Turning Web Lectures into User Generated Adaptive Multimedia

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Abstract

Adaptive Hypermedia bring a major benefit of traditional face to face teaching to electronic media in that they allow to custom tailor the way in which one media object is delivered to different users. While the creation of Adaptive Hypermedia is a highly labor intensive process for text based media, creating adaptive multimedia documents poses nearly insurmountable obstacles. This is mainly due to the fact that creating and editing multimedia documents requires considerably more effort then the creation of text based documents. However, recently more and more universities have begun to make video lectures publicly available. Community efforts like the Opencast project aim at standardizing video lecture formats, making re-use of content from different institutions possible. Involving end users can decrease per capita workload by involving learners in media creation. This paper describes a basic technology framework that empowers end users to create adaptive multimedia documents by merging parts from different sources.

1. Introduction

Adaptive Hypermedia differ from conventional hypermedia in that content presentation can be adapted to the user [3]. A popular application scenario for Adaptive Hypermedia in eLearning is custom tailoring the content presented to the users' level of understanding. This way users who visit the same node in a hyperdocument can view two totally different versions of that node. Each user is presented exactly with the content that explains the content of that node in a way that is suited best to the students current level of understanding [13] or learning style [5]. The approach presented in this paper shows that these advantages can also be applied to multimedia learning documents. To these ends a prototype player component for adaptive web lectures is introduced.

This paper does not focus on learner modeling, hence adaptivity in the player is not achieved by a complex user model but by a manual adjustment function.

However, the paper tackles the problem of authoring for adaptive media which has shown to be the main reason why Adaptive Hypermedia is not as common as one would expect [4]. The adaptive multimedia player introduced in this paper is based on the virtPresenter web lecture player which is used in the Opencast project, an initiative of more then 250 institutions aiming at the collective use of web lectures an podcasts. This opens up the possibility of re-using multimedia content from many institutions as a source for creating adaptive multimedia documents.

Another problem with generating adaptive multimedia documents in contrast to Adaptive Hypermedia documents arises from the fact that editing multimedia documents is far more labor intensive than editing text documents. In order to tackle both problems, the approach presented in this paper employs a web 2.0 strategy by empowering end users to create adaptive

multimedia documents by merging parts from different web lectures in an online interface.

The remaining course of the paper is organized as follows: Section 2 briefly describes related work in a number of fields touched upon by the approach presented in this paper. Background information on the Opencast initiative is presented in section 3. The basic concept of Adaptive Multimedia is introduced in section 4 while the actual prototype player is described in section 5. The paper concludes with an outlook on planned work in section 6.

2. Related Work

The approach presented in this paper is based on two important developments. These are the development of bookmarks in multimedia content and the idea of exchangeable learning objects in eLearning.

Exchangeable bookmarks form the basis for user driven editing of multimedia documents in the approach presented in this paper as further described in section 5. In classical hypermedia, bookmarks are a basic concept that is part of standard hypermedia navigation [2] and can be found in any modern web browser. Users can bookmark websites in order to facilitate retrieval of these websites at a later time. This concept can also be applied to multimedia like web lectures. The time based nature of these multimedia do, however make it necessary to extend the concept by adding a time based description such as a start point and an end point for replay in a video [10]. Up to date, time based bookmarks are very rare in web lectures, the only examples known to the authors are described in [10] and [11]. However, a number of video annotation tools such as the University of Georgia's VAT [12] offer functionalities for pointing to passages in a web lecture with a start and an end point in the video. For an overview of video annotation tools see [12].

Research in e-learning technology with respect to the concept of reusable learning objects and their standardization has evolved in the last years [1, 9]. Isolated learning resources that are created for specific applications are still an open problem for technology enhanced learning (e.g., exchange content between different learn management systems). The term learning object has different meanings for different people.

Definitions range from a small text, a picture up to a complete learning curriculum. Metadata standards like LOM, Dublin Core or SCORM exist to classify or group learning objects. Problematic is the concept of granularity that refers to the smallest item that can be used from a course. This is even more complicated for audio/video based material (especially in 1.5 h lecture recording). Identifying a small section in a video that exemplifies a certain topic implies that users know the recorded material. The approach described in this paper solves the granularity problem in audio/video material by giving users the ability to select and glue parts from different lecture recordings and make these recorded objects reusable.

3. Project Opencast

For more than a decade, international universities and research institutions have been experimenting with lecture recording. However, it is only in the last five years that, spurred by the development of "podcasting" technology, quantity, quality and use of the recordings have reached a level, which makes lecture recording and video management of strategic importance for universities. Carefully worded one could say that recorded material out of lecture halls gets much more attendance than typical e-learning content (examining only the user downloads).

The Opencast Project (http://opencastproject.org) with its Community is an international partnership of universities, academic institutions and individuals exploring the issue of "audiovisual objects" in academia. Until now, approximately 250 institutions have officially expressed their interest in the community. The Opencast community also supports community-driven projects to solve common issues in management of academic audiovisual content. These projects will include open source software development, such as the enterprise lecture recording system Matterhorn (the virtPresenter framework will be part of this system) and research focused projects. Particularly together with the metadata format to be specified, the Matterhorn software project and the collaboration within the Opencast Community enable its members to exchange and re-use audio/video based learning objects in a defined fashion over institutional and national boundaries [8].

4. Adaptive Multimedia

In this paper, the term Adaptive Multimedia was chosen to highlight the similarity between the approach described in this paper and Adaptive Hypermedia. In many Adaptive Hypermedia approaches, links are presented in a fashion that is adapted to the users' needs [3]. Adaptation of links might mean that links are reordered to reflect the order of importance of the links with respect to the current user's interests or level of knowledge. It might also mean, that on one web page, a certain set of links is presented to one user

while a totally different set of links is presented to another user, depending on the user's profile in the system.[1] In some systems adaptation is not realized on the level of links but on the level of content chunks so that users with different profiles are provided with different content on the same web page [3]. For instance, different versions of a paragraph or a figure could be displayed based on the current user's profile.

Since multimedia consists of continuous streams like audio or video, links can not be integrated in a multimedia document as easily as in a text document. However, chunks of content can be defined, that address a certain topic or sub-topic. In web lectures, these chunks could be segments of the recorded lecture in which the lecturer explains a certain concept or elaborates on a specific detail. By offering different versions of these segments as well as a rating of these alternative versions, a multimedia stream can be made adaptable in a sense that a segment from a multimedia stream can be replaced by an alternative segment that is better suited to the user's needs.

In the approach presented in this paper, the rating used for applying alternative segment for a stream is the difficulty level of the content as rated by users. As shown in figure 1, different segments of a video stream (*alt1*, *alt2* and *alt3* in the original stream) can be linked to replacement segments from other video streams that can serve as alternatives to the original segment.
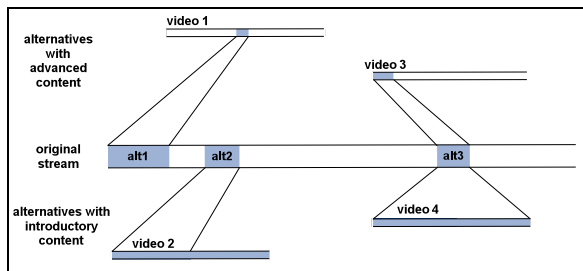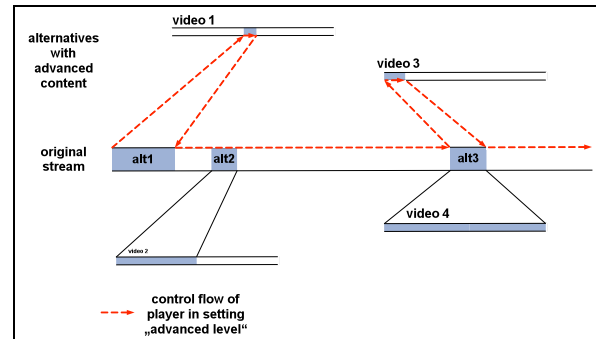

Figure 1: video with alternative segments

Note that a segment need not necessarily be linked to alternatives on all difficulty levels. Segment *alt1* only has an alternative on a more advanced learning level, while *alt2* only has an alternative on a more basic level. Segment *alt3* has both a more advanced and a more basic alternative.

Once a segment in a stream is linked to one or more alternatives, these alternatives can be taken into account when the stream is replayed in a suitable player. Figure 2 depicts the player's control flow in

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[1] In fact, different presentations of one web page can also be displayed to the same user, provided that users have different profiles or the users' profiles change over time.

case a user watches the above described stream with a profile that demands for advanced content. Instead of playing the original stream, those segments that are linked to alternatives with a more advanced rating are skipped and the respective alternatives are played instead.

Figure 2: control flow of player in mode "difficult"

While this basic idea is relatively simple to implement, adaptive multimedia applications are only feasible if enough alternative segments for a given video segment are available and if these alternatives are actually connected to that given segment.

For this reason, it is extremely important that any adaptive multimedia effort is backed by a huge content repository. It is also important that the right kind of alternative content passages for a given content passage can be found in that repository.

While creating learning content suitable for a specific learning style is a rare endeavor, creating content for different levels of knowledge is much more common. On the one hand, developing content for a specific learning style requires deep pedagogical understanding and can be quite a labor intensive process, for instance if it involves animated visualizations. Different version of learning content that tackle the same topic from varying perspectives and thus with varying depths of knowledge are on the other hand commonplace at most universities. An example of learning content tackling the same topic at different levels of difficulty and depths might be courses in mathematics that are designed for computer scientist, mathematicians, biologists and so on. At many universities, a special course is taught to each group, covering similar topics but at different pacing and different levels of difficulty. Alternative presentations of the same learning content are also created, when the same content is treated in a graduate course and in an undergraduate course. In undergraduate courses, the same content is usually presented at a slower pace and in a more shallow fashion.

For these reasons, the approach described in this paper does not provide adaptivity in terms of learning styles but in terms of difficulty levels.

The next section describes the adaptive multimedia player and the mechanism for adding an alternative passage to a given passage. This mechanism can be used by every user of the system to enable users to add new alternatives by themselves.

5. The Adaptive Multimedia Player

The Adaptive Multimedia player presented in this paper is based on the virtPresenter web lecture player. This player is part of the virtPresenter recording framework that is used to capture and process lecture and conference recordings in an automated way.

virtPresenter is able to combine recorded materials like the video of the speaker, presentation slides or screen capture videos and present this media in a synchronized manner in a platform independent web interface that can easily be integrated in other web based systems (figure 3 depicts the virtPresenter web lecture player). In addition the web lecture interface also implements a number of interactive navigation features like slide based navigation, visible scrolling for slides and video, a distributed search or the possibility to edit and extract parts of the recordings online and re-use these media snippets as multimedia hyperlinks in outside systems (e.g. student blogs, wiki pages, course websites) or as personal user bookmarks. More information about the virtPresenter recording framework, the user interface and architecture decisions can be found in [6,7].

In addition to the interface elements described above, the Adaptive Multimedia player is equipped with a selector for the presentation's difficulty level. In the current implementation, three different difficulty levels [introductory, intermediate and advanced] can be selected. Depending on the difficulty level selected, the player either shows the original lecture or replaces segments to which an alternative with the proper rating (easy or advanced, depending on the selected level) exists with that alternative.

Red lines above or rather green lines beneath the video scrubber in figure 3 highlight alternative media sequences from other recordings that represent user generated sections with a corresponding content difficulty level adjusted by the users (red – advanced, green – introductory).

On the right side of the video scrubber one can find the button by which users can adjust their level of under-standing. Once a user has selected "the beginners" mode – virtPresenter is able to seamlessly present the alternative sections instead of the original content.

Once the alternative section is finished or the difficulty button is pressed again, virtPresenter shows the normal recording.
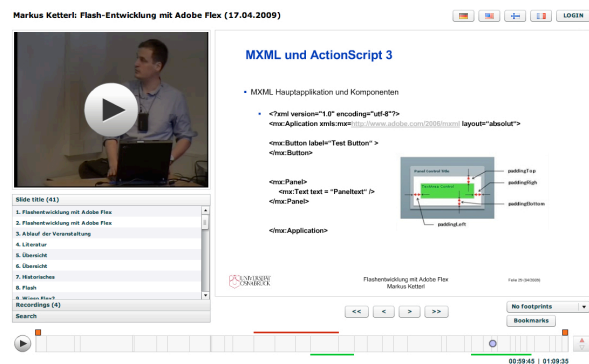

Figure 3: virtPresenter web lecture player

In the virtPresenter Adaptive Multimedia player, an ordinary web lecture can be turned into an adaptive web lecture by adding alternatives to one or more segments of the original web lecture. For each segment, this can be achieved in the two steps described in the next two subsections.

Selecting a Segment

Segments can be created using virtPresenter's bookmark function. A bookmark can be created by selecting an arbitrary time index in a video and an arbitrary end index.
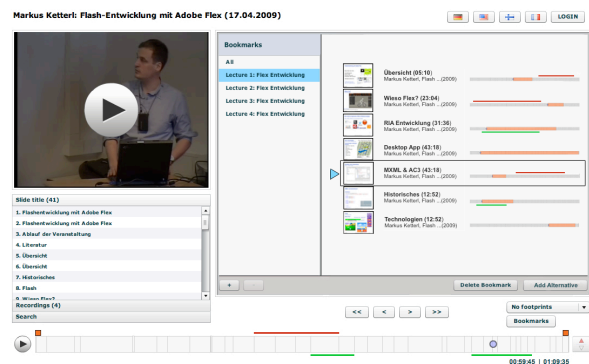

Figure 4: virtPresenter in Edit_Adapt_Mode

The fact that arbitrary segments can be selected makes bookmarks flexible and allows for marking segments that encompass exactly the passages to which an alternative exists, be it a sequence of slides or just a small passage within the presentation of one slide. All bookmarks for a web lecture episode can be shown in a special interface mode called Edit_Adapt_Mode.

This mode is accessible to all users. In Edit_Adapt_Mode, each bookmark of the selected web

lecture episode is displayed with information of where the bookmark is located within the episode (see figure 4).

Each bookmark also shows, whether an alternative has already been assigned to it. It also shows the difficulty of the alternatives assigned in relation to the currently selected difficulty level. New alternatives can be assigned by choosing "add alternative" in the bookmarks box.

Adding an Alternative

When "add alternative" is pressed, the window shown in figure 5 opens. This window allows searching all of the user's personal virtPresenter bookmarks. Since a bookmark is a passage from a web lecture video, it can serve as an alternative to the segment selected in the original lecture and be replayed instead of that segment.
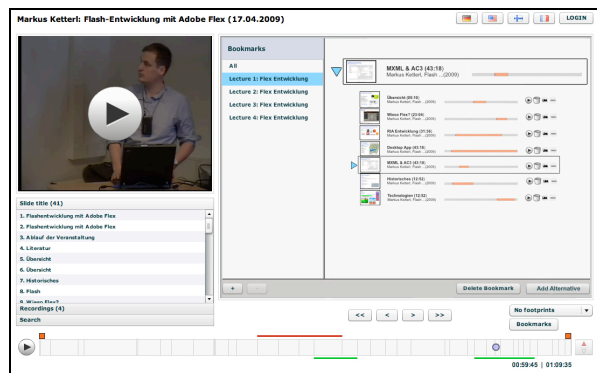
Figure 5: virtPresenter - selecting a bookmark alternative

As bookmarks can also be exported an imported via hyperlinks, users can also enter a virtPresenter hyperlink to a passage in another web lecture (or even in the same web lecture). These hyperlinks are automatically checked by virtPresenter in order to guarantee that they point to an existing video and that the time indices are correct.

A noteworthy point is that a segment in a lecture video and an alternative segment assigned to that segment need not be of equal length. For instance, a brief segment in an advanced lecture could be linked to a whole session of a lecture that presents equivalent content on a more basic level.

Recursive Use of Alternative Passages

While the process of generating Adaptive Multimedia with virtPresenter player can be summarized by the description above, some minor conceptual problems might arise, when bookmarks are used in combination

with Adaptive Multimedia as realized in the approach presented in this paper. The following passage briefly describes these problems as well as the solution chosen in virtPresenter.

Bookmarks that are used as alternatives might have been created using a video that also is a piece of Adaptive Multimedia. In figure 6 this is shown in the introductory alternative to *alt3*. This alternative is video4 which in turn is linked to videos 5 and 6.
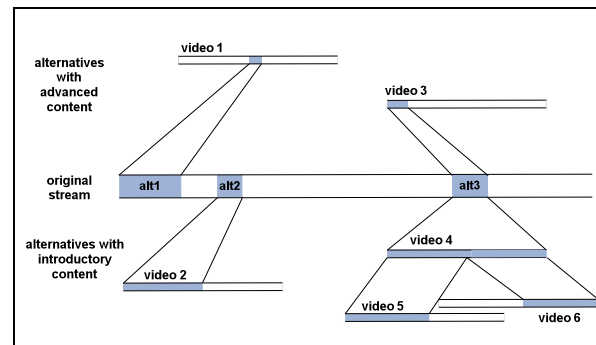
Figure 6: recursive use of alternatives

The problem with this constellation is that the bookmark might have been taken at another difficulty level than "intermediate". In this case, the content watched by the user while creating this alternative has to be preserved in order to avoid later changes. For instance, if an alternative were added to a segment of video 4, the introductory level alternative to *alt3* would also change. In order to prevent this kind of unintended content modification, alternatives are stored in a way that preserves the content shown to the user while creating an alternative with a bookmark. This means that not only later changes are avoided but also that the difficulty level selected while creating an alternative is taken into account. I. e. a bookmark that was taken of a web lecture playing at level "introductory" is replayed with exactly the alternatives of level "introductory" that were in place when the bookmark was created. Whenever such a bookmark is played, however, the user is notified that an updated version of the bookmark exist and can replace obsolete alternatives. An implicit update is, however, not possible since it would alter the semantics of a bookmark.

6. Future Work

The approach presented in this paper is just a first step in the direction of adaptive multimedia in web lectures. While the bookmark mechanism enables every user to actively work on the system's adaptivity, selecting just the right bookmarks is difficult in two senses. First, bookmarks can be cut out of a video at any position.

This means that an arbitrary bookmark usually starts somewhere within a sentence or even within a word. Hence, finding methods that facilitate creating bookmarks that do coincide with sentence boundaries or word boundaries is one of the future steps in enhancing the interface. These methods would lead to a much better quality of a user generated adaptive web lecture.

Another step could be the integration of the approach described in this paper with a tutoring system that determines a user's level of understanding of a web lecture's subject. This way, an appropriate level of difficulty for a web lecture could be chosen automatically by the system. Currently, there are, however, no concrete steps taken in this direction.

The system components described in this paper will be part of the Opencast Community Matterhorn software solution. Evaluation tests are planned for the next semester.

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