Studying with Mobile Devices: Workflow and Tools for Automatic Content Distribution

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Abstract: Recordings of lectures are a cost-efficient and easy-to-use way to produce e-learning content. In a university context with tight financial constraints they can only be used if the production process is automated to a high degree and a manual intervention is not necessary. With the emergence of powerful mobile devices like PDAs, mobile phones or audio players with audio and video playback it is highly desirable to integrate these devices in the educational chain. This paper describes a highly automated workflow to support e-learning content on different mobile devices. By adaptation of the enhanced podcasting technology in combination with lecture recordings and a flexible distribution system via internet as well as a Bluetooth-based distribution server, different types of mobile devices are supported for e-learning purposes.

Introduction

Lecture recordings have shown to be a cost-efficient and easy-to-use way to produce e-learning content (Lauer & Ottmann 2002). Employing lecture recordings as supplementary material in a conventional lecture has become a widely used application scenario (Krüger 2005) even though lecture recordings can also be employed in a number of other ways (Mertens, Knaden, Krüger & Vornberger 2004).

When used as a supplementary means in a conventional learning scenario, the role of lecture recordings resembles that of scripts or textbooks (Zupancic & Horz 2002). There are, however, a number of factors, that differentiate the way users can interact with lecture recordings from the way in which books can be used. Navigation within the recorded material and the possibility to use a book or script at any place, without having to carry around a laptop are most likely the two most important differences in the described application domain. While navigation has already been tackled by some approaches (Hürst & Götz 2004; Mertens, Müller, Schneider & Vornberger 2004), ubiquity is still an unsolved issue.

If students could use lecture recordings on a small mobile device, they could even use them on a bus or train when commuting. For this reason, a number of students had inquired for sound-only audio versions of the recordings of

some lectures recorded at the University of Osnabrück and at the University of Applied Sciences Osnabrück. These sound-only versions did, however, bring across only a fraction of the information conveyed in the lecture as they lacked the lectures' slides. Another drawback of this technology is constituted by the fact that students have to download the audio files to their players manually at an internet connected computer.
In the past, several interesting technologies have evolved to overcome these drawbacks. With podcast technology the explicit download driven by the user can be eliminated as the data is automatically handled on the receiver's end and downloaded to the play list of the playback device as long as the receiver subscribed to the cast. The latest updates are always readily available with no effort required by the listener. An enhanced version of this podcast technology offers a way to link pictures to an audio stream in a synchronized manner. Thus it is possible to offer a comparably high quality recording of a lecture on a mobile device.
Podcast technology can not only be used on the popular audio player iPod from Apple but also on other devices like mobile phones by usage of suitable players. When considering mobile devices, the distribution of learning content is an important issue. High communication costs for Internet access with mobile phones are a barrier for students to use lecture recordings on their phones. Therefore other distribution channels are necessary. To overcome this drawback a Bluetooth-based server as a Point-of-Information for e-learning content distribution has been developed which is capable of providing area-restricted media services for mobile devices. This approach makes it possible to offer lecture recordings not only over expensive internet connections but also as a free of charge area-restricted media service, whenever the student is close to that server.

This paper describes a prototype implementation of a workflow for the production of lecture recordings for mobile devices and is organized as follows. Some general requirements for usage of mobile devices for learning purposes are described first. After considering some related work a workflow for fine granulated lecture recordings for different mobile devices is presented. The paper is concluded with a description of future work and application perspectives of lecture recordings for mobile devices.

Requirements for E-Learning on Mobile Devices

Interesting and new applications are made possible with the emergence of powerful mobile devices like PDAs, mobile phones or audio players. They offer a promising option for ubiquitous learning. They can be used anytime and anywhere. However, several issues have to be attended in the context of computer supported learning processes with these kinds of devices. A clear separation between mobile devices and desktop systems has to be regarded (Steinberger & Mayr 2002). Mobile Devices will not substitute desktop-based learning environments but they will offer a valuable supplement. What are the requirements and facts for this ubiquitous learning environment, which is made possible with mobile devices?

- *Short usage*: Mobile devices usually have small visual user interface. They are not suited for long and intensive learning periods. Thus, usage time is short compared to desktop-based services.
- *Fast and precise access to learning material*: Short usage times require a very precise navigation to learning content. By offering recorded lectures on these devices, a direct navigation to the chapters and smaller semantic units of a lecture is necessary.
- *Easy-to-use*: The user interface of mobile devices is tiny. Complicated user interaction is a barrier for user acceptance. Thus, navigation has to be designed as simple as possible.
- *Media-support*: The small screen-size of mobile devices is not suited to offer long text material for learning purposes. In pictures with a high graphics resolution, many details can not be recognized. Audio is very well suited from the technological point of view, however, from a pedagogical perspective, the learning effect of audio-only material is not considered as high as the learning effect of audiovisual media.
- *Additional Benefit*: Lecture recordings as supplementary learning content are valuable if they can be accessed very precisely, i.e. the user can easily navigate to very specific parts of a lecture, e.g. a specific bullet point on a slide. With the availability of recordings on mobile devices, ubiquitous access is possible. The user can access the fine granulated content in situations usually not suited for learning, e.g. traveling or waiting.

Therefore, a simple mapping from desktop-based learning approaches to mobile devices will not work. A dedicated approach for learning scenarios on mobile devices has to be developed.

Mobile Learning - Related work

Learning with mobile devices is getting more and more attractive. The reasons for this are manifold. One reason is the increased computing performance and storage capacity of these devices. Another issue is the available transmission quality and bandwidth over wireless connections. Therefore, investigations on mobile devices for educational purposes are becoming more and more popular. A fruitful source for mobile educational technology and strategy is the workshop series *Workshop on Wireless and Mobile Technologies in Education* (WMTE), which is conducted since 2002 (WMTE 2002; WMTE 2004; WMTE 2005). There are three main purposes in which way mobile devices are used in education:

- *Organizational Purposes*: Mobile devices are seen as important tools to support the learn management process, i.e. for organizational purposes. In that context accessing campus information systems and services by mobile devices play an important role.
- *Communication Purposes*: As tools for communication, several investigations are done as to how mobile devices can support the work of learning communities. The aspect of context awareness is an area of intensive research.
- *Learning Purposes*: Off course, a lot of investigations are concerned with mobile devices as tools for direct access to course material. Only a few are considering lecture recordings as a supplementary service for students. In (Heinrich, Morisse, Niehoff 2003) a single source publishing approach for e-learning content is described, where the content is stored in XML-format and is converted on the fly for the particular device. Experiments have been made with Compaq PocketPC devices.

With the emergence of Podcasting and Enhanced Podcasting, this technique is expected to be a helpful tool for learning purposes. A lot of work is done in this area. A very popular project in a university context is (Stanford 2005). Lectures are recorded as audio material and are made available via Apple iTunes. The very fine granulated content presentation with image support is missing. (Herzog 2005) reports very positive feedback from the students by providing fine granulated chapters in a podcast service. Work in this article is following that direction. Main purpose is to automatize the production workflow with a fine granulated content presentation.

Fine granulated Lecture Recordings for Mobile Devices

This section presents an approach for highly granulated lecture recordings for computer-based platforms as well as for mobile devices. After describing some technical issues, a highly automated production and distribution workflow is presented.

Lecture Recording with VirtPresenter

The virtPresenter is a PowerPoint-based lecture recording system. It is currently being integrated with the learn management system Stud.IP in order to automate production of lecture recordings as described in (Mertens, Knaden, Thelen & Vornberger 2005). For the lecturer the production of a lecture recording starts with activating the recording tool which works in the background during the lecture.
The resulting lecture recording of the current production version is a web enabled presentation that incorporates a number of navigation features like full text search on the slide text or structural elements based on slide animations that are combined to a hypermedia navigation concept (Mertens, Schneider, Müller & Vornberger 2004). The development of the virtPresenter has started in mid 2003 and the tool has been used since then in a number of lectures to implement several didactic scenarios. Student comments and experiences with the technology have constantly been integrated into the development of the system.
With the use of animations on the slide level (like bullet lists or animated figures) as navigation elements and the additional possibility to set external links to arbitrary passages within the lecture (Mertens, Ickerott, Witte & Vornberger 2005), the virtPresenter offers a high degree of ‘semantic resolution’ that enables users to navigate to important passages at a click. The system even features a bookmark mechanism that allows users to mark arbitrary positions on the timeline persistently over different usage sessions.

Enhanced Podcasting

The word *Podcast* is a combination of the word *Broadcast* and the name of the popular audio player from Apple Computer called *iPod*. It is a bit of misnomer in that it implies that an iPod-player is required to listen to a podcast. In fact, a podcast can be used with a variety of digital audio formats and can be played on almost any audio player or

computer. (Meng 2005) Even on mobile phones it is possible to use podcasts. The term *Podcasting* describes the production, distribution and the automatic download of audio data from a publisher to a subscriber over the Internet. The digital sound object is passed to a Web site or a Blog in a data structure called an RSS 2.0 envelope or feed. RSS stands for *Real Simple Syndication* and is an agreed specification of XML tags. This envelope contains all the information about the audio object (e.g. URIs, publish dates, titles, accompanying text descriptions) in a XML data structure.

Enhanced Podcasts do not only contain audio information, but also integrate new data information that can be synchronized to the audio information. E.g. an image or an URL can be shown at a certain time concurrently to the audio information in a synchronized manner. There are software tools available to support the production process as well as the consumption of Enhanced Podcasts. Most of them are free- or shareware. Like usual Podcasts, Enhanced Podcasts can be used on different platforms and devices. Players are available for Windows or Mac computers as well as for mobile devices.

Enhanced Podcasts based on recorded lectures offer a very interesting approach to support the ubiquitous learning process. With the combination of a fine granulated structure of a recorded lecture, an Enhanced Podcasts allows a very precise navigation to specific content of a lecture that can be used anytime and anywhere. However, especially considering the very tight financial and personal resources at universities, the production process must be automatized to a high degree. A manual step in the production workflow of a supplementary Enhanced Podcast for a lecture is not acceptable. Through the combination of virtPresenter lecture recordings and Apples ChapterTool for segmentation of podcasts it is possible to automate the creation of Enhanced Podcasts on base of recorded lectures.

Content Distribution

Desktop Computer platforms and mobile platforms differ in many aspects. Due to the limited abilities (e.g. display resolution, media support, network access) of mobile devices, lecture recordings cannot be adapted and distributed that easily. The media has to be converted considering the specific requirements or better capabilities of different devices. A further important question is, how the recorded content can be loaded to the handheld, i.e. how the devices get access to the offered service?

Some mobile devices (Cell Phones or PDAs) can access local networks (the internet) with their wireless capabilities. WiFi and Bluetooth radio transmission supplement each other. Due to the resulting transmission costs UMTS and other over-the-air transmission technologies cannot be an option. Moreover many mobile devices (usually audio players) do not have this network access features. Usually, these kinds of devices get their content by a synchronization step over a direct connection, e.g. via USB, with a desktop computer.

Part of the work on e-learning for mobile devices is the development of a *point of information* (POI) for content distribution purposes (Ketterl 2004). The aim of this POI is the research and implementation of an area-restricted media service offer for mobile devices. However, first and foremost is the requirement of a content distribution service for learning purposes, which is free of charge to the user. For this reason, the POI relies on the Bluetooth radio technique, as this is now readily available and capable of good performance and above all does not cost the user anything for the connection and transmission. A further central issue was research into the extent of our daily used equipment in relation to the presentation and development of different media contents.

The POI server is able to offer and distribute media objects of different formats. Apart from the reduced transmission range (depends on the Bluetooth power class of the assigned product) the only restriction is the efficiency of the mobile device. Bluetooth lets these devices talk to each other when they come in range, even if they are not in the same room.

Media Production Chain

The post-processing of lectures that are recorded with virtPresenter comprises conversion of the recorded video from a high quality video to a web enabled streaming format, synchronization of video and slides and the generation of a navigation interface. The production process is described in (Mertens, Knaden, Thelen & Vornberger 2005), the interface is described in (Mertens, Schneider, Müller & Vornberger 2004). The use of two different video formats is due to the fact, that some teaching scenarios like the fixed-time-presentation-scenario described in (Mertens GI 2004) call for high quality videos while others like on demand viewing call for web streaming formats that can be used with lower bandwidth connections.

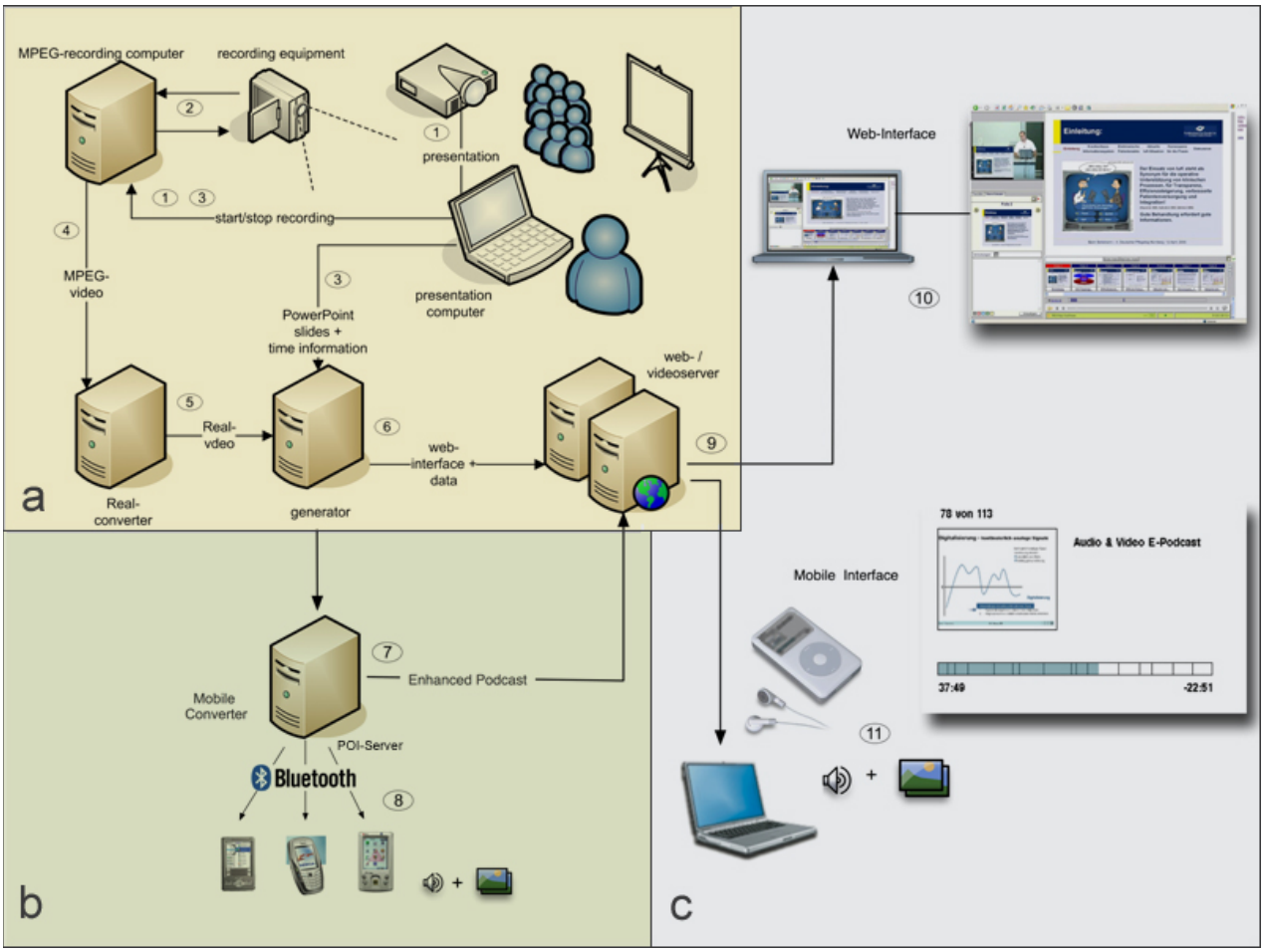

Figure 1: Media Production Chain

The automated production chain consists of the steps depicted in part (a) of figure 1: First the presentation and the recording of the video is started from the lecturer's laptop (1). The recording PC is connected to a video camera installed in the lecture hall (2) and to the lecture hall's sound system. When the presentation is stopped, a termination signal is send to the recording PC and the presentation slides as well as synchronisation information is send to the *Generator* PC (3) which will later generate the web interface. After receiving the termination signal, the recording PC sends the video to a converter PC (4) that converts the video to a streamable video in Real-format (Quicktime format is also envisaged). After the Real-video has been transmitted to the generator (5), the material is combined and a web interface is generated. During this step, the slides are also converted to the SVG (Scalable Vector Graphics) format, which allows an arbitrary scaling of the resulting images. The web interface then will be uploaded to a web-server and the video will be uploaded to a streaming server (6). The distinction of web server and video server usually is transparent to the user. The only reason for the use of two different servers is that video streaming allows users to watch parts of the video without having to download the whole file.

The *Mobile Converter* (7) in part (b) of figure 1 expands the production chain to respond to the characteristics of mobile devices. The *Mobile Converter* receives all the information needed to create Enhanced Podcasts for handhelds from the Generator (part a). It is supplied with the PowerPoint slides, the exact time/slide information, i.e. the interaction of the lecturer during the presentation, and with the videofile. The reduced abilities of the small devices makes it necessary to convert the PowerPoint slides (which are already converted to SVG images) to a format and size that can be handled by most devices. A compromise for that is the JPEG image format. The scaling of the image is done by the *Mobile Converter*. The next step is the extraction of the audio information from the recorded lecture and converts it to a suitable audio format for the mobile device. For an iPod, Apple's implementation of AAC (Advanced Audio Coding) is used, for mobile phones and other audio players, the audio data is converted to MP3 or (MMS) AMR. After the audio conversion, the XML description file with slide, time, title and further link information is

created. E.g. Apple's Chapter Tool is used for the iPod. Finally, all information, i.e. audio, time, slide images and the XML description is compiled to the final enhanced podcast. The final file is then transferred and referenced on the Web/Video Server (part a (9)) as an RSS feed. It is additionaly offered and disseminated as a distribution service from the POI server (7) to different hand-helds (8). Special enhanced podcast players for different mobile devices are in development. With the transferred RSS description on the webserver, users can get access to the lecture recordings by subscribing to the RSS feed on the website (Part c (11)), or they can access the standard web interface with a common Internet browser (10).

Summary and Future Developments

Recorded lectures as a supplementary service for students are used at several universities. Different technological approaches are available – commercial as well as free software. This paper describes an extension of lecture recordings for mobile devices by combining the virtPresenter technology with the podcasting technology. A highly automated workflow for a multi-channel lecture recording service has been presented. Services for desktop computers or computers in a mobile but networked environment, e.g. WiFi, are considered as well as mobile devices without network access. The latter are accessing content by downloading. Since communication costs for mobile phones, especially for data communication, are still very high, an alternative distribution channel via a Bluetooth-based server has been integrated.

All tools necessary for the presented workflow are available in a lab environment. The combination of all tools in a single workflow environment is still under development. An intensive evaluation of the workflow will start in the summer term 2006 starting from March on. Recorded lectures are then offered for desktop-based systems as well as Enhanced Podcasts for users of mobile devices.

Fine granulated lecture recordings offer interesting applications for universities. Of course, they are providing a good and convenient service for the students. The students can subscribe to the automated workflow such that they are provided automatically with the corresponding content. Additionally the content can be offered to external users. By a fine granulation of the content, very specific information or knowledge channels can be offered to a larger audience. This might be an interesting option for additional business models for universities.

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