have about five active links. In order to be clear and efficient links to general ideas of dependant information are favored. This approach of construction will result into hypermedia with a simple structure, which is more efficient. The inconvenience of this method is, the user has to split for example a design of complete course into subsections which are accessed separately. But we can always links these subsections to each other indirectly.

The second way is to provide a set of computer aided tools that will allow the client user to navigate the web with ease using his/her preferred browser. The general browsers, Netscape or Internet Explorer propose some functionality such as history, and bookmarks but these kinds of help are insufficient for user needs. In addition, the users of a hypertext system create different representations.

Many computer-aided systems to help the users to browse the Internet have been proposed in the literature. Among them are Nestor [24], Broadway [7], FootPrints [23], Hypercase [12], and Letizia [10]. A comparative study of some of these tools is available in [7]. Nestor and Broadway are the closest to our design of computer aided tools to navigate the Internet.

NESTOR browser is developed by CNRS-GATE laboratory and it is similar to Netscape or Internet explorer. It runs under Windows 95, 98 or NT on personnel computer. NESTOR main screen is divided into two windows. In the right window a classical browser based on the component Active X Internet Explorer is displayed. A graphical and interactive help window is displayed on the left. A map is drawn automatically as the user browses the Internet. The user can edit this map, and can use it to go directly to a site that he visited before. This navigator is built to achieve the following two main goals: help the trainee to become an active leaner and make the browsing easy because most of the users have little experience with Internet. It is important to help them make full use of their experience [24]. NESTOR is a complete and excellent navigator. It is a very good tool to build the navigation map. However, NESTOR is plate form dependent, it works only under Window with Internet Explorer. Also it does not keep track of the time factor.

Broadway is a computer-aided tool for navigation of the web that uses case reasoning to recommend pages for visit according to the behavior of the current user. Broadway can be accessed by

a group of users and supports indirect cooperation. The system

These parameters describe the address, the content, the explicit evaluation and the ratio of display of each web page visited. Thy will be the base to extract useful cases to be used in the future. The evaluation of a sequence of pages gives an indication of the behavior of the user being observed. The index model used allows the modeling of these types of cases. Broadway is extended with a new tool that keeps track of the user behavior in a large number of variables. A detailed and flexible behavior management is possible due to the extensive observation combined with the indexing model [20]. Broadway does not include the navigation time as a user parameter. But it remains a very good tool to model the user behavior during a browsing session.

5. Description of NaVir System

In order to allow the user to keep track of time and to know where he/she is, we have designed and implemented a computer-aided system for virtual navigation of the web called NaVir. This system which is implemented in Java can be used with any browser (Netscape, Internet Explorer or other). The main screen is made up of many windows. Its kernel is made up of two important modules: one is to collect the different URL addresses and the other is to build and interact with the graphical map and the management of navigation time [5]. The user has access to a dictionary containing the frequently used words in Internet that may not be understood. Also help for the system can be displayed in a separate window.

Software Architecture

In order to guarantee that our system is independent of the browser, the way we recuperate the addresses of the sites/pages visited is using a proxy server. This proxy server seats in between web clients and information servers using different protocols. It is used to pass the information from one end to the

server which will respond directly if it has the information in its cache, or it will pass the request to the destination server. The proxy server keeps a copy of each document it sends in its cache. This copy is kept for variable amount of time. This way if a document is requested and is available in the cache of the proxy there is no need to get it from the destination server. The management of the cache is done based on the following parameters: date of the last time when the document was updated, maximum time that a document can spend in the cache and for how long has the document been in the cache without being used. This service which is transparent to the user, makes the responses to the user requests more efficient. It also reduces the traffic on the network.

The proxy server receives the requests from the browser, rearrange them if needed and sent them to the module that is responsible to build the map. This server is installed locally on

browser has to be configured to use this proxy server. Each HTTP request will be intercepted and sent by the proxy after extracting the necessary information (address requested, elapsed time since the last time this address was requested) and saves it. This data is stored in a file that will be used by the module responsible for building the map later on.

Graphical Map for Navigation

The development of a graphical map and its use as a computer-aided tool for web browsing is based on the studies of cognitive processes that happen during the navigation of distributed hypermedia. It is a graphical representation at the same time of conceptual and geographical search path followed by a user while searching for a particular topic. The Navigation map that we designed is based on the idea used in conceptual maps [6].

A conceptual map is a new way of representing the relationship between a set of knowledge and the nature of this relationship. It is a graphical representation of links among different concepts about the same topic. It should evolve with the knowledge of the trainee.

The conceptual map is also a computer-aided tool for navigation. It allows a hypertext reader to see on the screen the titles of information units and the links that connect them in a form of a network. It is drawn with a goal in mind, within well-defined references, and according to a graphical representation suitable for browsing problem.

Classification of Graphical Representations

Browsing the Web implies the manipulation of huge amount of information. The major role of the graphical interface of system developed for this purpose is to make this information easy to comprehend by the users. This is based mainly on the graphical representation of the different pieces of information and the relations connecting these pieces together. The graphical interface between the users and the system is a way to construct the image of the system. A review of the literature indicates the existence of many graphical representations. So it is necessary to study and classify these different representations.

The taxonomy developed in [21] is based on the notion of the e

of actions (direct or indirect selections), their levels (single, group, and attributes and objects integrity) and their effect on the graph, on the representation and the transformation or organization of the objects selected.

The study proposed by [9] classifies representation techniques in five categories: geometric, network based, hierarchy, pixel oriented, and iconic. This approach has the disadvantage of mixing construction and graphical tools used as classification criteria, which makes it very difficult to characterize some systems.

The approach described in [18] is based on the type of data represented and the low level task performed by the user on this data. The author then listed different graphical representations used for each type of data. He also identifies seven task types that the graphical representation should favor. The high level tasks that are independent of the data being manipulated are: general view of the information, zooming, filtering, getting the details, link representation together, having a history of actions performed, and extracting part of the information so that it can be used by other applications. Three of these points (general view of the information, zooming, and getting the details) are considered during the conception of the representation.

IN [4], the authors propose to characterize the graphical representation based on a chosen point of view about the data but not on the type of data. A point of view is defined by deciding what is necessary out of the data that should be given to the users based on his needs to perform his task in a satisfactory manner. If we are unable to characterize in a precise way the

flexible enough to detect one or many points of view that are suitable to accomplish the task. For a set of data we might have more than one point of view depending on how the data is considered. These points of views might complement each other ry to be able

to represent simultaneously many views which means we should

choose a graphical representation guided by multiple points of view. This corresponds to multiple views discussed in [11] and [22]. This multiplicity should be taken as a factor during the design of an interface that can adapt itself to different tasks.

Choice of Graphical Representation

The navigation map gives the possibility to keep track of path followed by the user while browsing the web. The map is modeled by a directed graph. Each page address (URL), the topic or title of the page, and the time spent connected to this page are kept in the nodes. The map is displayed upon request of the user at any stage of the browsing.

A directed graph representation of the map is most suitable for its visualization. Each node contains the name and the information of the page visited. The information kept should be in such way that it does not affect the clarity of the graph. The nodes are connected to each other to indicate the fact that the user has moved from a specific page to another. The nodes should be displayed on the screen in a way that all are visible and with minimum edges intersection.

To choose the best representation of the map, we looked into different techniques (available in the literature) to display graphs. Also we kept in mind the specific properties of our graph and the different operation that are performed on it. We found that the circular graph representation is the most suitable for our case. In this approach, all the nodes are drawn on a circle. The information represented in the graph is very easy to read. The nodes do not touch each other, and are uniformly distributed over the circle. The edges may cross one another, but the intersection is concentrated around the center of the circle. It is very clear which edges are coming or going out of a node. The user can modify this representation as it is explained later.

Manipulation of the map

In addition to the automatic graphical map generation representing the visited pages, the system allows the drawing of the map from a list of identifiers of pre-selected pages. Also the user can follow the map evolution by creation, deletion of any link or reorganization of the graph, or do only a read of the map for a simple task. All actions that are performed and amount time spent on each page are saved and used for evaluation. This information can be shared among a group of users.

The navigation notion through the web can take another meaning if we make a space correlation between the graph containing the web addresses and a geographic map. The zooming idea starts from here. We propose many zooming levels to make correspondence between different extension of Internet addresses (.com, .edu, .fr, .ae, etc) and countries on the geographic map. Different sites having the same extension represent states, pages of the same site represent cities of the same state. This leads to a better comprehension of the Internet hierarchy and helps the user to locate himself within the network. Also the same way we keep track of the time spent during a navigation session can be done for a page, a site or a set of sites with the same extension. The cognitive overload problem is solved by the possibility to do a map zoom (or part of the map) to be able to hide or unhide different details. Also the user can display many graphs corresponding to different zooming level: extension graph, graph of visited sites, graph of pages of the same site, etc.

The graphical map can be displayed in three different modes to simplify the comprehension of Internet navigation. The first is *extension* mode used to group sites according to their extension. The nodes of the graph represent all extensions of sites visited. The other two modes are *site* mode and *page* mode. They are accessible by clicking on the desired node. If we wish to see all sites visited that have the extension <<.fr>>, we just click on the corresponding node. The graph displayed represent all sites visited and which have extension <<.fr>>. Each node of this graph represents a site. If we want to visualize all the visited pages of a particular site, we click on the corresponding site. The nodes of newly displayed graph represent the pages.

At any moment it is possible to go backward by clicking on back button. When we are in *page* mode, we can recognize the complete address and title of a node by simply clicking on it.

Actually to make the comprehension easy a coloring system is adapted. The node colored in green represents the first site (page if we are in *page* mode) visited by the user. A node colored red represents the last site visited. The intermediate sites are colored orange. If the first site visited is also the last site then it is colored in gray.

The user has also the possibility to save, print or reopen the map constructed during a navigation session. He has also access to the log report during a session that will allow him to do a self-evaluation and to be able to follow his progress during a training period or a search for information. It is also possible to have report indicating the daily interactions and the time spent connected to each site. The graphical map can be used to share information within a group of learners in a cooperative learning environment [24] [7]. Each user can benefit from the experience of the other members of the group [20].

6. NAVIGATION TIME

Internal Clock and External Clock

According to [14], people do not manage the time the same way while using a media to learn or to just get information. Some users manage their time efficiently but others do not. In this regard people act in different ways. There is a huge difference in the estimation of time spent browsing from one person to another. Certainly our interest in the message being read and our motivation for browsing the Internet play a major role in our time estimation but there are other factors related to the communication tools which also influence our intuition. These observations suggest a dual notion of the time. On one hand each media has its own internal clock, on the other hand the users have their own notion of the time based on the interaction with this media.

Actually there are two kinds of speed (which imply that there are two amount of time for this execution) related to the execution of any phenomena. The first time is the universal time measured by our watches. This is the real time. The duration of the execution of phenomena is equal to the difference between its start and completion times. The second time is the time estimated by the user. This time does not have any mathematical

perception of the real time.

Our mathematical values loose their significance because we have a deformed perception of time. We can not define a response time in an absolute way but we define it based on the time that we perceive. While using a graphical interface, the manipulation is done in a direct way via the interface objects (keyboard, mouse, etc.) in response to these actions the represented objects change to inform the user that the event has taken place. These requirements are generally taken in consideration by the software developers. But the time dimension is rarely considered by most applications such as the available web browsers.

Time Panel

In order to give to the user the ability to be aware of the time spent during a browsing session, we added panel on which the time is displayed. When the user starts the system he will be asked to enter the expected time to be spent. Once the time expires the system will inform the user by displaying a message. Then the user can decide what to do next. The choices are continue the browsing, save the information find so far, or quit. Actually the user can request the system to display the total time spent on each node.

7. DESIGN AND IMPLEMENTATION OF AN EDUCATIONAL ENVIRONMENT

Educational Server

We have developed an environment to experiment with distance learning. The system offers to the users a set of courses and a graphical interface to access the system and communicate with each other and/or with the instructor. We designed the system

Internet from their locations, which might be home, learning centers, public libraries, etc. The system is made up of a server for different educational activities (courses support, presentations, images for illustration, and exercises for evaluation) accessible to the general public, trainee and tutor to access the server, communicate and cooperate.

The trainee can contact the teacher via electronic mail from any web page. The user can ask questions, access the questions frequently asked, and read the answers.

The educational server is structured in a set of practical sessions whose content is in accordance with the teaching of technologies for information and communication (data and documents management, Internet tools, multimedia, and web site development). Each course is composed of chapters, sections and paragraphs. Also for each course there is on line a table of content, a presentation page, access to the subject index, and the bibliographic reference list. The movement from one place to another is done using buttons. The educational server has to follow a graphical and pedagogic chart prepared before hand.

Guide of Educational and Graphic Design

The quality of an educational site depends mainly on the organization of textual and graphical information, the browser flexibility and the level of interactivity. The guide of educational and graphic design containing a design plan and a set of recommendations is provided to simplify the task of the site designer. This guide is created based on our own experience in sites development and the analysis of many web sites.

The pedagogic concept is used to structure the content of the page in a way to make the learning process easy. This helps to reach the educational goals and solve the problems raised by the users. It is done based on many phases: identification of specific objectives for the training, setting goals, structuring the content in logic training units, development of a complete scenario of a site, design of the complete chart of navigation and logical links of the site, and construction of a page model. A prototype is built so that we can have a uniform presentation of the different semantic units of the site.

8. EXPERIMENTS

These tools presented here were in response to certain browsing problems. There are a number of computer-aided tools that give the possibility to the learners to experiment. We concentrated on the problem of disorientation and putting some reference points.

During the experiment, the use of usual browsers, such as Internet Explorer or Netscape, by novice users while solving a pedagogic task, is observed.

We have tested the set of tools developed in a real practical sessions in cooperation with a teacher and his students. This testing was done in a course about the new information and communication technologies in general and about the web in particular. There were about 100 second year university students, aged from 19 to 22 years. Their major is earth science and all had some experience with some browser. They used the Internet to search for information before. This is a limited experience because we have only the strict minimum needed equipment. Also the connection equipment is not suitable for heavy use.

The experimental environment is made of:

1. Free access to the educational server (self-learning mode) as a complement to the course taken in a regular class.
2. A guided access to the course according to a plan, prepared by the teacher, which is made of a set of documents on the educational server and some links to public documents available on the web.
3. The collection of information about a particular topic from the Internet and the structure of this information into a personnel or group document will be submitted to the teacher using the browsing map.
4. The time panel is used with the browsing map to limit the time of search and access of information.

The use of the browsing map has given the students the possibility to structure their knowledge, recognize their limitation and to have a graphical support that can be used to prepare the plan how to search for the needed information. The proxy architecture made it possible, while using the tools, to display on the screen the browser on one window, the sequence of site and the navigation map on another. This solution helps to reduce the cognitive overload of the users.

For the teacher the graphical map can be considered as a tool to analyze the content of what is being taught, to have a better structure of the programs and manuals, and to build a plan for the course. The preparation of a guided tour with comments helps to get the new learner to start. These guided tours allow a simple browsing without limiting the freedom of exploring. They include some public documents available over the Internet and some local documents prepared for pedagogical purpose.

9. CONCLUSION

The computer-aided tools developed (navigation map, time, and educational server) help to solve many navigation problems according to the objectives stated earlier. But we think it is time to start solving questions related to the use and control that the user should be able to do. We plan to allow the user to add comments about each site or page visited. This is a simple way to personalize its path. The other possibility is to be able to start the browser from the graph. Clicking on a node will link the user to the corresponding address [2].

Another goal is to evaluate the system in a cooperative learning environment. This will allow us to measure the success of our system in simplifying the browsing procedures and the search of information via the Internet.

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