Videostreaming over the Internet to support learning: the LODE system

Mauro Dolzani and Marco Ronchetti
mauro.dolzani@studenti.unitn.it,marco.ronchetti@unitn.it
Department of Information and Communication Technologies
University of Trento, Italy

Abstract

The rapid expansion of DSL technology has finally brought wider availability of large bandwidth connections reaching the homes. This new channel can be used for distance learning. We acquired two years of experience in using this technology to support regular university courses. As a result, we developed our own software for asynchronous delivery of the videos of classroom lectures. In this paper we shortly describe the system and we report our experience.

Keywords: Video Streaming, Distance Learning

1 Introduction

Thanks to the rapid expansion of DSL technology, many of us have now large bandwidth Internet connections in our homes. According to Point Topic [1], broadband penetration is currently at 28% in South Korea. In Europe the largest penetration is in Belgium (19%). It's 13-15% in Germany, France, Italy and the United Kingdom and in some smaller European countries. Broadband adoption is occurring at high speed: a 55% year-over-year increase in the number of worldwide lines has been reported. This means that the content that can be delivered through the Internet is dramatically changing. How this fact will affect e-learning? A first answer is to use technology to break the space-temporal constraints that limit attendance at university lectures. Being able to view lectures at different times and in different places, or to re-view some portion of a lecture may help considerably. In the past many distance learning initiatives have been based on the diffusion of audio and video material in the form of VHS

cassettes. Such model is however limited by the problem of distribution of the cassettes and by the poor navigability offered by VHS.

In this paper we present Lectures On Demand (LODE): a software for low-cost acquisition of the video of regular university lectures, and for their asynchronous video-streaming. The (good quality) audio and video (550x440 pixels, interpolated) can be accompanied by images of the slides projected in class (for Power-Point-based lectures), and by tools for navigating the lecture (by section title, by other indexes or through a time-bar). LODE also allows attaching arbitrary documents to any point of the lecture. It is best used when integrated by a forum that allows asynchronous interactions among students and teachers. The system can live stand-alone: we however integrated it in the (home-made) learning management system that is being used by the Facoltà di Scienze and Facoltà di Ingegneria at the Università di Trento. DSL technology offers a wide enough band for our videostreaming to run smoothly. To use the system students only needs a standard Internet browser enhanced with the Apple QuickTime plug-in.

2 First phase: acquiring experience.

Our work proceeded in two phases. The first phase lasted three semesters and involved over 200 students, 6 faculty members and 7 university courses for a total amount of approximately 350 hours of lectures. During this phase we acquired experience on the field by using the e-Presence system: a research product of the Knowledge Media Design Institute (KMDI) of the University of Toronto, Canada. The main goal of e-Presence development was to make web-casting highly interactive, scalable and robust, engaging, and accessible both in real-time and later via structured, navigable, searchable archives [2]. The client runs in a normal web browser enhanced by a plug-in chosen among Real Player, Apple's QuickTime and Windows Media Player. The acquisition station is composed of two PCs with video acquisition cards (one for the webcast, the other for capturing the version to be used asynchronously). A server is then needed to host a web site, and a streaming server software. e-Presence is designed to support manly events like MS PowerPoint-based presentations, as it is reflected by the client layout. The idea is that the most important cognitive factors are the voice, carried by an audio stream, and the slide that illustrates the concepts that the speaker is talking about. The actual video is less important from the point of view of carrying information, although it may be very useful by showing gesture, expressions, and contextual indications. Therefore the video carried by the system is small (180x144 pixels) so as to save bandwidth, but very fluid and sufficient for carrying the needed information. The most significant portion of the screen is dedicated to an image of the PowerPoint slide, which can be enlarged in a pop-up window by double clicking it. On one side of the screen there is the list of the slides (titles are shown). The user can navigate through the slides clicking either on the titles, or on two buttons that allow moving back and forward. In any case, when the speaker changes slide, the system presents the new slide to the viewer. The event is webcast, and later, through a post-

processing stage, a copy of the event is produced and kept on a server for asynchronous access. During webcast it is possible to pose questions through an integrated chat, while in the asynchronous version a timeline allows the user to navigate the event (marks on the timeline show slide transitions and semantic marking of sections).

In our experiment we recorded approximately 350 lecture hours of seven Computer Science courses. We experimented with web-casting, and developed a strategy to support students not having DSL access in their homes. Our students are distributed on a mountain territory, where not every location is yet reached by DSL services. To provide support, we modified the original e-Presence process by making the asynchronous version available both as streaming and as a standalone browser-based system on CD's. A full fifty-hours course fits on 6 CD's, or on a DVD. Also, students asked for a fourth possibility, i.e. downloadable zipped files. Such request came mostly by students living out of town, not having DSL at home but having friends who do: for them the most convenient alternative was to ask their friend to download the image of a CD using his/her fast lines, and burn the CD remotely avoiding the need to come to the University to get a physical copy. We also augmented the system by using a forum to allow for asynchronous interaction. Our experience with the e-Presence system is reported in a more detail in [3,4].

3 Second phase: developing and using LODE.

After using e-Presence for one and a half year, we found a number of requirements that convinced us to write our own implementation for a similar system that we called LODE. The main points regarded further reduction of acquisition and running costs, better transportability of the system, better quality of the videos, better support of generic OS platforms (linux/mac/windows). As far as costs were concerned, we based the whole system on free software, we made the postprocessing of the videos fully automatic, and we created a simpler interface for the video operator, so that unskilled new operators can be trained quickly. We also scaled down requirements for the hardware, so as to reduce cost and size of the station and to have shorter setup time (the acquisition system now simply consists of a laptop with Firewire connection plus a digital camera).

As far as the video quality goes, we based the LODE system on MPEG-4. This allows us to have good quality video with a resolution of 550x440 pixels, which is large enough to support non-PowerPoint based events like blackboard writing. All the client needs is a Java-enabled browser and the Apple QuickTime plug-in. The needed bandwidth has not increased, nor has the size of saved lectures. The user can (at any time) switch among three different resolutions: 550x440, 360x288, or 180x144 pixels and correspondingly allocate less or more space to the slides (if present). Fig. 1 shows the smallest and largest video resolution. The small resolution allows to allocate more space to the accompanying image (typically a PowerPoint slide) and is equal to the resolution offered by the e-Presence system. The largest resolution allows the teacher to make use of the blackboard, which is nicely readable, while strongly reducing the size of the

accompanying image, which in any case can be enlarged to full-size in a pop-up window.

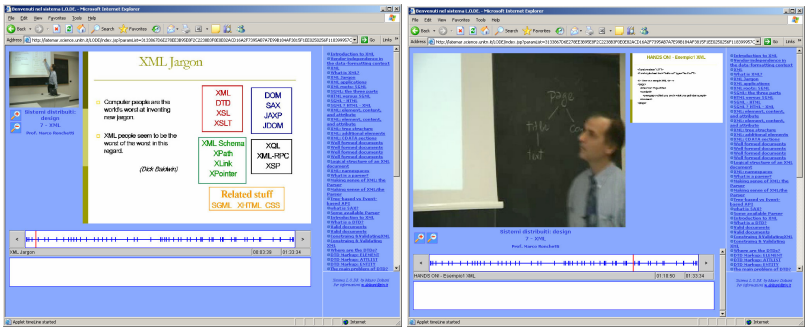

Figure 1: LODE with a small resolution (left) and high resolution video (right)

Among the other improvements we mention the ability to suspend and resume the recording of a lecture (e.g. to allow students to make an exercise in class), and the option to cut a lecture into pieces and recompose them according to semantics rather than to temporal sequence (this helps reusing lectures over the next year, or cutting out unwanted sections). Also, it was important to build modules to integrate the lectures into the (home-made) university Learning Management System, so as to deal with access permissions. Finally, we made it possible to attach arbitrary documents to any time of the video.
A more technical report on the software and hardware architecture of LODE has been published elsewhere [5].
We started using LODE during the academic year 2004-2005. We found that the all improvement that the system offers are in fact important. Postprocessing work is reduced to a minimum, taking now very few minutes. Portability of the system is greatly enhanced. The ability to suspend and resume recording when students work on exercises in class is very useful. Using the relatively large video effectively supports the use of the blackboard.

4 Conclusions

The initiative has had many advantages. Among them we mention:
- the ability for worker students to attend regular lectures, breaking space and time barriers;
- the ability for all students to recover lectures lost due to forced absence (e.g. illness);
- the possibility to chose a non-standard temporal organization, deciding not to be present at some lecture (elective absence);

- support for foreign students who might have difficulties with the Italian language (they would benefit from the possibility of re-hearing portions of lectures);
- symmetric support for Italian students attending to courses given in English (as presently are all the higher level courses – Laurea Magistralis);
- the possibility to review fragments of a lecture at any time, to check own notes and understanding.

A high percentage of students (66%) used the system and found it very useful. The only students who did not take advantage of the system are a subset of those who were able to successfully take the exam right after the end of a course. So our feeling is that such technology helps exactly those students who most need to be assisted.

Although we can imagine situations in which synchronous webcasting would be precious, it was almost of no use in our case. Asynchronous streaming looks like the most interesting option for our needs. Options supporting students who do not have DSL line at home are still necessary.

We investigated whether the presence of a camera in the classroom had an impact on either the teacher or the students. It turned out not to be the case, at least in the explicit answers to our questions. Some students might however have been a bit more intimidated than usual in posing questions during the lecture.

We also experimented with reusability of lectures: we took the lectures on one academic year and we successfully reused them on the next year, although we found that it is useful to be able to reshape them with the above mentioned editing functions.

Overall the experiment has resulted in an outstanding success, and we are now planning to cover all the Computer Science courses with the LODE system, and to export it to other Schools.

References

[1] The Point Topic Business DSL Report, published by Point Topic Ltd, Cardinal Tower, 12 Farringdon Road, London EC1M 3HS, United Kingdom (www.point-topic.com)

[2] Baecker, R.M., Moore, G., Keating, D., and Zijdemans, A., (2003) Reinventing the Lecture: Webcasting made Interactive, Proceedings of HCI International 2003, Crete (Greece), June 22-27 2003.

[3] [Ronchetti M., "Using the Web for diffusing multimedia lectures: a case study." Proceedings of the "ED-MEDIA 2003" Conference, Honolulu, Hawaii, USA, June 23-28, 2003, p.337

[4] Ronchetti M., "Has the time come for using video-based lectures over the Internet? A Test-case report". Proceedings of the IASTED International Conference "Computers and Advanced Technology in Education 2003", Rhodes (Greece), June 30 - July 2, 2003, p. 305

[5] Dolzani, M and Ronchetti, M. Lectures On Demand: the architecture of a system for delivering traditional lectures over the Web. Submitted for publication.