Multimedia Distance Education Using a Local Mass Storage Device

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ABSTRACT

Development of computer technology, like multimedia and the Internet, enables new possibilities for distance education. Lessons are prepared from different type of materials to give learners a better insight into the topic and to enable them to be more creative in the educational process. This means that learners have possibilities to study from their home or their jobs without loosing the quality of the education. Distance learning is usually based on the World Wide Web (WWW) to be platform independent and available to the most learners. Remote education can be performed on the server side from the learner's computer over the network. The problem is, however, that most learners usually do not have high bandwidth network connections at their homes or at the campus. Another problem is the cost of telephone lines used by modems for connections to the network. A possible solution is usage of a local mass storage device to store almost all multimedia data locally and only a small amount of material is accessed remotely over the network. The purpose of this article is to present the basic idea and the concept of the distance education, where a local mass storage device is used to store all multimedia data locally. A COMBO [1,2], which combines a linear tape and a hard disk into one storage system, is used as a local mass storage device.

I. INTRODUCTION

Distance education or distant learning has great potential to aid education, which is of critical interest due to the convergence of trends in education. First, occupational and personal success highly depends on education and formal education is becoming a lifelong endeavour for those in the professions. Second, education has become increasingly expensive and there is now increasing pressure to re-engineer the educational process to be significantly more cost effective. One of possible solutions is distance education, which will allow learners to study from their homes or from their jobs. Educational lessons can be very efficient if they are carefully prepared using multimedia, which enables usage of text, images, video, and audio materials together.

Distance education is usually based on the World Wide Web (WWW) and supported by multimedia to improve the educational process [5,6,7]. Learning can be performed on the server side from the learner's computer over the network. However, high-speed networks are required to transfer a huge amount of data from the server to the learner's computer, and the problem is still bigger if many learners use the system at the same time. On the other side, most learners usually do not have high-bandwidth network connections at their homes or at

the campus to transfer the same multimedia data each time they want to study. The problem is not only the speed of the network but also the cost of telephone lines used by modems for connections to the network. However, some educational applications are based on high-speed networks [9], but they are appropriate only for professional learning, where high-bandwidth network connections are not a problem.

Educational lessons are carefully prepared in advance, what means that only a small amount of data is modified very often and it should be available on-line. Another approach to the distance education can be developed on a base of a local mass storage device, which is the goal of the project ACTS AC-018 SMASH [1,2]. Instead of transferring all data over the network, multimedia lessons are stored on a local mass storage device and only the modified material is obtained over the Internet. The network access can be used to communicate with the teacher, to get the homework, to send the finished projects back, to ask the questions, and also to collaborate with other learners. A local mass storage device can be any storage device with enough free storage space. However, it will be useful to have an all-purpose local storage device that could be used to store all multimedia data at home, like multimedia educational lessons, digital movies recorded from the TV, and other multimedia materials obtained from the WWW. An example of a mass storage device suitable for distance education is a COMBO [1,2], which consists of a linear tape with the capacity 13 GB (or even more) [3,4] and a hard disk for caching data. The COMBO device is intended as a local mass storage device for all multimedia equipment at home.

II. Multimedia Distance Education

Using new multimedia technology, education can be more efficient with many advantages over the "blackboard only" lecturing mode, but it remains non-interactive and learners are passive recipients in the learning process. A new approach should be interactive to enable learners to become fully active in learning. The best way would be "learning by doing", where learners could perform practical exercises during the self-study. To achieve these goals, the educational concept should be designed very carefully; otherwise the obtained results could be worse than those for the blackboard learning mode, although the most advantage technology was used. It is very important to always consider pedagogical influence of new technology and methods on results of the learning process. The approach should be more problem and less technological oriented. This means that the learning process should be considered first and that the available technological solutions should be exploited in order to satisfy the needs of this process. However, designing of multimedia rich systems can take months or even years and a usable multimedia educational system may become outdated when it is finished. There is a need for a simple-to-learn methodology to help educators design and implement hypertext educational systems [8], which are usually used for multimedia distance learning based on the WWW.

A distance education application should be platform independent and easy accessible to all learners. One of the most appropriate solutions is usage of a WWW browser like Netscape, which is available for almost all types of computers and operating systems. It has a multimedia support and learners can use if free of charge. A graphic user interface can be built as hypertext pages with additional enhancement with Java applets. The idea of distance education is to keep the application as general as possible. This means that the same educational tool can be used with or without a local mass storage device. To achieve such goal, the distance education application is built as a general education application based on a

WWW browser with an additional interface between the application level and the storage device to hide the storage system from the application. If the local mass storage device is available, educational lessons are obtained from it through a simple WWW server used only for communication between the application and the local mass storage device. However, if the local mass storage device is not available, all data could be transferred over the network from the server and the distance education system would be a usual client-server application. A basic concept of a distance education application using a local mass storage device and the network access is shown in Figure 1.

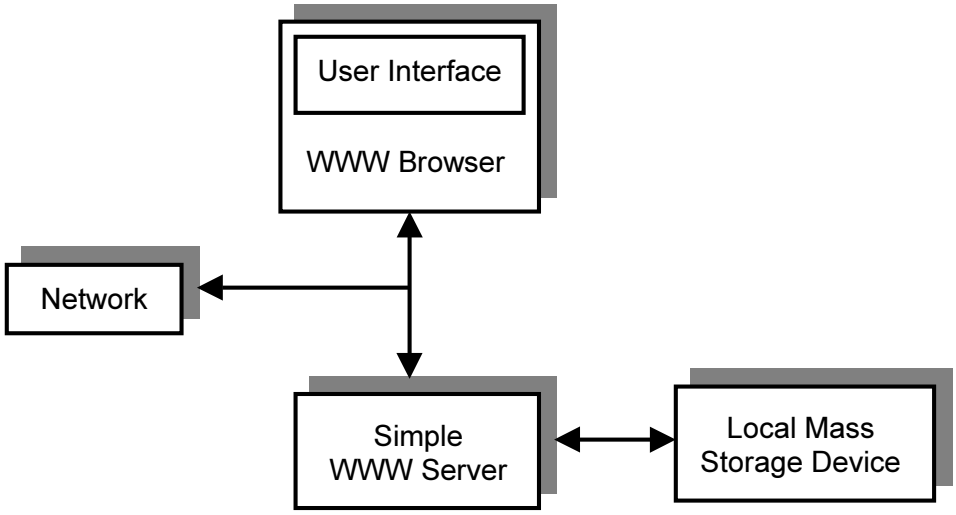

Figure 1. A basic concept of a distance education application using a local mass device.

III. A GRAPHIC USER INTERFACE

A graphic user interface is a learner's door to the course material and it should be designed very carefully. It should be simple to use but with the clear overview of educational material and available functions. The interface could be implemented as ordinary hypertext pages, but usage of Java applets allows additional features like gathering of statistical information about the learning process and showing graphic map of the course. If the structure of the course is given only as a table of contents, the course is a hypertext book with additional multimedia materials on the document pages. The user interface can be improved by the graphic presentation of the educational material, which is more flexible and easier to remember. Mind patterns, which are similar to the human way of thinking, are graphic diagrams with different shapes and different types of connections, and therefore, they are suitable for representation of the relations between topics of the course. A simplified schematic example of the graphic user interface, which is built on the WWW browser, is shown in Figure 2. A window of the user interface is divided into four sub-windows. The left upper corner is used for showing a small graphic map of the whole course. This map is useful for finding out a temporary position of the learner in the structure of the course. The left lower window is a hypertext table of contents with links to subtopics. The table of contents defines the structure of the lesson, which is defined by the teacher, and it could be upgraded over the network. The main window is the right lower one, which shows mind patters. The mind patters are a very flexible and efficient way to show the educational material. They use different shapes, sizes and colours, as well as different types of connections, to show the structure of the course and the relations between topics. The mind patterns don't show only the lesson prescribed by the teacher, but they show all available material included in the course, although the teacher does not require

some topics. Multimedia technology enables more efficient presentation of the mind patterns, which can be additionally described by text, images or audio and video clips. The mind patterns are also links to subtopics and html document pages. They can be used to navigate through the course material. When an html document is reached by mind-patterns links or by links in the table of contents, this main window is used to show the multimedia data. If a link in an html document is followed, a new window for browsing is open to avoid losing of the learner's navigation through the course material. The last window of the user interface is the right upper toolbar with navigation arrows and action buttons for different functions like help, the interaction with a local mass storage device or the network interaction with the teacher's computer.

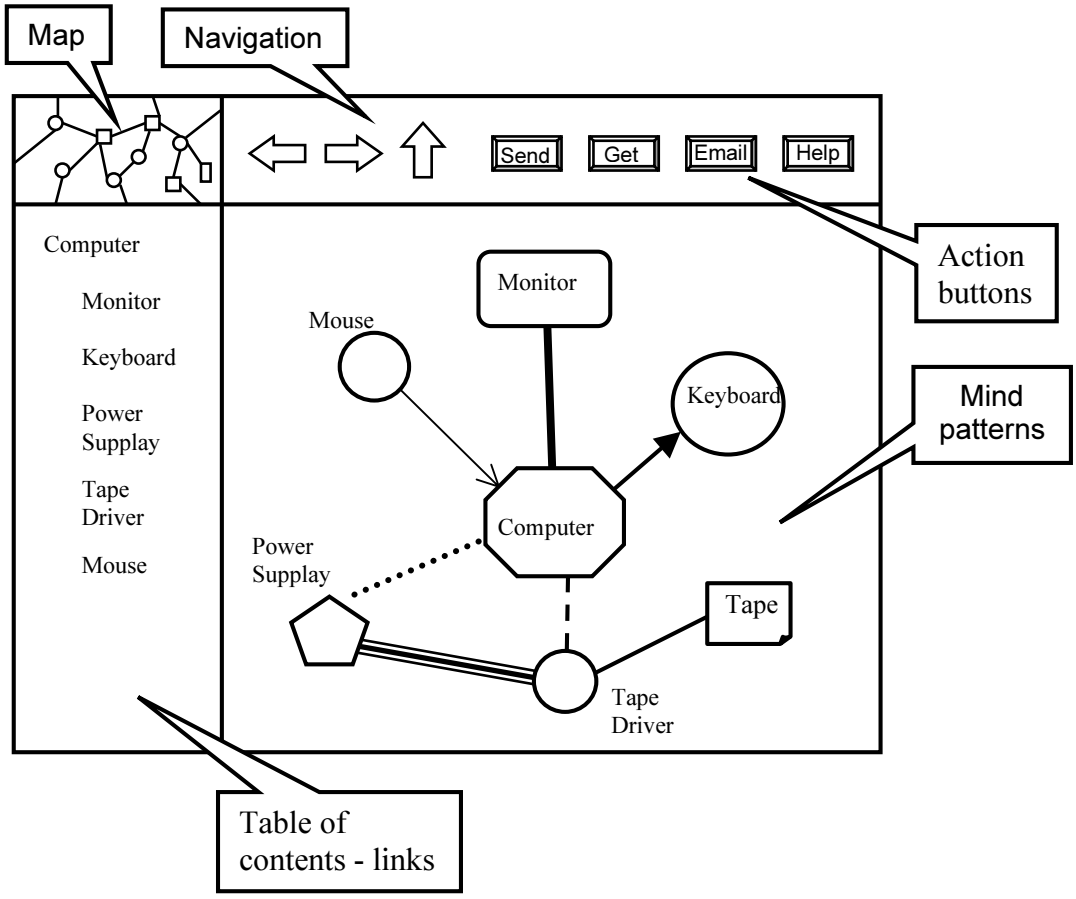

Figure 2. A schematic example of the graphic user interface.

All course material is stored on a local mass device and it seems that the Internet is not needed, but this is not true. The network connection is used for additional browsing by the learner according to the links in the lesson as well as for obtaining the homework and instructions from the teacher and other modified data. For example, the structure of a lesson, which is defined by the teacher, can be obtained over the network if the teacher change the lesson. The learners can also send their homework back to the teacher, ask some questions, or they can communicate over the network between themselves.

IV. Interaction between the User Interface and the Local Mass Storage Device

A distance education application is supposed to be a general education application regardless of the source of data. Educational material could be stored on a local mass storage device, on a CD, or it could be obtained over the network. To achieve this, a simple WWW server is included between the education application built on the WWW browser and the local mass storage device. Network requests are sent directly to the Internet while local request are sent to the simple WWW server. This means that the links in the course should be relative hypertext links and not absolute file names. At the beginning of the lesson, an absolute hypertext link that point to the local computer is used as a reference for further relative links.

A local mass storage device COMBO [1,2] consists of a linear tape with huge capacity 13 GB [3,4] and a 2 GB hard disk for caching data from the tape. At the moment, the Ethernet connects the local mass storage device with the computer, but in the future, a fast connection over the IEEE 1394 port will be available. When a learner requires a local file, the request comes from the WWW browser to the simple WWW server, which tries to obtain the file from the hard disk of the COMBO. If the file is on the disk, it is sent to the browser, otherwise, the request is sent to the controller of the tape. The controller copies the whole partition (360 MB) with the required file on the hard disk. When the file is on the disk, the simple server sends it to the browser. The tape controller also takes care of writing files on the tape, which support only writing of streams. Files are grouped together into one stream which is then written on the tape. The concept of the interaction between the simple WWW server and the local mass storage device is shown in Figure 3. The direct interaction between the simple server and the hard disk of the local mass storage device is performed if the hard disk can be mounted as a local hard disk of the computer. If this is not possible, the hard disk is available only to the tape controller, which sends files to the simple WWW server.

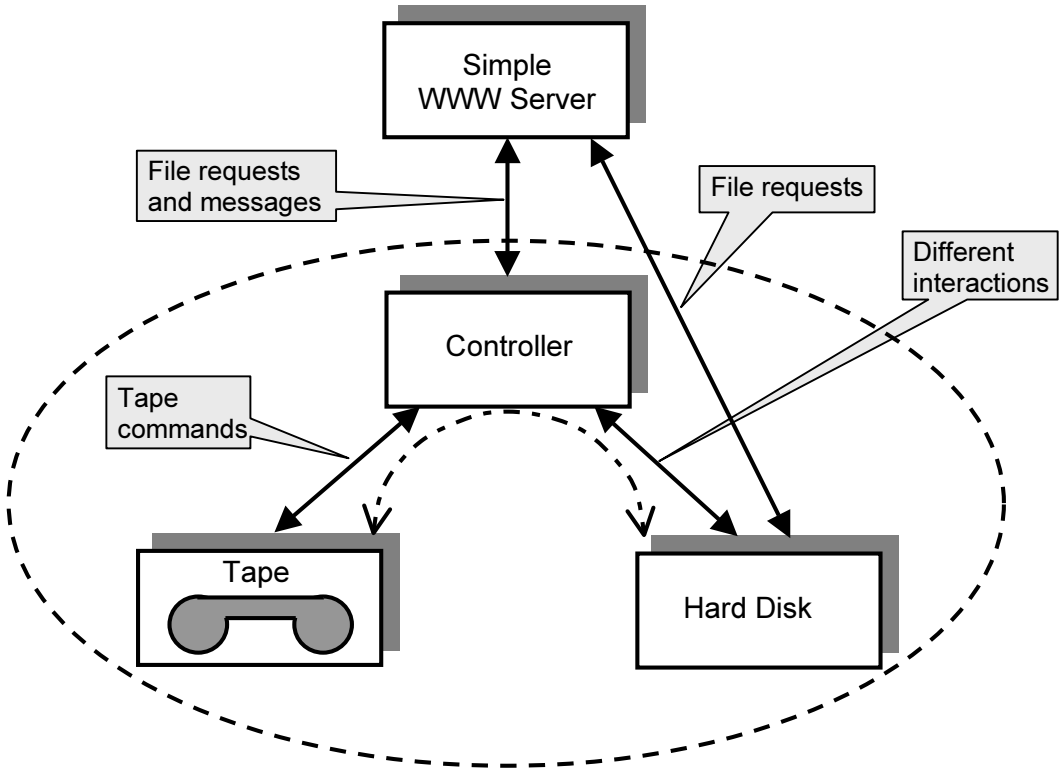

Figure 3. Interaction between the simple WWW server and the local mass storage device.

A. Storage of Data on the Tape

The local mass storage device COMBO [1,2] uses linear tapes QIC-5010-DC (13 GB) [3,4] as storage media. The hard disk is used for caching data from the tape to minimize the delay. However, linear tapes require some time (few minutes) to read, write or rewind from the beginning to the end. This time depends on the storage capacity of the tape. Higher storage capacity means a longer tape and larger delay. To minimize the delay and to keep the storage capacity the same, the linear tape is shorter but it is divided into parallel partitions because the movement of the magnetic head is much faster (few seconds) than rewinding of the tape. The smallest partition can be 361 MB and it seems that there is no need to have larger partitions for the distance education application. This means that all partitions can be of the same size or the tape will be divided into the smallest partitions.

For distance education, the courses are prepared in advance and all materials can be stored on the tape in much more efficient way to further reduce the delay of copying files from the tape on the hard disk during the learning. Optimization of storage can be achieved by defining the sequence of the files on the tape partitions. The optimization process should consider the structure of the courses, file sizes, the structure of the tape and the possibilities how learners will go through the lessons. Because the optimization according to such criteria is not easy and the objective function doesn't have a simple form, it seems that selection of the genetic optimization is one of the best solutions.

The layout of a linear tape with parallel partitions is shown in Figure 4, where is also shown an example of storage data on such tape. The first partition is used to store the table of contents with all necessary information about files stored in stream files on the tape partitions, while other partitions are available for storage of data. Linear tapes don't allow rewriting of a part of the partition, what means that the entire partition should be rewritten if only one small file is modified.

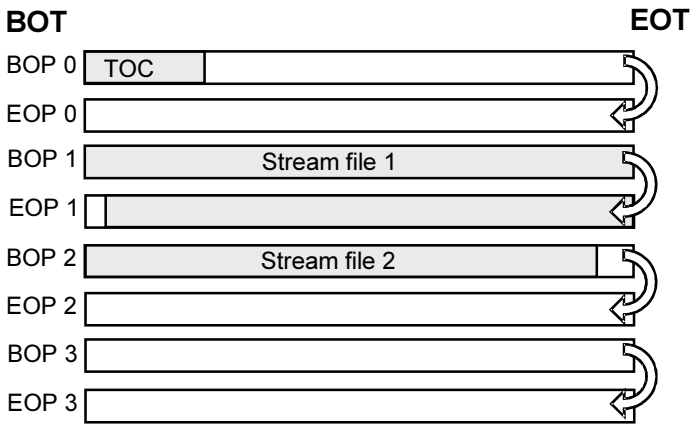

Figure 4. The layout of the tape.

V. CONCLUSIONS

The article presents a basic idea and a concept of the distance education, where a local mass storage device is used to store all multimedia data locally. As a local mass storage device is

used the COMBO [1,2], which combines a linear tape and a hard disk into one storage system. The educational system also supports the network connection, which is used for additional browsing of the WWW, for getting new modified data from the teacher, and for communication between the learners and the teacher. The application is not designed only for usage with a local mass storage device. It can also be used with any other storage device or as a client-server application with all material stored on the server side. A simple WWW server is used as a connection between the education application (user interface) and the local mass storage device. The graphic user interface is based on a WWW browser and it implements mind patters as multimedia supported graphic diagrams to present the course material and interconnections between related topics in a more efficient way.

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