Tools and Services for Authoring on the Fly

Ch. Bacher, Th. Ottmann
Institut für Informatik
Universität Freiburg, Germany
email: {bacher|ottmann}@informatik.uni-freiburg.de

Abstract

We describe an attempt of automatically transferring a lecture, which is given using the computer instead of an overhead projector, into a multimedia document for offline use. This approach is called *authoring-on-the-fly* and is very close to the traditional style of lecturing. It facilitates the production of high quality educational material far exceeding the quality of books and audio and video recording of lectures. Moreover, if the MBone whiteboard *wb* from the MBone toolset is used, it also has the potential of merging different tasks like teaching in class, teleteaching and courseware production together. Experiments using the whiteboard *wb* from the MBone toolset show, however, that it does not offer enough facilities for the lecturer to support teaching of nontrivial content of any kind, even if one restricts oneself to the area of algorithms and data structures. We have therefore begun to develop a new whiteboard and report about its use for teaching and *authoring-on-the-fly*.

1 Introduction

Paperbound documents like books, course notes and copies of transparencies, have traditionally supported teaching at university level. Currently available technology of networked computers, however, may open new avenues of supporting lecturing with hypermedia documents. In this paper we describe a new approach of automatically transferring a lecture given using the computer into a multimedia document. This approach of *authoring-on-the-fly* is close to the traditional style of lecturing, because the lecturer as the content provider can concentrate on how to present a certain topic without depending too much on mastering systems and technology. But it is nevertheless possible to create high quality educational material for off-line use in this way, whereas the quality of presentation is by far superior to a book or a video and audio recording of a lecture.

The key idea is to use the computer as a substitute of the blackboard and overhead projector. So far we have used the whiteboard *wb*, which is part of the MBone toolset [Eri94]. The actions carried out on the whiteboard by the lecturer were synchronized with digitized versions of audio and video recordings of the lecture. Using *wb* as an electronic substitute for the blackboard has the advantage that a computer given lecture can be transmitted to remote locations via the Internet, which makes it possible to merge computer presentation, distance teaching, computer conferencing and CAI-authoring.

We have run a number of successful experiments and have demonstrated the feasibility of this approach for carefully selected topics in the area of algorithms and data structures, which belongs to the core of any computer science curriculum. Computer given lectures up to the length of 70 minutes have been broadcasted to different locations in Germany. We have developed new software for postprocessing the recorded data, in particular an external viewer for Hyper-G [KMS93], which synchronizes audio- and video-streams and whiteboard actions. We have linked the postprocessed data together with scientific papers, book chapters and animation- and simulation programs using the linking facilities of Hyper-G.

In this paper, we start by briefly describing the lecturing scenario and the kind of software we have developed and used for producing multimedia documents in this way. As the result we obtain educational material, which can be stored on a server and distributed in local area high speed networks for offline use by students. We have started to produce a series of computer given lectures on 'Algorithmic Design Principles' (such as Divide - and - Conquer, Backtracking, Dynamic Programming, Heuristic Search, Randomization, and others). Simultaneously we have developed the tools to automatically transfer the lectures into multimedia documents.

Our approach is similar to the one of [CGJ+94] who have produced multimedia (CD-ROM based) proceedings of scientific conferences. Our approach, however, differs from theirs in several important aspects. We mention in particular: Direct recording of actions carried out on the computer instead of scanned-in slides shown on an overhead projector, possibility of transmission of lectures to remote locations when using *wb*, use of standard open hypermedia linking tools (Hyper-G), which make it easy to augment the resulting multimedia documents with additional features (glossary, animations, simulations, exercises, bulletin boards etc.) and to make them accessible over information highways.

2 Preparation and delivery of a computer lecture

After selecting a topic the teacher (lecturer, professor) concentrates on the question of how to present the content similar to the traditional way of teaching using an overhead projector. However, instead of drawing transparencies for overhead use he prepares "slides" as computer screens. For that purpose he can use a standard tool (like showcase, Framemaker, LaTeX), if colored postscript files are paged up and down on the screen. An alternative is to use the computer whiteboard itself in order to prepare slides. Slides should be carefully designed in the sense that they should not contain too much text and can be used as fill-in forms or templates to be completed during the lecture. Note that this requires the lecturer to have some knowledge of the facilities which the (electronic) whiteboard offers him. The slides are then loaded and shown in the whiteboard window. It is assumed that the whiteboard window is either projected to a large screen in a lecture hall or transferred to student computers at the same or at remote locations. (This was the scenario when we used the *wb* of MBone.) The teacher can not only page the slides up and down but can also highlight, mark and draw on the slides. He explains everything like in a standard lecture but uses mouse and keyboard instead of chalk or pen.

The audio and video streams and all actions on the whiteboard are also communicated to the students, either online in the lecture hall or, again using the MBone-tools, to remote locations. Experiments, which we have carried out by transmitting lectures to Munich and Mannheim from Freiburg show that the delay-free transmission of the audio streams and of the whiteboard actions is much more important than the continuous transmission of the video stream of the teacher. This means that it is acceptable to 'freeze' the picture of the lecturer as long as the audio stream and the whiteboard actions arrive almost synchronously at the remote location. Though the Internet was not designed for guaranteeing a continuous data transmission with a given bandwidth, our experiments have demonstrated that even a small data transmission rate (e.g. 128 Kb/sec) is sufficient to obtain acceptable quality at the receivers location. This implies that it is currently not the small bandwidth of the transmission, which is the most serious drawback for a good computer lecture given in this way, but the rather limited features of the whiteboard *wb* of the MBone toolset. Of course *wb* of MBone was not designed for the purpose for which we have used it. Therefore, we have begun both to gradually enlarge the features of *wb* and to develop our own whiteboard with enhanced facilities. These can be used more comfortably by the teacher to deliver lectures on the computer, which are then turned into multimedia documents for offline use (see section 4).

3 Transferring a computer given lecture into a multimedia document

The raw data of a digitized computer lecture consist of the stream of whiteboard actions, the digitized audio stream and (if desired) the digitized video stream. We recommend to make a S-VHS recording of the lecture and to digitize it with SGI capture tools afterwords. Using these tools, we can either produce an AIFC audio file (using audio only) or a SGI movie. This is actually a non standard format but it will soon be extended to include the MPEG-I system format. If the MBone whiteboard is used, the whiteboard actions are recorded with our multicast recorder (MCASTREC[1]), which transforms the whiteboard actions into a readable format.

We have implemented a viewer (SYNCVIEW[2]), which replays the movie or audio stream and synchronizes them with the actions on the whiteboard. This viewer allows to scroll back and forth (while following what happens on the whiteboard) and to be started at every frame of the movie or every millisec of the audio stream. SYNCVIEW can thus be used as an external viewer for Hyper-G. The main reason for chosing Hyper-G as a linking tool was that it makes it easy to use locations in postscript files as anchors for links. If, for example, a student reads a paper (with the postscript viewer of Hyper-G) with

[1]available under ftp://ftp.informatik.uni-freiburg.de/pub/AOF

[2]see 1.

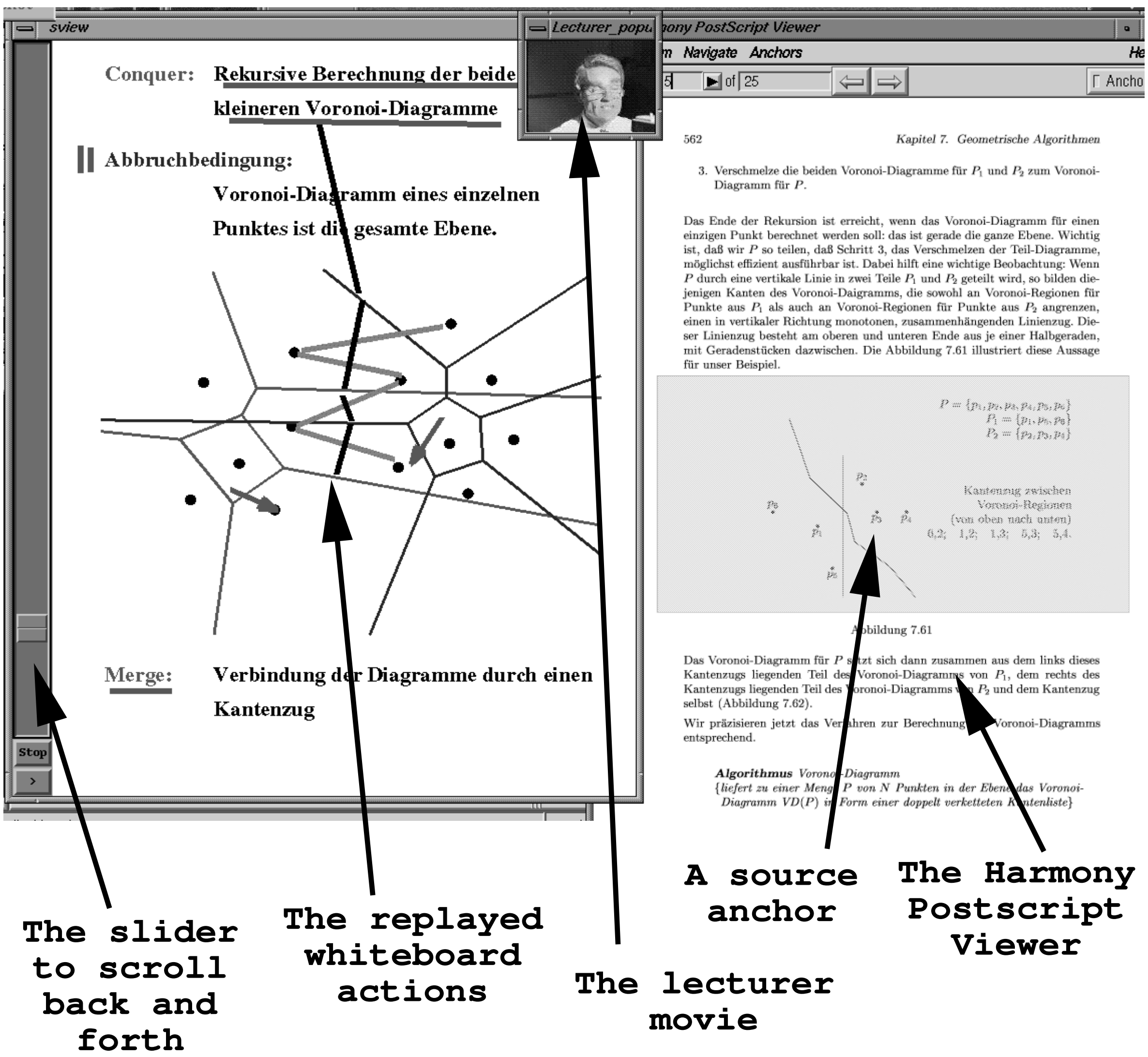


Figure 1: A screenshot of SYNCVIEW

embedded links to a corresponding lecture, he can jump to those points in the lecture, which might aid the understanding of certain parts of the paper. If necessary he can select the information he wants by scrolling back or forth. (This situation is shown in figure 1.)

In order to make this possible, it is necessary that the viewer displays always the objects visible at a given point in time on the whiteboard. A simple recording of the data stream generated by the MBone whiteboard does not fulfill this requirement. Think, for example, of messages like "delete object A", where object A was drawn a long time ago.

But if we postprocess the whole lecture, we can transform the whiteboard stream to a desirable format. We compute an object list each time a change of (graphical, textual, ...) objects occured on the whiteboard. Hence, we can attach to each point in time a display list, which contains exactly all the objects accumulated on the whiteboard until the respective point in time.

Thus, our set of software tools is sufficient to transfer a lecture 'on-the-fly' into a hypermedia document, if the whiteboard *wb* of the MBone-toolset is used. However, our experience shows that *wb* does not offer enough features to the lecturer in order to prepare and deliver nontrivial content of any kind, even if one restricts oneself to the area of algorithms and data structures. In fact, the *wb* has simple drawing facilities for drawing freestyle lines, straight lines, arrows, rectangles and ellipses. It is possible to erase and move objects. But *wb* does not allow to group graphical objects, to control an animation from the whiteboard, to zoom-in-and-out, etc.

4 The enhanced whiteboard

We want to use the computer screen, or more precisely, a small number of windows on the screen as an electronic substitute for the blackboard and the overhead projector. Because *wb* turned out to be insufficient for our purposes, we have started to develop our own whiteboard[3]. Note that enhancing the facilities of the whiteboard implies that simultaneously the viewer software for computer given lectures has to be enhanced also. Note that giving up *wb* in favour of our own whiteboard has the consequence that the multicast facility of *wb* is lost. However, the data stream generated by using our own whiteboard can still be interpreted by our viewer software; hence, the *authoring-on-the-fly* facility is maintained. Because the *wb* code is not public domain we had to start from scratch in order to develop a new whiteboard. So far the following editing and control facilities have been implemented into our own whiteboard (see also Fig. 2):

1. Editing of text including cursor-, delete-, insert operations.
2. Drawing of graphical objects like lines, rectangles, circles, freehand etc.
3. Loading, presenting of image data in various formats (jpg, gif, tiff, rgb, postscript).
4. Modifying of graphic or text objects.
5. Selecting and Grouping of graphic or text objects.
6. Move/copy/push/pop objects or object groups/selections.
7. Zooming-in, zooming-out, s.t. the relative distances between objects are preserved.
8. Pre-development of objects/pages which can be reloaded and modified during a session.
9. Preview pre-developed pages/objects before presenting.
10. Replacing selected objects with pre-developed objects.
11. Launching applications (e.g. animations).
12. Recording audio directly in order to replay the session immediately after it was given.
13. Edit a LaTeXsegment (i.e. a mathematical formula) and inserting it as image data.

Note, that these features by far exceed the facilities of *wb*. Let us discuss a few features in some more detail:

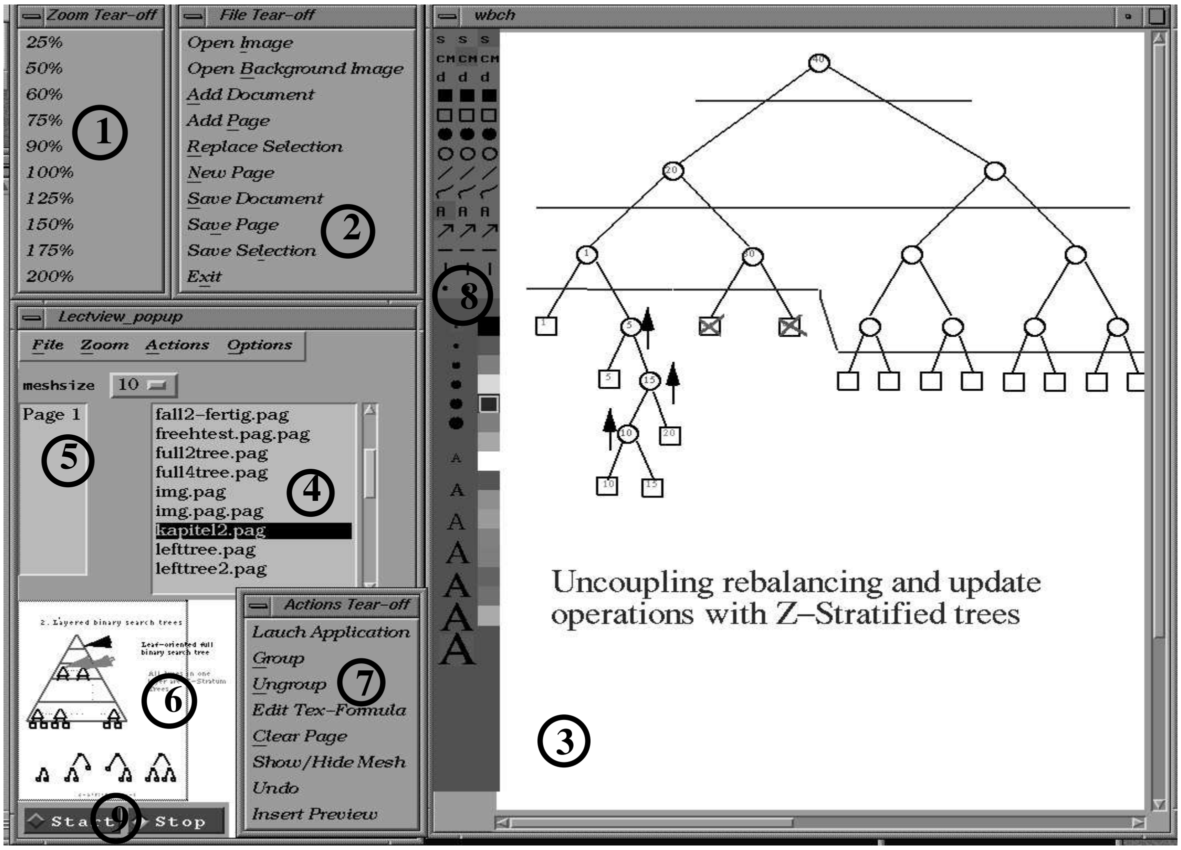
Feature 1 enhances the weak text editing facilities of the MBone whiteboard. Note that all actions during an editing session (except cursor operations) are recorded and, therefore, part of the replay.

Pre-developed screens can be overlayed in order to simulate the overlaying of transparent slides on a overhead projector; they can also replace selected objects, which are currently shown on the screen. These pages can be previewed and then overlayed with a simple double mouse click.

The problem of how to launch and control an application has not been solved completely yet. So far we restrict ourself to applications with the following properties:

1. The application opens a new window and starts running immediately.
2. No interaction can change the behaviour of the application.
3. The application stops running automatically (and destroys its window).

[3]available under ftp://ftp.informatik.uni-freiburg.de/pub/AOF



1: The Zoom menu
2: The File menu: – Loading/saving pages
– Loading image data
– Inserting screen pages
3: The drawing area
4: Selecting and inserting pre–developed pages
5: Selecting screen pages
6: Preview pre–developed pages

7: The Acion Menu: – Launch Applications
– Group/ungroup objects
– Edit LaTeX–formula
–...
8: The Toolbar: – select action for each mouse button
– select colors, textsize, linewidth
9: Start/Stop recording (with or without audio)

Figure 2: A screenshot of the enhanced whiteboard

Assuming that an application fulfills these properties we may expect that during a replay of the session the synchronization of speech and the graphical output of the application is preserved.

It is well known that a mathematical derivation (like the development of an algebraic transformation) is optimally explained if each step is slowly written (by hand) and commented by the lecturer. Because writing on the screen by the mouse or keyboard is not as easy for a lecturer, it is still open how we can provide a lecturer with a good facility to slowly develop and comment mathematical formulas on the screen. So far we experimented with LaTeX-input (feature 13) prepared by the lecturer prior to the lecture and then loaded to the drawing surface line by line, but we plan to test other input devices such as electronic pencils etc..

Ideas, of what other features an electronic substitute of a blackboard should have could also be borrowed from [LH94].

Our aim is, simultaneously to enhance the whiteboard and to use the respective new facilities to prepare a more demanding lecture on a new topic (from the list of topics mentioned above). This gives us direct feedback of how well the facilities of the whiteboard are suited to support lecturing, that is, we show what features are necessary, respectively, optimal for the topics we considered (algorithms and data structures, in particular: algorithm design principles).

5 Conclusion and further work

The ultimate aim of our effort is to obtain a multimedia document on the fly with the audio-, video- and whiteboard recording of a lecture, a scientific paper (book chapter, journal paper), animations, simulations (learner controlled), questions, glossary, table of contents, etc. These different parts are linked together using the linking facilities of Hyper-G.

Currently available MBone-recorders are not sufficient to produce a multimedia document useful for offline use. They simply record all data transmitted over the net and allow a replay from the very beginning. Our aim, however, is to enable the user to jump to a specific point in time of the lecture and to display precisely what was accumulated on the whiteboard. As mentioned above, if we use the MBone whiteboard, this requires a postprocessing step, which attaches to each point in time a display list containing exactly all the objects accumulated on the whiteboard during the respective instance of time. This allows scrolling back and forth in the recorded lecture, always displaying the correct situation on the whiteboard.

It should be clear that the inclusion of new features into an enhanced whiteboard may imply an extension of the viewer as well. We want to mention two basic enhancements of our whiteboard, which can be useful in future:

- Providing the enhanced whiteboard with a multicast facility s.t. it can be used for teleteaching as well. Note that this implies the implementation of a transmission protocol and of a viewer for the receiver.
- Inclusion of a HTML3.0 formatter for presenting HTML-documents. This will be the key for using large distributed electronic libraries (e.g WWW or Hyper-G based) as source for online teaching.

It may also be desirable to edit the recorded material; for example, the lecturer wants to cut out pauses or mistakes, and he may want to merge material from different lectures. Current editors for audio- and video-streams are, obviously, not sufficient for this task (because one has to pay attention to the whiteboard stream, too). We have begun to implement an appropriate editor concurrently with the enhanced whiteboard.

References

[CGJ+94] M. Cheyney, P. Gloor, D.B. Johnson, F. Makedon, J. Matthews, and P. Metaxas. Conference on a disk: A successful experiment in hypermedia publishing. In *Educational Multimedia and Hypermedia Annual*, pages 129 – 134, Vancouver, June 1994. ED-MEDIA 94, AACE.

[Eri94] H. Eriksson. Mbone: The multicast backbone. *ACM Communications*, 37:54–60, 8 1994.

[KMS93] F. Kappe, H. Maurer, and N. Scherbakov. Hyper-G – a universal hypermedia system. *Journal of Educational Multimedia and Hypermedia*, 2:39–66, 1 1993.

[LH94] J. Lennon and Maurer H. Lecturing technology, a future with hypermedia. *Educational Technology*, pages 5–14, 4 1994.