MAPPING THE CLASSROOM INTO THE WEB: CASE STUDIES FROM SEVERAL INSTITUTIONS

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Abstract

The paper describes our research with a system that automatically produces web based education out of regular classroom lectures. In the classroom, the lecturer writes on a wide pen sensitive display in place of the traditional chalkboard. The system records all actions and makes it possible to replay the lecture from the web at any time. Remote students follow the lecture looking at the dynamic board content and listening to the recorded voice of the instructor. In addition to drawings, the new chalkboard handles a range of multimedia elements from the Internet. Using handwriting recognition, mathematical expressions can be evaluated and functions can be plotted immediately on the board. Since the first release in early 2002, we have gained practical experiences with different use cases and scenarios which we present in this paper.

1 Motivation

Figure 1: E-Chalk sketch of E-Chalk

In many disciplines, especially in the natural sciences, the chalkboard has been an unmatched teaching tool for ages. Lecture participants can see how ideas are developed instead of being overwhelmed with complete results. The initial idea behind the development of our system, E-Chalk, is to preserve the pedagogical advantages and the easy handling of the traditional chalkboard, while extending its reach to distance learning. A good chalkboard lecture automatically results in a good e-learning lesson. Furthermore, we enhance teaching quality in the classroom by allowing the instructor to integrate multimedia elements and to interface certain external programs. In the classroom, the lecturer works directly on a pen-active display or uses a digitizer tablet. At the same time, the lecture is being saved and transmitted live over the Internet without any additional effort. The ratio of production time versus duration of the produced learning unit using conventional authoring systems is typically a two to three

digit number. The main reason for this is that traditional teaching know-how does not easily match contemporary authoring tools. Besides technical efforts, they require a huge amount of work to structure pedagogical content for the web. With standard video web cast tools, the technical quality of the recording is not appropriate for educational content. Writings and drawings, either from slides or from the chalkboard, are poorly encoded since video compression omits sharp edges.
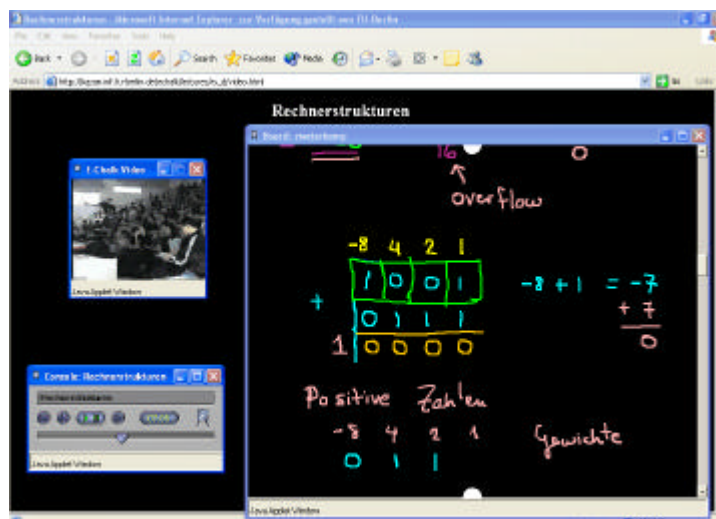
2 Software

Our main objective is to present teachers the environment they are used to (Rojas et. al. 2000). The lecturer steps into the classroom and starts teaching on the board like he always does. In addition to the standard drawing functionalities, the lecturer can place images on the board loaded from the Internet. CGI scripts in the web delivering text and pictures can be queried inside the board environment. A lecturer can paste an interactive Java Applet to the board and interact with it. The Applet behaves the same way on the receiving side, while the program is used on the server side. Additionally, there is an interface to a computer algebra system via handwriting recognition (Tapia, 2003).
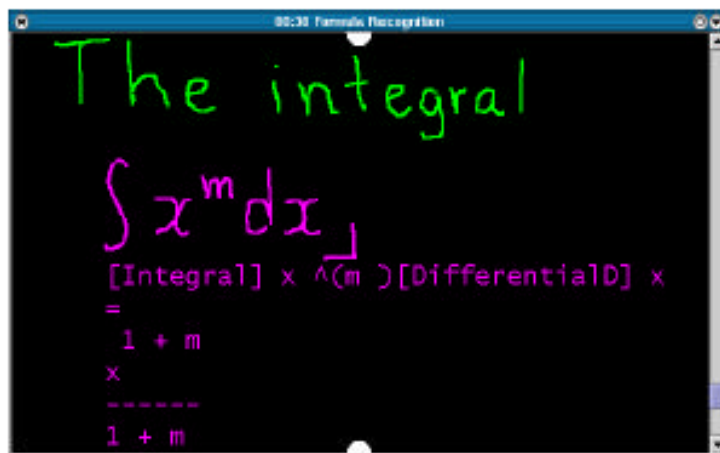
Figure 2: Handwriting recognition as an interface to an algebraic system

Using a microphone and/or a web cam, audio and/or video of the instructor can be transmitted and archived. When the live transmission of a lecture has ended, the lecture is archived in a way ready to be played back with any Java-enabled web browser. A printable transcription of the board as Adobe PDF file is also included. The entire software system (board application, audio system and video codec, streaming components, PDF converter) has been written in Java. The system is used on Linux, MacOS, and MS Windows platforms. For the optional postproduction of lectures we developed a generic multimedia editor named Exymen (Friedland, 2002).

Figure 3: E-Chalk lectures as seen in a browser

3 Hardware

In order to use the E-Chalk Software in the classroom, you need a pen based input device and a wide display (Friedland et al., 2001). The following list is a selection of commonly used devices:

- Digitizer tablets with LCD projection or tablet PCs
  Digitizing tablets are comparatively cheap and easy to transport. Using a tablet with integrated display one can write like on a sheet of paper. Optionally, the computer screen can be projected against a wall.

- Digitizing whiteboards
  Several companies distribute digitizing whiteboards. These are wide, perpendicular mounted digitizing tablets (up to 80' diagonal). The screen content is displayed on its surface by an LCD projector.

- Retro projectors with pen tracking
  The advantage of using a retro projection system as wide display device is that nobody can interfere with the projection beam. Contrast and luminance are much better than those of an LCD projector, which makes them usable without darkening the room. Disadvantages are their heavy weight and the high purchase costs.

4 Practical Experiences

An idea like E-Chalk depends on instructors' and students' preferences. Since the summer term of 2001 the computer science department of the Freie Universität Berlin has been regularly using E-Chalk for courses. In the beginning many professors were afraid of trying yet another e-learning technology. However, E-Chalk is now used more and more since last year's release. This makes it possible to study the different types of applications that people have found useful. The following sections present a selection of them.

4.1 Classroom Scenarios

Having many students in a lecture room requires a very big display surface. The practical solution is to use a digital whiteboard or a digitizer tablet as writing surface plus an extra projector that projects the board content widely. This way, board content is better readable than on a regular chalkboard. The Technical University of Berlin uses this setup regularly for the mathematics lectures for beginning engineering students.
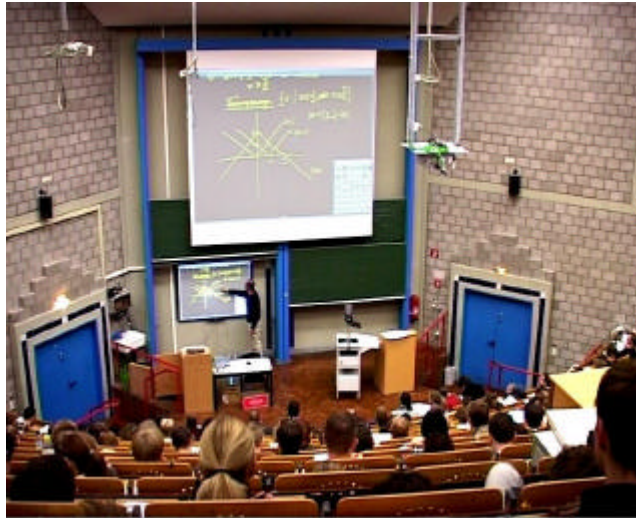
Figure 4: Mathematics lecture at the Technical University of Berlin using a digital whiteboard and an extra projector

For smaller seminars we often use a setup with several digitizer tablets, enabling students to directly participate in the lecture. In the case shown in the picture, the geology teacher uses a rear projector and the students use small digitizer tablets to work on geographical maps.


Figure 5: Geology seminar at Freie Universität Berlin using rear projector and several tablets

A handicapped professor for Arabic linguistics was glad to be able to give a chalkboard lecture while seated using a digitizer tablet for himself, instead of writing on the rear projection screen. This scenario is also useful for a German high school: The computer room of this school is so small, that neither a chalkboard nor tables for the students big enough for a computer and writing space fit in. The teacher uses E-Chalk with a digitizer tablet and projects the board content onto the wall. The generated PDF of the lecture is printed out at the end of the class, so that the students can get a copy of the class even though they do not have enough space for writing.

Figure 6: Computer science class at a high school: E-Chalk helps to handle the space problem

We use E-Chalk also in combination with videoconferencing systems, which enables us to have audiences in different universities at the same time. The chalk content is synchronized with the video conferencing system. This enables us to follow chalkboard lectures from important personalities that are held at a different place.
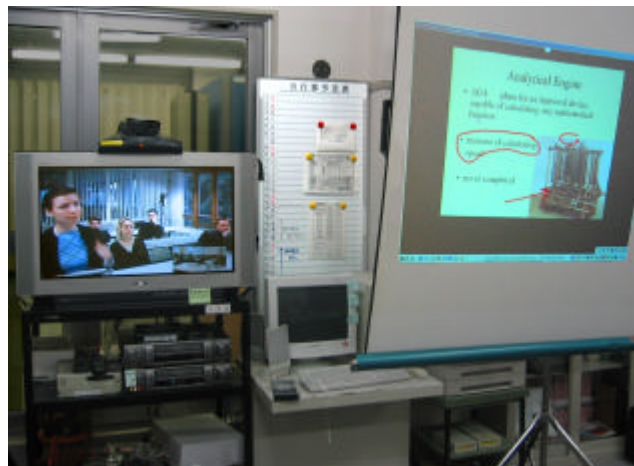
Figure 7: A cooperative lecture between FU Berlin and Kyoto University of Education (view in Japan)

4.2 Off-Classroom Scenarios

Because everything is recorded for the web, it is also possible to give a lecture at home and present it later. Many school teachers told us, that they find this a practical feature because they can easily create classes for the students to see at home. This makes it possible to teach more content, as students can repeat material at home.
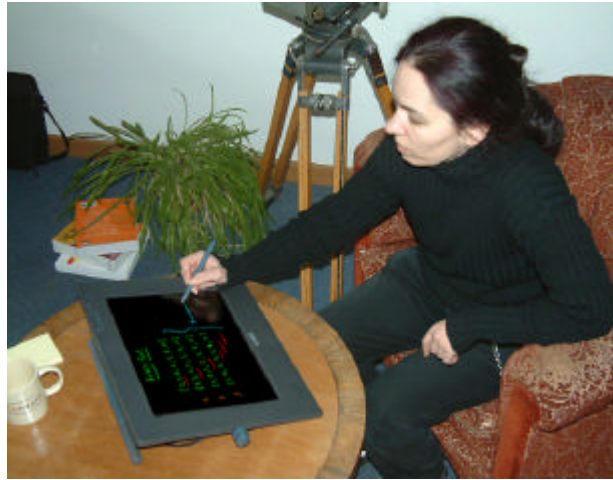
Figure 8: Using a microphone and a digitizer tablet lectures can also be recorded at home

Recorded lectures are also useful for students not being able to be present in the classroom for different reasons, for example scheduling collisions. The most frequent use of recorded lectures is for exam preparation. Students use the classroom recorded lectures to prepare for oral or written examinations by again listening to parts of the original lecture. Listening to a given lecture does not require a computer: Students have also converted the audio to use an MP3 stick plus the PDF printout to prepare for an examination in the subway. High school students gave us feedback, that they used a lecture for undergraduate students to get an impression of our university.

The live transmission of the lecture also helped to relieve classrooms. Students that did not find a place in the lecture hall used the PC pool and ear phones to follow the lecture.

5 Current Work

We are working on the integration of E-Chalk into different E-Learning platforms, such as Blackboard and WebCT. The advantage is that the produced lectures can easily be managed together with announcements and exercises.

In cooperation with the Berlin school administration, we are conducting a field study to evaluate the use of E-Chalk in schools. E-Chalk is used in combination with different kinds of digital whiteboards in elementary schools and in the three types of high schools that exist in Germany. A preliminary result is that elementary schools seem to be the type of school where the concept fits best. The reason may be that in elementary school the chalkboard plays the most important role. A final result of this study is expected at the end of 2003.

6 Summary

With the system presented here it is possible to produce distance lectures as a by-product of classroom teaching. Different hardware configurations are used for different classroom situations. Our distance lectures are not meant to substitute classroom lectures but to support them. They help a student to rework the material and provide a living and active script, where asides are not lost. In the long run we hope that a broad usage will substantially improve teaching and learning quality. Remote students do not need any special equipment or software other than a computer with a web browser. Only a browser is needed. All substantial information in the form of audio and dynamic board image can be received with low bandwidth requirements.

E-Chalk was awarded the European Academic Software Award 2002. The web site of the project can be visited at *http://www.echalk.de*.

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