Approaching a low-cost solution for distance university courses*

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Abstract: We discuss a system to broadcast the live experience of university lectures and to archive it for further asynchronous use. At the time of lecture the broadcast is bi-directional, to guarantee interactions between local and remote classes: both rooms display the teacher's educational material while the video of the teacher is projected in the remote class and the remote class in the teacher's room. Questions can be risen by students in both settings. The project requires minimum overhead on a teacher and no post-production. We give teachers the freedom to use different sources of information to deliver their lectures (slides, video, audio, a white-board for quick sketches, applications running on a desktop). All these events are captured and compressed into two video streams that are accessed through an interface generated by SMIL. The lectures archive is integrated with other communication tools, such as e-mail, forum or collaborative web.

Introduction

The main goal of higher education is to provide *knowledge*, and then to provide *know–how*. As for *knowledge*, we mean the acquisition of basic principles, concepts and methodology of a given discipline; enough to allow average students to become enough self-confident to pursue further professional life following the evolution of the discipline and gifted students to become active in the innovation of the discipline. As for *know–how* we mean the ability of pragmatically apply principles and methods in specific application fields, i.e. the ability of transforming knowledge into practice.

The unique characteristic of university education is not just that the knowledge inherent a discipline is transferred to student, but rather that faculty members contribute to its evolution by practicing scientific research on methodological, theoretical, practical, technical issues of the field. As a consequence, the university education is strictly correlated to university research, and often, during the final stage of their education, students take active part to scientific research carried on at their universities. Given this scenario, distance learning should smoothly integrate with traditional education, should improve the degree of student participation to the university life and cannot become a substitute of it. Overall distance learning cannot take the place of the complex and rich relationships that are established among students themselves and among students and faculty members.

From this viewpoint distance learning is to be considered as an opportunity to improve and re-organize the teachers and students community. To organize, implement and offer distance learning products as information delivery platform, even very structured and well organized information, show the potential risk of impoverishment. The most relevant aspect we must preserve in higher education is the *experience* of learning, the learning praxis, which is the result of a continuous exchange of human relations, of common experiences and of knowledge sharing. We view the

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network as a tool to empower community life rather than an information repository. Community networks are world wide experienced, and it is quite possible to organize distance learning as a community learning network.

A real lecture in a real classroom is perceived through the voice and the gestures of the teacher; body language and verbal language co-operates to convey the message, to attract the students interest, to focus their attention. All this complex communication process conveys the teacher interpretation of the issues considered. Edwin Land [Land 57] in 1957 suggested to MIT faculty members and administrators "*… to capture the good lecturers at the moment when they are most excited about a new way of saying something …, and make moving pictures of them right in class. Can the lecture with the vitamins in*!".

Our experience follows these ideas and aim at recording the live experience of a lesson to give students the opportunity to review topics along their studies and to keep the pace if they miss classes. Lesson's audio/video recording is only a piece of the complex model of community distance education, also vital are interaction, discussion etc. that can be easily supported by traditional network utilities like BB, e-mail etc.

The *Virtual Lecturer*: a low cost solution

Our first objective is to deliver a class to multiple geographically distributed rooms in a synchronous setting. A second objective is to increase the degree of participation of students to the course life, particularly for part-time students, a large component in our student population. These goals are to be fulfilled with the minimum possible requirement of resources. In particular we foresee:

- no extra burden on the teacher side, before delivering the lesson;
- to avoid any lesson pre-production;
- to avoid the technical staff supervision in the classroom;
- to minimize post-production process before lesson archiving.

The specific functional requirements of the *Virtual Lecturer* project, to be added to more traditional distance learning support tools, like document archiving, newsgroup, etc. are:

- synchronous delivery providing the maximum possible level of interaction and remote presence of teacher and students;
- asynchronous delivery via lessons archiving in a multimedia database, capturing all the events that happen during the real class.

To satisfy the first functional requirement we have designed lecture rooms, with two video projectors to display the remote room and the teacher's desktop. These two screens allow to make visible to students either remote students or the remote teacher and the same lesson content. Since the remote teacher is displayed to remote students on a large screen, they can get a strong feeling of presence, and the teacher as well has a clear perception of the remote students presence. Interaction between remote students and teacher is allowed by simply question rising, since video and microphones are always active in both rooms. In other words the opportunities of interacting with the teacher, given to students in both rooms is, in principle, the same. We underline that also the students in the teacher's room have a view of the remote class, therefore having themselves a perception of a distributed learning community simultaneously acting.

Some problems are to be solved to fulfill the second functional requirement of archiving lessons in a multimedia data base, capturing all the events that happen during the real class. During a lesson a teacher will present information from several different sources, e.g.: slides, programs, pictures, video, web documents etc. Most of these sources are delivered usually from a desktop computer, but sometimes a teacher can also use other devices, some very old like a blackboard others more technical intensive, like an electronic whiteboard or a tape or DVD player. All these information sources should be captured and, more critically, are to be delivered at the time in which they have been generated. We face therefore a problem of multimedia data capture and stream synchronization from the desktop and from other devices.

Efficient and low cost software tools are available to capture desktop content at the lesson onset. So we record two video streams that start almost at the same time and have the same duration. The possible very short delay in the two streams can be solved inserting a few seconds of still frame in the desktop stream with a limited post-production

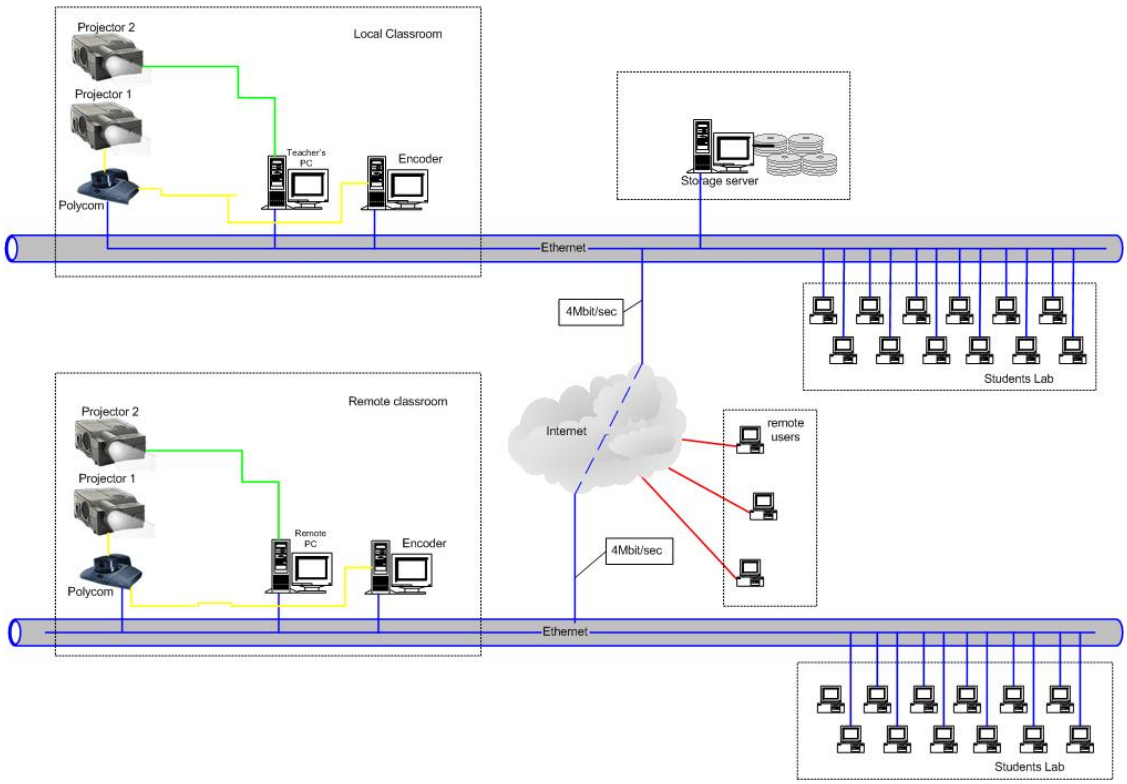
overhead. To solve the capturing and synchronization of information from other devices we limit ourselves to video sources (tape, DVD, electronic whiteboard): a simple switching mechanism allows us to select which input source has to be recorded as the parallel stream to the video/audio stream and in alternative to the desktop stream.

Summarizing, the adopted solution allows to:

- have a low latency audio/video bi-directional channel to guarantee active participation from local and remote sites; from the technical viewpoint we can add up to three remote classrooms;
- lessons can be distributed using multicast protocol to local or university network, allowing single students to attend a class, giving up to real time interaction;
- to archive lessons in order to provide the possibility of asynchronous fruition by low band video streaming;
- the typical delivered and recorded content is: teacher's audio/video; all events displayed in teacher's desktop, including, e.g., slides, application programs, video, pictures, web documents etc.; other video sources that are broadcasted and recorded as an alternative to the video stream of the teacher.

A still unsolved problem is the capturing and synchronization of all the events originated in the remote room; indeed, our solution at present captures only the audio of questions from remote students and the teacher's answers, but to video record the remote room at the moment would require a technical monitoring and post production.

The *Virtual Lecturer* architecture



The architecture of the *Virtual Lecturer* system for recording and archiving lecturers

Synchronous delivery

Each classroom involved in the delivery of lectures has been equipped with the same devices:

- audio/video Codec: Polycom ViewStation®, by Polycom Inc., connected to Ethernet via IP and to a video projector; it encodes audio and video based on H323 protocol with 384 kbps bit rate; the latency is about .5s, thus allowing effective remote interaction;
- a desktop computer, connected to Ethernet via IP and to a video projector, running Microsoft NetMeeting to share the desktop, therefore adopting T120 protocol.

Lecture recording

To record a lecture the classroom has a Vbrick MPEG-2 hardware encoder, by Vbrick Systems Inc., that takes the video and audio stream from the Polycom viewstation and encodes it with a bit rate of 4 Mbps at video broadcast quality. The desktop is also encoded using Camtasia Recorder, by TechSmith Corporation. The high bit rate for recording the audio/video stream of the teacher speaking saves at best the quality of the original information source, that then must be delivered to a much lower bit rate, compatible to narrow band connections. An automatic post-processing is therefore performed to convert MPEG-2 video to lower bit rate format: we use RealVideo, by RealNetworks Inc., with a maximum bit rate of 50 kbps. Also the desktop stream adds to the total bit rate rising it to 276 kbps. The choice is to use the best quality for slides or desktop application stream to allow an easy reading of possible small typographic sets and mathematical symbols, and enough quality not to spoil the audio of the teacher.

Each lecture is temporarily stored in the internal disk of the VBrick encoder and, as the lecture is over, the two streams are ftp'ed to a central storage. A final automatic post-processing is thereafter performed, the output of which is a SMIL file (SMIL: Synchronized Multimedia Integration Language 2.0 enables authoring of interactive multimedia by W3C). The file displays in a suitable interface the information recorded, the synchronized teacher's audio/video and desktop streams, and the URL address of the lecture materials.

Note that the encoder is actually in both rooms, even if only one at a time is in use: where the teacher is giving the lecture. This requirement allows the teacher of a distributed class to travel to a different location according to the week schedule and avoid to give preference to one of the class. It is very important to prevent the rise of feeling of being deserted from students of the remote side. Again, we see remote teaching as integrated in traditional teaching.

Final remarks

As we mentioned in the introduction of the paper, we strongly believe in the integration of traditional and distance learning, based on technology. The rational for recording the whole lecture, while it is happening, rather then pre-recording it, stays with the belief that emotional of the true event is more attention capturing, especially if it is seen integrated with other tools that help to create the community of learners. We use the video/audio recording associated to other forms of communication: e-mail, students forum and collaborative web techniques, such as WikiWiki web.

A pre-recorded class is more time and resource consuming. It could be more tailored for the remote students in principle, but our idea is integration of traditional and technological based class, because we want students to be able to feel part of the university community in the way we mentioned above. Other approaches put too much burden on the teacher side, who would have to plan exactly what he is going to say and to show, cutting out all the spontaneous teaching functions triggered by questions or by observing students. Forcing teachers to deliver material in an abstract setting or with no audience is not, in our minds, how teaching is performed in a university setting, because the perception of what is going on in the classroom and the degree of comprehension on students' side is missing. The solution we developed and engineered, is low cost for teachers and does not require pre-activity of any kind, nor post-processing, except for automatic compression process. To reduce costs further one possibility is to substitute the MPEG2 hardware encoder with a software one compressing with lower quality but less demanding bit rate.

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