

Integrating Lecture Recording with an LMS: An Implementation Report

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Abstract: The most obvious approach for integrating lecture recordings into a learning management system (LMS) is adding lecture videos to a course's presence in the LMS. Delivery of lecture recordings and access control can thus be facilitated by the LMS. A broader approach is coupling LMS and lecture recording system at all phases of content production and use. This paper describes an approach bringing together the virtPresenter lecture recording system and the LMS Stud.IP. In the pre-production phase, course data in the LMS is used to schedule the recordings in lecture halls that are equipped with recording hardware. In the production phase, this scheduling data is used to determine in which lecture hall a recording takes place and start the recording automatically. In post-production, metadata from the LMS is used to tag the recording and connect it to the corresponding course. In the usage phase, authentication and access to the content using the virtPresenter player is handled by the LMS.

Introduction

At many universities, lecture recording is becoming an increasingly important part of the e-learning content portfolio. Especially when used as a supplement for a traditional lecture, a recording captures most of the information delivered in that lecture. Apart from being 'just' a kind of e-learning content, it also conveys the fact that others are learning too and that the content is taught by an actual person. In other words, watching a recorded lecture might be the next best thing to actually attending a real life lecture, added the benefit that a student can watch it wherever and whenever he or she wants to. But lecture recordings are not only attractive from the learners' point of view. They are also a feasible and cost-efficient way for traditional universities to take first steps into the direction of offering e-learning content (Müller, Ottmann & Zhang 2002). An important factor here is that lecturers do in most cases know how to give a good lecture. For a lecturer, giving a good lecture that is to be recorded does not require significantly less preparation than giving a good lecture that will not be recorded. Thus in 2003 the virtual teaching support center (virtUOS) at the University of Osnabrück has begun working with lecture recording. There it has soon become evident that while lecture recordings are easy-to-produce from the lecturers' perspective they still require a considerable amount of support behind the scenes. This support ranges from administrative steps and setting up recording equipment to cutting videos, preparing an internet presence of a recording and many other collateral actions (Mertens 2007). Given the fact that many universities possess only limited funding for e-learning, the cost of these support actions pose an obstacle that has to be overcome when lecture recording is intended to be used on a regular basis. This paper presents an approach implemented at the University of Osnabrück that tackles

this problem by automating most of the support steps involved in the creation and dissemination of lecture recordings. The implementation of this approach is realized by combining the LMS Stud.IP which is established at an institutional level at the university and the virtPresenter open source lecture recording system. The remainder of this paper is organized as follows: section 2 briefly discusses a number of related approaches for automatic lecture recording at an institutional i.e. university wide level. Section 3 presents the IT involved and section 4 describes how the coupling of the LMS Stud.IP and virtPresenter is realized.

Related Work

Many approaches tackle the problem of automatic lecture recording at the level of single recordings. In these approaches every step from recording a lecture to creating a fully navigable multimedia document is fully automated. Issues concerning collateral actions such as reserving appropriate lecture halls and distributing the content produce do, however still involve a considerable amount of manual work. In an approach presented in (Knight, Steinbach & White 2002), classrooms are equipped with fixed recording equipment and start/stop recording lectures at times that are previously defined. Videos are processed automatically and uploaded to a webserver without manual intervention. The ProjectorBox system continuously records RGB information sent to a lecture halls's projector and detects when one presentation end and when the next one begins using a heuristic method (Denoue, Hilbert, Adcock, Billsus & Cooper 2005). The EYA system records a lecture hall in one-hour slots and stores them on a web server (Zennaro, Fonda & Canessa 2007). While these systems fully eliminate any manual intervention in the preparation and distribution of the recording, they do not provide students with any symbolic information about the lectures content, except for maybe a course title. In order to improve the searchability of these recordings, symbolic information like course session titles and slide texts can be used. In the virtPresenter this information is obtained by reading it from an LMS and by analysing lecture slides.

IT involved

For lecture recording and distribution, virtUOS applies four open-source solutions, virtPresenter (www.virtpresenter.org) for automatic lecture recording, the Lernfunk (www.lernfunk.de) content management for audio-visual e-learning content, Stud.IP as a learn management system and the universities student / lecturer blog-farm which is based on WordPress Mµ.

virtPresenter is a lecture recording framework. One component of this framework is a small client that runs on the lecturer's PC to start and stop the recording. Another component serves the purpose of recording audio and video in a lecture hall. This component is triggered by the software on the lecturer's PC. The software on the lecturers PC also collects all necessary information for indexing and synchronizing slides to the video in case PowerPoint is used by the lecturer. After the lecture an automatic system of conversion servers produces lecture recording in Adobe Flash 9 and, if needed, also podcasts in different formats for extern platforms like the popular iTunes music store (Ketterl, M., Mertens, R., Morisse, K. & Vornberger, O. 2006). A more detailed description of virtPresenter's standard production chain can be found in (Mertens, Ketterl & Vornberger 2007). The virtPresenter framework contains a custom-developed Flex3/Flash player for replay. The player comes with a video slider that allows to pick single slides directly and provides functions for lecture editing and bookmarking via browser for social networks like facebook for example. While this paper shows how virtPresenter can be integrated with an LMS, the framework can also be used on a stand-alone basis.

An important intermediary component in coupling virtPresenter and Stud.IP is Lernfunk (Birnbbaum, Rolf & Wulff 2008). Lernfunk is developed to collect all metadata for audio-visual e-learning content produced by both the University Osnabrück and the University of Applied Sciences Osnabrück. Based on this database, the e-learning content can be distributed to the different systems in the university. The most important target system for the lecture recordings is the LMS which provides the students' access to the recordings. Other systems are the lernfunk.de portal which allows public access to the universities lecture recording, then the universities homepage to use the content for university marketing and the virtUOS PMWiki farm, where the recordings can be integrated into e-learning modules. Lernfunk's role in integrating Stud.IP and virtPresenter is that it operates as an intermediary content management for the lectures recorded. This step is necessary as Stud.IP itself is not a content management system. Fig. illustrates the role of lernfunk in distributing lectures recorded with virtPresenter.

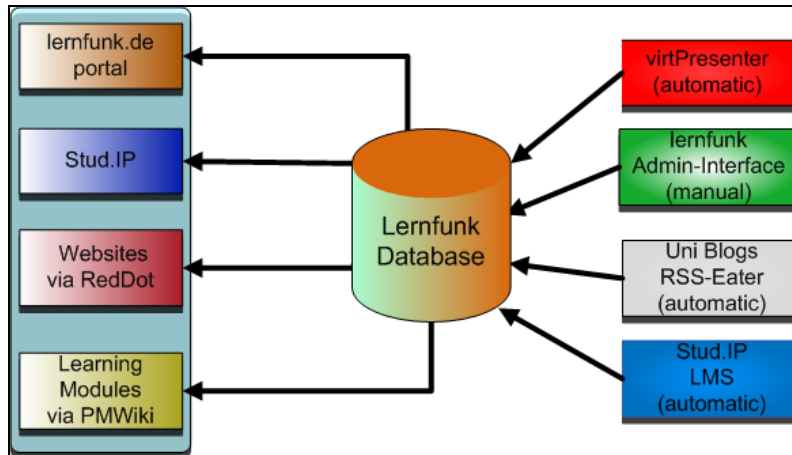


Figure 1: role of lernfunk database

In order to make learning objects like lecture recordings accessible by other systems within and outside of the university, lernfunk associates learning objects with metadata. This metadata is stored according to the ELAN Application Profile ELAN-AP, an inter-university standard agreed upon by a number of Universities in Lower Saxony (DINI 2005). This format contains a subset IEEE LOM and Dublin Core and contains 17 obligatory and 4 optional characteristics for courses and 16 obligatory and 5 optional characteristics for content objects. The size of 16 resp. 17 obligatory characteristics per object has shown to work in practice given the fact that parts of these metadata can be extracted automatically from other systems.

The base data set was also extended by further tables and columns, which provide for correlating content that is stored in different systems. Among other things, these extensions make it possible to assign recordings of a series of events to several courses within one Stud.IP installation.

Standards such as ELAN AP, LOM or Dublin Core consider all necessary data related to E-Learning. In daily use, however, additional data is needed. for the LMS binding and new distribution channels like iTunes or RSS feeds. Therefore, lernfunk adds additional data that links learning objects to courses in the LMS or to specific feeds.

Stud.IP is an open-Source learning management system which is widespread in Lower Saxony's universities. The system can be extended with custom built plug-ins. This mechanism has been used to integrate the virtPresenter viewer into the LMS. The virtPresenter Stud.IP plug-in is currently available in Version 0.2 and provides a list of all available recordings and a alternative web user interface described in more detail in (Ketterl, Mertens & Vornberger 2008) for previewing the video respectively the slides of the lecture recording. In the standard case, a recording will not only be used for the course in which it is recorded. The Lernfunk system allows to distribute the recordings to several courses in the same or other Stud.IP installations at other universities. This enables universities to exchange lecture recordings among each other.

The Web Lecture Production Process

The process of automatically producing a recorded lecture can be regarded as consisting of four significant phases described in (Hürst, Müller & Ottmann 2004). These phases are preparation, live event & recording, post-processing and usage. Fig. 2 gives an overview of how the coupling of Stud.IP and virtPresenter is realized in these four phases.

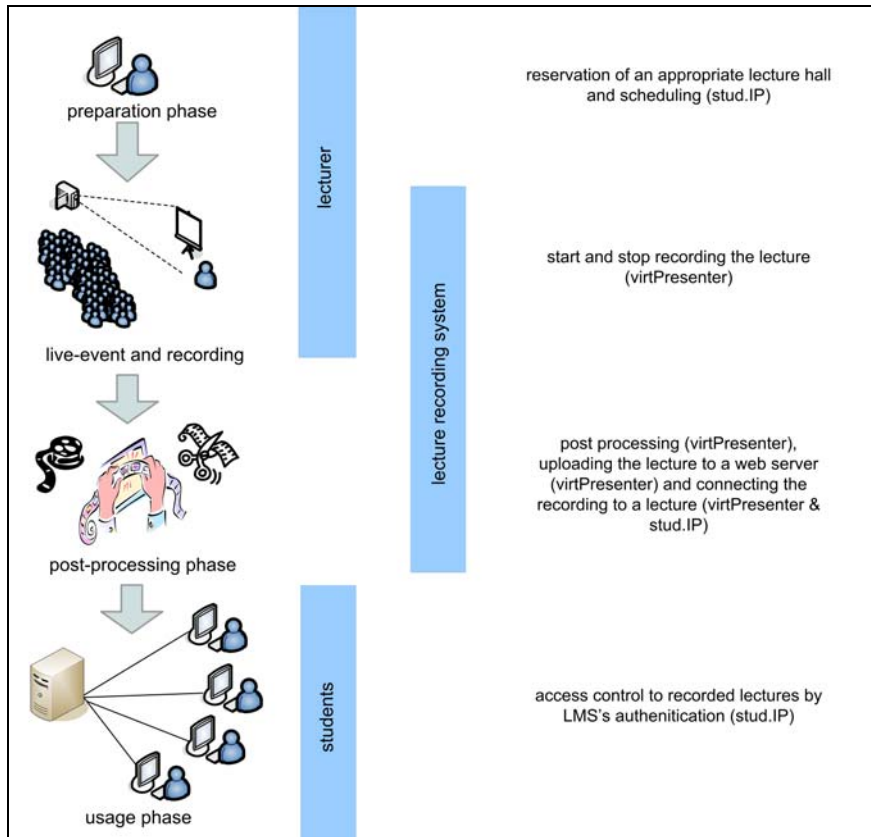


Figure 2: coupling of virtPresenter and LMS in phases of production and usage

The preparation phase starts with selecting the courses that should be recorded. Stud.IP is used for planning lecture hall reservation at the University of Osnabrück. So if a course is planned to be recorded, it can easily be scheduled in a lecture hall that is equipped accordingly. The second step is to select a unique course-ID for the virtPresenter. If there is no preferred manually selected course ID the Stud.IP course-ID will be taken. Some of the metadata required (lecturer name, lecturer-ID, seminar title) for the course description in virtPresenter can be taken from the LMS, too. This way, a recording can easily be associated with a specific course in the LMS.

In the second phase (live event & recording) no direct coupling between Stud.IP and virtPresenter is needed. However, data about the lecture theatre in which the recording takes place is required. This data is needed since virtPresenter uses recording equipment that is installed in a number of lecture halls (Mertens 2007). This recording equipment is controlled by one server per lecture theatre. The server records audio and video in the MPEG2 format which is later converted into Flash video. The IP of the server that is located in the lecture theatre is saved in a course specific content file that was generated manually in the preparation file using the course schedule and a correlation table of lecture halls and the respective video recording servers. Fig. 3 gives a schematic overview of the recording process and the post-processing phase. Recording equipment is installed in the lecture hall and is thus continuously accessible by the recording server (1) even though no video or audio is recorded when no lecture is scheduled. When the virtPresenter lecturer component is engaged by the lecturer, it sends a start signal to the recording on server (1) and gathers synchronization data on the lecturer's PC. During the lecture, this component also collects event data like slide changes and when an item appears on a slide. This data is later synchronized with the video. When the lecturer finishes the presentation, the component automatically sends a stop signal to the recording server (2), and initiates the post processing phase by sending a signal to the video converter (3) and the generator (3).

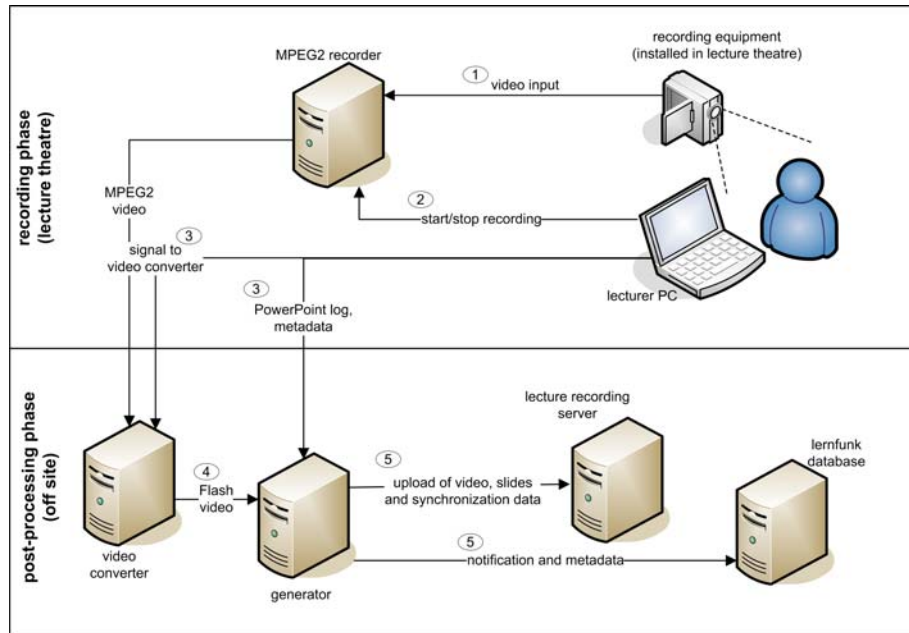


Figure 3: virtPresenter production process

In the post-processing phase, the lecture video recorded by lecture hall equipment and the slide presentation used by the lecturer are combined into one multimedia document. Once the video-converter receives a message that a lecture is finished it retrieves the respective MPEG2 file from the lecture halls video recording server. Then it converts the source video into Flash video for web delivery and cuts it so that the video starts at the same time index when the presentation was started at the lecturer's PC. This way, video and slide data become synchronized. When video processing is finished, the video is send to the generator (4). On the generator, the original PowerPoint presentation is turned into SWF. Textual information and information about slide events and slide changes are synchronized to an index which can be used for searching the recording in the usage phase. At the end of the post processing phase, the virtPresenter production chain writes the metadata for the recording including the course ID exchanged in the pre-production phase in the lernfunk database (5) and stores the flash slides along with synchronization data on a lecture recording server that is used for delivery in the usage phase.



Figure 4: virtPresenter integration in StudIP

In the usage phase, a list of recordings can be added to a course web site in the LMS. If a course has been linked to a set of recordings (like all recording from the course sessions), this list is automatically generated from a database and thus always up to date. Courses can also be linked to other lists of recordings which are composed manually. In order to facilitate navigating in the list, a preview player is added to the LMS as a plug-in (see figure 4). The preview player is described in more detail in (Ketterl, Mertens & Vornberger 2008). When students decide to watch a certain recording, it can be opened in the fully fledged virtPresenter lecture viewer described in (Ketterl, Mertens & Vornberger 2007).

However, coupling between the LMS Stud.IP and virtPresenter does not end at this point. The LMS can also be used for authentication management in case the lecturer decides to make a recording available to a limited audience such as student of that lecture only. Details of how authentication can be routed to the LMS are described in the next section.

Lecture Retrieval and User Authentication

In the usage phase, recordings are available from the lecture recording server (Apache blazeDS in combination with the open source Red5 streaming server), which handles besides the normal web server service also the communication with the involved web services provided by lernfunk and studIP in combination with the virtPresenter Adobe Flex based web interface. Links to recordings can be embedded in arbitrary web sites or they can be retrieved from the LMS Stud.IP or from lernfunk DB. In Stud.IP, all recordings that share the course ID with a course are automatically listed on that course's webpage. In lernfunk DB, recordings are associated with metadata that facilitates finding recordings belonging to certain topics or categories.

As mentioned before, not all recordings are available for public access. Hence an authentication process is required for some recordings. At present we distinguish between three main usage scenarios for the recordings.

Scenario 1: The web server provides web lectures marked as publicly available without checking the LMS or the lernfunk DB. The recordings can be accessed directly.

Scenario 2: Students use the recordings with the LMS virtPresenter plug-in (figure 3). The recordings are only available for students belonging to a course. Whenever a student has logged in the LMS, a session handles and identifies the user for the lecture recordings. There is no additional authentication after the student has logged into the LMS.

Scenario 3: Restricted recordings are requested from outside users via an external system (for example, users access the recordings over the publicly available www.lernfunk.de website). The virtPresenter web interface directs the user to the LMS login screen to authenticate. After successful login, the user is authenticated with a unique session handler and can watch the web lecture.

Behind the scenes, the user web interface checks whether the recording is allowed for a public audience (in collaboration with the backend system) or if there are any access restrictions whenever a virtPresenter lecture recording is used. Figure 5 (lefthandside) depicts a simplified overview of the systems involved. The figure depicts three different stations (a,b,c) for the virtPresenter user authentication process.

Part *a* in figure 5: The web interface reads an associated xml file which includes besides other meta-info (like lecture room, time, lecturer, course) also information about user access policy. This is the first step and is provided by the web server. Currently we provide three access policies. Policy 1 indicates that recordings are open for public use, policy 2 indicates that the university LMS is used for user authentication. policy 3 restricts the web lectures to selected users for other system. Additional policies can be defined to handle other systems.

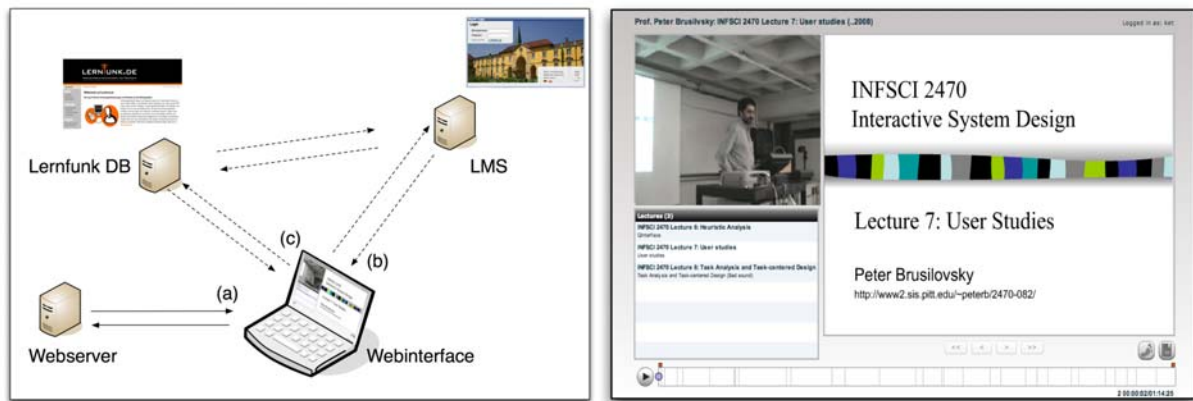


Figure 5: Simplified virtPresenter system communication (left) / virtPresenter web interface (right)

Part b in figure 5: The recordings are restricted to LMS users. The virtPresenter web interface calls an LMS web service to check if the user is already authenticated in the LMS or, in case this check fails, directs the user to the LMS login screen. Besides this authentication, the system web service can also verify if the user is a seminar participant. If the user was already authenticated in the LMS, the web lectures start immediately. A so called unique session id enables the web client to identify the user and the authentication state of the user over a certain time period.

Part c in figure 5: The lernfunk db stores, besides the course recording lists also anonymised user data for public and student users. This information is used to manage user notes, bookmarks, lecture parts etc. Lernfunk is connected to the university LMS to check whether a user is new or already in the system.

A more technical description about available web service interfaces and data exchange for the lernfunk db and the university LMS can be found at www.virtpresenter.org.

Due to the fact that only estimated 8% of the lecture recordings at our university are open for public use, the access control (user authentication) via the university LMS is most important to assure that only authorized students can access the learning content. Other universities appear to have similar problems concerning their content. A positive trend that we could discover during the last months is that more and more lecturers are willing to open up their recordings for outside systems and for public use.

Conclusion and Further Work

The virtPresenter lecture recording framework was initially designed as a stand-alone set of tools for lecture recording and replay. Every-day experience with the system has, however, shown that a number of routine tasks in lecture recording can be facilitated by coupling the lecture recording system with the University's LMS and content management system (CMS). This paper presents a solution to this problem that is custom tailored to the LMS Stud.IP which is the LMS of the University of Osnabrück as well as a significant number of other universities in Lower Saxony. In other settings, in which an LMS already contains its own CMS, an intermediate CMS like lernfunk DB might not be needed, however the overall coupling strategy presented in this paper might also be applicable. The features described in this paper have been used in operational mode for several months and have already shown to decrease the ever-day workload of lecture recording administration personnel. Student feedback also indicates that single sign on provided by the LMS and web lectures is appreciated.

At the moment, a student project is implementing a version of the virtPresenter Player as an application for social networks like facebook or studiVZ. There are many parallels between an LMS like Stud.IP, which has a focus on communication between the users and these social networks. The users have profiles that provide information about them, so they can build groups with their friends. There are messages, guestbooks, forums, chats, etc. with which the users can communicate. In a way, these networks can be an alternative for recordings that are not restricted to the students of a special course only.

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