IDEA GROUP PUBLISHING
701 E. Chocolate Avenue, Hershey PA 17033-1117, USA
Tel: 717/533-8845; Fax 717/533-8661; URL-http://www.idea-group.com
ITP4122

A Video Based Tool For Distance Learning

Mario A. Bochicchio and Nicola Fiore
SET-Lab–Dipartimento di Ingegneria dell'Innovazione, Università degli Studi di Lecce, Via per Monteroni, 73100 - Lecce, Italy
Tel: 39 0832 320216, Fax: 39 0832 320279, mario.bochicchio@unile.it, nicola.fiore@unile.it

ABSTRACT

LEZI II is a software to develop interactive educational movies with hypermedia elements. With LEZI II, a conventional conference/lesson can be effectively transformed into a powerful multimedia product based on a very simple and regular structure. The LEZI II environment, which does not require specific expertise in information technology, allows the author of an educational multimedia product to work at a higher level than conventional authoring tools, in a short time and at low costs.

INTRODUCTION

In general, modern multimedia applications are complex to conceive/design, and their development process can become rather expensive in terms of time, knowledge, specific techniques, complex graphics, animation, high quality video and audio [1-4]. Attempting to reduce costs or to shorten production time may easily result in poor quality.

Nevertheless, in certain types of educational application, the quality of educational content may easily compensate for a user interface limited to the essentials or a reduced set of multimedia features. Production of this kind of multimedia application can be high quality, even with short production cycles, at very low cost.

This work concentrates on this particular field, with the aim of supplying teachers with a valid tool for publishing their educational material easily and at low cost.

Good teachers obtain and hold the attention of their students by speaking, using images and slides to explain, showing objects, writing on the blackboard and using gestures. However, traditional lessons/conference presentations can be easily transformed into good quality multimedia applications for both on-line (the Web) and disk-based (CD/DVD) distribution.

This paper describes the main features of LEZI, a software tool oriented to the production of indexed videos (hypervideos in the following), enriched with hypertextual and multimedia elements. Section 2 sets out the position of our work in relation to the literature. The requirements are presented in section 3. The conceptual modeling and considerations regarding the current implementation of LEZI are presented in section 4. A description of the LEZI prototype and an example of its use in our University is given in section 5 and 6. In section 7 we present our conclusions and discuss future work

BACKGROUND

In recent years, international workgroups have defined standards (e.g. SMIL [5], HTML+Time, etc.) and developed tools to design, model and produce interactive hypermedia applications, based on multimedia objects with temporal synchronization requirements (i.e. animation, video etc).

In our opinion these tools, well defined from the theoretical point of view, and very effective in terms of results, are often complex and unsuitable for people with low technical aptitude. Simplicity and user-friendliness are fundamental in the environment of teaching, in order to enable teachers and scientists to publish educational material without specific technical skills and economic resources.

An interesting example is GRINS [6], an authoring interface and run-time environment for creating and executing hypermedia SMIL documents. In general, GRINS needs a great amount of detailed information on the space-temporal aspects of the presentation; this increases the versatility and the flexibility of the tool, but requires technical skills and implementation abilities which the non-specialist may not have.

MTEACH [7] is based on a different approach: it is an authoring methodology supported by a language and a compiler, which allows the authors of educational hypermedia products to work at high level. MTEACH aims to simplify the design and the development phases of educational applications by adopting some predefined application templates. Nevertheless it does not cover a number of interesting "authoring occasions", as defined in the next section of the paper.

The Video Madeus authoring tool [8,9] was designed to test a model for the description of audio-visual information. Video Madeus focuses on the interaction of video elements (character, slot, scene, etc.) with other elements (text, sound, etc.) in a multimedia document. The approach used is data-driven rather than user-centered.

Real Presenter [10] is a commercial product, recently introduced by the well-known RealNetwork company to add audio and movie to PowerPoint presentations and to publish the results on the Web. Real Presenter approaches the idea of "very easy content production", but it is limited to PowerPoint presentations, without considering that teachers, during their lesson, also need to use other resources (blackboards, gestures etc.).

In our opinion, each one of these tools tackles different aspects of the problem. An accurate analysis of both research and commercial tools permitted us to extrapolate the essential requirements (discussed in section 3) of a good development environment based on indexed video.

Starting from these requirements, a LEZI prototype was developed at the Hypermedia Open Center (HOC) of the *Politecnico di Milano*, and a number of real lessons were produced and tested [11]. A project for a more complete prototype, called LEZI II, was then started at the SET-Lab of the University of Lecce, within a large research project focusing on the development of innovative educational tools and applications. The project comes at a moment of growing interest for educational video production in general and for WebTV in particular [12-15].

The first complete version of LEZI II, released in July 2001, performs very well in terms of ease of use, effectiveness, production costs and operating speed.

REQUIREMENTS

The fundamental requirement, for LEZI, is very high ease of use, so that it can be truly accessible even to users with very basic computer knowledge. This is essential for many scientists or teachers who have, in contrast, great communicative skills and could easily give high-quality conferences and lessons.

An even more important requirement is to keep production times down (ideally to about one hour of work, or less, for each hour of lesson). In some cases (e.g. conferences or special events) it may be important to apply this constraint up to the "real time production" limit (i.e. the indexed hypervideo of the event should be available on CD/DVD, and on-line, by the end of the event itself!).

A third very important requirement is the ability to effectively support the most common "authoring situations", listed in the following:

This paper appears in *Issues and Trends of Information Technology Management in Contemporary Organizations,* the proceedings of the Information Resources Management Association International Conference.

- a teacher presents his/her lesson in a classroom, possibly with a blackboard or slides;
- a teacher presents his/her lesson outside the classroom, if this is appropriate for the topic concerned. For example, a lesson on archeology could be much more interesting if it is performed at an archeological dig;
- a teacher uses gestures to "animate" some concept expressed by "static schema" (typically a slide), so that students need to simultaneously view the two different information sources (the teacher and the schema);
- a teacher uses his PC to explain how to use a specific computer program. The attention focus is on the display of the PC, on the voice of the teacher and, optionally, on a blackboard;
- a teacher uses his PC to make a PowerPoint presentation. The attention focus is on the display of the PC and on the voice of the teacher;

The fourth requirement relates to finding the various topics and subtopics in the lesson. The user, in fact, needs a fast and effective way to find out the contents of the video lesson, so they can easily find and reach the subjects of interest without wasting time on uninteresting or already-familiar video sequences.

We maintain that the most common video players (Real Player, Microsoft Media Player and QuickTime player) in general do not offer an adequate solution to this problem. Indeed:

- they use a linear cursor to move forwards and backwards in the video. This system is usable and effective when the video duration does not exceed a few minutes. Very poor results are achieved however, when the same system is applied to longer videos, such as a whole lesson (1 hour or more);
- they do not provide a simple system for "describing" the lesson overall, at various granularity levels, or for using this description to "navigate" within the lesson;
- they are very slow to restart, while operating in streaming mode on Internet, when the cursor is moved. So it can be very frustrating to find on-line a specific subject in long video sequences.

The fifth requirement concerns the technical skills needed in the authoring phase: it is well known, for example, that a few hours of lesson can produce a very large amount of digital content (video, texts, audio, photos, etc.), which can be difficult to manage. This kind of problem requires a high-level authoring tool, to simplify all technical tasks and to fully support teachers/lecturers, whatever technical knowledge they may have.

An additional requirement concerns the possibility of linking suitable comments, bibliographic references and other teaching materials to the indexed hypervideo. The most common digital document formats (PDF, HTML, PPT, …) should be supported.

Figure 2: W2000 functional use-case diagram of LEZI II

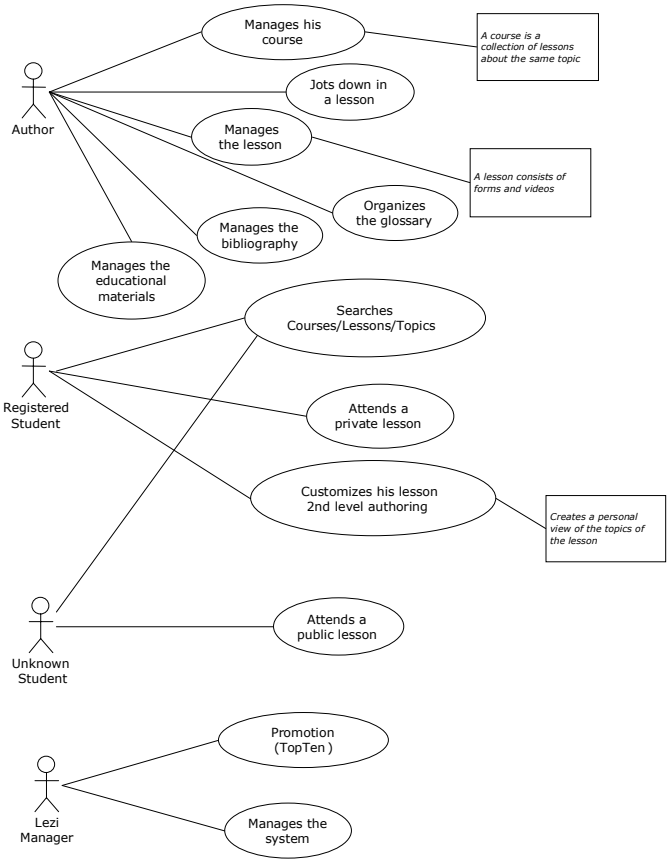
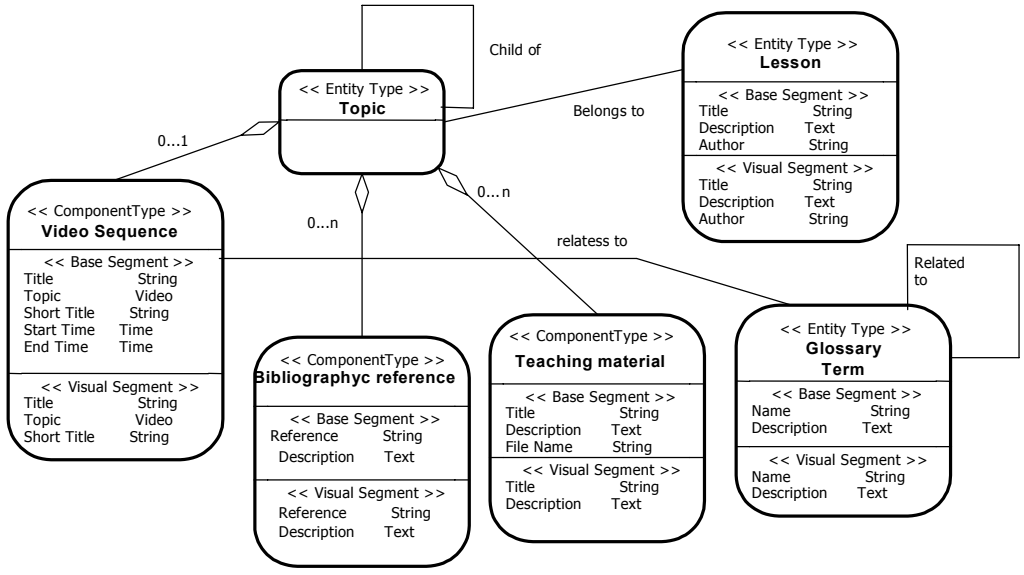


Figure 1: LEZI II–Hyperbase



CONCEPTUAL MODELING

The W2000 [16] methodology has been adopted to refine the informal description presented so far, to obtain a suitable conceptual model for LEZI II, and to derive from it the current LEZI II prototype.

W2000 is a user-centered methodology to conceive and define, at conceptual level, hypermedia applications. It is based on the HDM2000 [17-21] modeling language, on UML-like use-case diagrams and other similar formalisms.

Following the W2000 approach, a number of LEZI II variants have been identified, consequently LEZI II has been classified as an *application family* [3].

In brief, for the main prototype we have identified the following roles:

- *Author:* manages his public/private lessons and related students;
- *Registered Student:* attends his public/private lessons; can perform second level authoring (co-authoring) operations [1,3,21];
- *Unregistered Student:* can only attend public lessons;
- *Lezi Manager* manages the system.

We should observe that the users of the LEZI II system are not rigidly associated with a single role. A Registered Student of a given lesson, for example, could be, at the same time, the Author of a different lesson. Specifying roles is the best way to make user profiles explicit and to avoid duplicating functionalities and navigation paths for all users.

In Figure 1 the hyperbase diagram of LEZI II is outlined in terms of HDM2000 primitives [17-21].

The hyperbase schema is adopted to specify:

- the information structures needed by the various classes of users (information design)
- the navigation paths that allow users to find the piece of information suitable for their task (semantic navigation design)

In Figure 2 we show the main functional use-case diagrams, in which the main functionalities are associated with the previously identified roles.

THE LEZI II PROTOTYPE

A prototype of the described application was released in July 2001 at the SET-Lab of the University of Lecce (http://www.mb.unile.it/lezi).

Referring to the fourth requirement specified in section 3, the access structure has been implemented as a tree, organized into topics and subtopics nodes. Each topic node corresponds to the sequence of the videos associated with its subtopics, and the root corresponds to the entire lesson. No more than four subtopic levels are allowed, and each leaf of the tree corresponds to 2¸5 minutes of video. Each node (both topic and subtopic) of the tree contains a short textual description of the video associated to that node and the indication of its duration. This short description is very effective for finding the interesting topics and skipping the uninteresting (or the already-familiar) ones.

The tree-index acts as a hierarchical table of contents (TOC in the following). It can be generated:

- manually, by marking the start and the end of each subtopic on the video, in correspondence to a timeline measured during the lesson.
- semi-automatically, by generating a set of nodes equally-spaced in time. The authors of the lesson can then add/delete/modify the text associated with each node, as well as its duration and its start/end time.

Multiple tree-indexes can be created for a given lesson, so that the same lesson can be easily readapted for different purposes and different users. Multiple tree-indexes can also be created by students for their own purposes, or to share with other students.

The prototype has two distinct parts: the authoring part, suitable for creating a new LEZI lesson, and the fruition part ("lesson player" in the following), which may be used to navigate among existing lessons and to select and play the desired one.

Two versions of the prototype have been produced, with the same functions, for both on-line and disk-based operation. The disk-based version is suitable for creating and/or using stand-alone LEZI lessons, especially CD/DVD production, while the on-line version allows remote users on the Internet to create and/or play LEZI lessons. At any time it is possible to port stand-alone lessons to and from the Internet.

From the technical point of view, the on-line LEZI environment requires, for the lesson server, a networked workstation, equipped with RealServer (for the video streaming) and Internet Information Server, while the on-line LEZI client, suitable for both authoring and fruition, can be executed in any browser supporting JavaScript and equipped with the RealVideo plug-in. The disk-based version of the LEZI environment (both the authoring tool and the lesson player) is a standard MSWindows application including all necessary software components.

Different user interface styles (multi-skin), and a customizable set of interface objects (background, buttons, colors, fonts etc.) are supported to better adapt each LEZI II lesson to the expected audience.

From the implementation point of view the on-line version is based on the MS-asp object model for server-side scripting and on JavaScript and DHTML to implement the visual interface for the client. A SMIL program [8] has been used to correctly synchronize the tree-index with the video streams; for the same purpose the JMF [22] performed much worse in terms of speed and reliability.

In comparison with the MS-ASF format, and the related set of tools for video production and streaming, the RealVideo format was more reliable and performed better. In particular, with RealVideo it was very simple and effective for producing video clips for multiple bandwidth targets, and able to automatically switch to lower/higher bitrates according to network conditions.

The main steps to create a lesson with the LEZI prototype are:

- The lesson is recorded in Real-Video format on a PC or on a notebook by means of a video-camera and an USB video-converter. The whole system is inexpensive and easy to set up and transport. Many hours of video can be recorded even on normal hard disks or other storage devices.
- At the end of the recording session, the tree index is created. Ten to thirty minutes are sufficient, in general, for each hour of lesson.
- Teaching materials (if available as digital documents), and bibliographical references are added to the indexed video. Multiple document formats (doc, pdf, ppt, xml, html etc.) are supported.
- The LEZI II lesson is then generated (both for disk-based and on-line use).

The prototypical use of the current version of LEZI II has shown the effectiveness of the LEZI approach for educational purposes. More extensive production of video lessons, and more accurate evaluation of the effectiveness of the approach are foreseen for the next academic year.

From the performance point of view, the number of concurrent users supported by the LEZI II server depends on RealServer, i.e the video streaming server we adopted [23].

Empirically 10 users looking at various nodes of the same lesson (worst case test), or at different lessons, are very well supported by a server equipped with a Pentium III 800 processor, with 128MB Ram, on a 100 Mb/s LAN. Also the connection of clients by ISDN line has shown excellent results. A more detailed and systematic test is planed for the future.

A SAMPLE APPLICATION

The University of Lecce has produced many applications with LEZI II. In the following, we briefly describe an application based on the computer-graphics class given by Prof. Paolo Paolini (Milano-Lecce-Como 1999). The screen shots in Fig. 3 and 4 are related to a group of lessons on the design/modeling methodology HDM 2000.

The class is given to students at University level.

In order to provide an example of TOC, let us consider the topic "general content", which was structured in terms of the following subtopics: "definition of hypermedia", "definition of the hypertext", "purposes", "methodologies", "structure, dynamics, layout" "In-the-Large, In-the-Small". Each point is then structured into sub-sub-topics.

The user is free to "attend" the lesson starting from any point he prefers.

For instance, if the paragraph "Methodologies" is chosen, it is not necessary to run the video at higher hierarchical levels, which can be skipped over directly to the selected node. The usual keys enable the user to go back, to advance rapidly (fast forward), to put the lesson in standby position or stop it.

Figure 3: In the left frame, we can see the table of contents. Once the "Definition of Hypermedia" has been chosen, the content appears in the right frame

Figure 4: The software allows the user to watch the lesson they choose, in this case "Definition of Hypermedia"

CONCLUSIONS

The idea described in the above sections is very simple: it is possible to publish good educational multimedia applications developed by academic staff with very little technical effort, in a short time and with limited financial resources.

In our opinion, LEZI II enables teaching staff without specific technical preparation in multimedia production, but with valid content and good teaching skills, to easily prepare good multimedia interactive lessons, both for disk-based (CD/DVD) or on-line (Web) purposes.

More generally, the widespread use of LEZI II or other similar tools can effectively support the development and use of educational multimedia content in universities and schools.

Obviously, this kind of multimedia content is not intended to replace the publications of professional editors.

The next steps in the LEZI development at SET-Lab are:

- to complete the analysis of the authoring part of LEZI;
- to implement a textual search among the nodes of all lessons available locally or on-line, based on a content-sharing model similar to NAPSTER, to support the re-use of existing LEZI lessons on the net.
- a more detailed and systematic test
- to integrate the system with new video formats and channels (such as satellite and wireless), to better support the LEZI philosophy.

A free version of LEZI is available at http://www.mb.unile.it/Lezi. It can be also requested from mario.bochicchio@unile.it for experimental purposes.

We are convinced that many qualified teachers, especially those specializing in non-technical subjects, can easily use LEZI to create a wide range of first-rate educational multimedia materials, thus improving the effectiveness of teaching methods as well as cultural exchange between educational institutions.

REFERENCES

[1] M.A.Bochicchio, R.Paiano and P.Paolini "JWeb: an HDM Environment for fast development of Web Applications", Proc. of Multimedia Computing and Systems 1999 (IEEE ICMCS '99), Vol.2 pp.809-813

[2] M.A.Bochicchio and P.Paolini, "An HDM Interpreter for On-Line Tutorials", Proceedings of MultiMedia Modeling 1998 (MMM '98), pp.184-190, Ed. N.Magnenat-Thalmann and D.Thalman, IEEE Computer Society, Los Alamitos, Ca, USA, 1998

[3] M.A.Bochicchio, R.Paiano and P.Paolini "JWeb: an Innovative Architecture for Web Applications" Proceedings of IEEE ICSC '99,Hong Kong.

[4] F.Garzotto, L.Mainetti and P.Paolini, "Hypermedia Application Design: A Structured Approach", In J.W.Schuler,

N.Hannemann and N.Streitz Eds., "Designing User Interfaces for Hypermedia", Springer Verlag, 1995.
[5] www.w2.org/Audio/Video
[6] www.oratrix.com/GRiNS
[7] P.L.Montessoro, S.Caschi "MTEACH: Didactic Multimedia Production", Proc. of Multimedia Computing and Systems 1999 (IEEE ICMCS '99), Vol.2 pp.1017-1019
[8] C.Roisin, T.Tran_Thuong and L.Villard "A proposal for a Video Modeling for Composing Multimedia Document", Proc of MMM2000, Nagano (Japan)
[9] M.Jourdan, N.Layaïda, C.Roisin, L.Sabry-Ismaïl and L.Villard "Madeus, an Authoring Environment for Interactive Multimedia Documents", ACM Multimedia 98 - Electronic Proceedings
[10] www.realnetworks.com/products/presenterplus
[11] M.A.Bochicchio, R.Paiano, P.Paolini, E.Andreassi and T.Montanaro "LEZI uno strumento per un facile sviluppo di video interattivi a scopo educativo", Proc. of DIDAMATICA 2000, Cesena (Italy), May 2000 pp. 72-78
[12] M.Handler, O.Benavides, K.Morgan and R.Houghton "iMovie and Educators: The Right Partnership for Making Digital Movies"
[13] A.Hochman and S.Marshall "Camp Crystal Lake: A Wireless Network in the Wilderness Brings Video, Databases, and the Web to Elementary Students", SITE 2001 proceedings.
[14] M.Heath, K.V.Dimock and J.Burniske "Classrooms Under Construction: A Video Series", SITE 2001 proceedings.
[15] I.Abeshaus and R.Dickinson "Clay Animation How-To Video", SITE 2001 proceedings.
[16] L.Baresi, F.Garzotto, P.Paolini "Extending UML for Modeling Web Applications", Proc. of 34th Hawaii International Conference on System Sciences (HICSS'01), Maui (USA), Jan. 2001
[17] F.Garzotto, P.Paolini and D.Schwabe "HDM – A Model for Design of Hypertext Applications", in Proc. ACM Hypertext '91, S.Antonio (TX,USA), ACM Press, Dec. 1991
[18] F.Garzotto, P.Paolini and D.Schwabe "HDM – A Model-Based Approach to Hypertext Application Design", TOIS 11(1) (1993), pp.1-26
[19] F.Garzotto, L.Mainetti and P.Paolini "Navigation Patterns in Hypermedia Data Base", in Proc. 26th IEEE Int. Conf. On System Sciences, Maui (HW,USA), IEEE Press, January 1993
[20] F.Garzotto, L.Mainetti and P.Paolini "HDM2: Extending the E-R Approach to Hypermedia Application Design", in Proc. ER'93 – 12th International Conference on the Entity-Relationship Approach, Arlington (USA), Dec.1993
[21] F.Garzotto, L.Mainetti and P.Paolini "Hypermedia Application Design: A Structured Approach", in Designing User Interfaces for Hypermedia, W.Schuler, J.Hannemann, N.Streitz (eds.), Springer Verlag, 1995
[22] http://www.javasoft.com/products/java-media/jmf/index.html.
[23] "RealServer Guide", RealNetworks 1995-2000, Chapter 4 and 5.