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Using the tele-TASK Lecture Recording System to Improve E-Learning

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Abstract: tele-TASK is a research project for improving e-learning and tele-teaching. Within this project a lecture recording system has been developed which makes it very easy to record university lectures and presentation for efficient self-learning after the event or at another place via live streaming. In this paper we give a short overview of the project and further components and we will show that the tele-TASK recording system can be applied to capture (even implicit) knowledge and can be an improvement to traditional university learning scenarios.

Keywords: *e-learning, tele-teaching, distance learning, teaching, lecture recording, recording system*

Biographical notes:
Matthias Bauer studied computer science at the University of Rostock. During his studies, he took part in e-learning trainings and worked as a tutor for distance learning. After finishing his studies, he first worked as a software engineer, but then decided to become a research associate and start working on his PhD at HPI. Matthias works at the chair of Internet Technologies and Systems headed by Prof. Dr. Christoph Meinel. He is a member of the tele-TASK group and coordinates development, sales, partnerships, research projects, events, etc. In addition, he teaches university classes and seminars and has supervised several bachelor and master's theses.

Prof. Dr. sc. nat. Dr. rer. nat. Christoph Meinel is President and CEO of the Hasso-Plattner-Institut for IT-Systems Engineering (HPI) and full professor for computer science at the University of Potsdam. At HPI he heads the department for Internet Technologies and Systems. Christoph Meinel is member of acatech, the National German Academy of Science and Engineering, heads openHPI, the social online learning platform of HPI, and is program director of the HPI-Stanford Design Thinking Research Program. His research fields are Internet and Web Technologies and Systems. Besides he is a teacher at the HPI School of Design Thinking and an honorary professor at the Computer Science School of the Technical University of Beijing (China). He is also head of the Steering Committee of the HPI Future SOC Lab. Christoph Meinel is author or co-author of 13 text books and monographs and of various conference proceedings. He has published more than 400 peer-reviewed scientific papers in highly recognised international scientific journals and conferences.

1. Introduction

At Hasso Plattner Institute (HPI) at the University of Potsdam, Germany there is a research project named tele-TASK. Formerly it was an abbreviation for Tele-Teaching Anywhere Solution Kit, but nowadays the long name is not used in official correspondence anymore. The project is aimed to support and improve video-based e-learning.

The project's main goals are to record university lectures, offer tools for post-production and a web portal for lecture distribution. In these fields there is plenty of work and a variety of research topics. In this paper we would like to concentrate on the fact how to improve the outcome of online-

or online-supported learning processes by applying the tele-TASK recording system.
With our solution not only the slides, but also the lecturer himself are recorded as separate video files. For doing so we have developed a portable recording system that is capable of recording and encoding two videos at the same time. In the following section we are going to give a brief overview of the applied technologies.

1. Recording System

As there are many lectures being held even on a small institute like HPI and nowadays most of the students wish to have lecture recordings, we have developed a portable lecture recording system.

1.1. Software, Characteristics, Formats

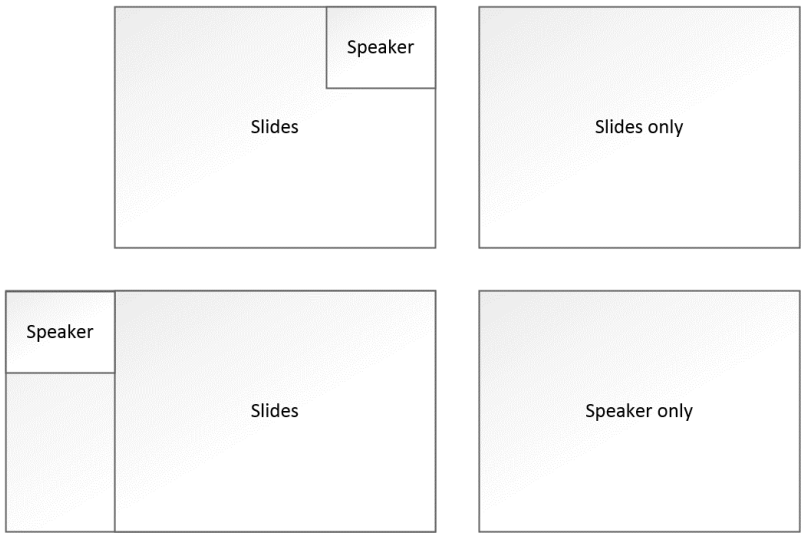
The recording software running on the recording system was developed by our team. It is written in C# 4.5 (.NET) and runs on a standard Windows 7 operating system. So it is possible to benefit from the regular Windows updates and patches which are supposed to fix security flaws and vulnerabilities. At the moment we are working on a software migration to make the recording software compliant to the Modern UI Style of Windows 8. The recording software already works on Windows 8 and 8.1, but at this point in time it is still a Windows 7 style desktop application. We want to give it the Modern UI Style so that it can be operated even more intuitively and benefit from a few more advantages of the new user interface paradigm.

As already mentioned earlier, our recording system records two videos at the same time. One is the camera video showing the lecturer and the other one is the video of the presentation. Why do we record two videos? This is one the one hand side because of the analysis processes like slide detection, optical character recognition (OCR), keyword extraction, and many more and on the other hand side to maintain flexibility regarding the offered formats. We can easily offer recorded lectures as two-video learning

units, video-only or desktop-only with the lecturer's voice or video-in-video podcasts with or without overlay as shown in Figure 2.

The question why we record the presentation slides as a video can be answered as follows: One of the premises of tele-TASK is that every single step in the chain of content recording, postproduction and delivery shall be as easy, fast and flexible as possible. So we grab the complete VGA output of the presenter's computer going to the projector by connecting the tele-TASK recording system in between. The built-in active VGA splitter amplifies the signals so that it is possible to connect much longer cables and place the recording system in the back of the room. By recording all the graphical output we do not depend on a certain operating system, presentation software or contents. An installation on the presenter's computer is not necessary – after plugging in, the recording can be started immediately. The lecturer may even show a video instead of slides for example to show a live demo of a system or scientific process. Both videos (lecturer and presentation) will be recorded with 25 frames per second each.

Figure 1 Overview of some of the available output layouts



1.2. Is it HD?

A question often asked about the recording system is if it is capable to create recordings in HD quality. To give a proper answer without just responding *yes* or *no*, of which both are not correct, we would like to explain the following: High Definition (HD) refers to several resolutions and frame rates. Typical HD settings are 1080p which means a resolution of 1920*1080 pixels. Or for example 1080i, which can be either 1920*1080i or 1440*1080i. The letter "p" stands for progressive scan while "i" indicates interlaced. So actually every video frame in interlaced videos consists of two fields, upper field and lower field. Another typical HD resolution often used in HDTV or on YouTube is 720p which contains 1280*720p pixels.

One of the specialties of the tele-TASK recording system is that it records two videos at the same time. These two videos typically have the resolutions 720*576p (camera) and 1280*960p (presentation).

Table 1 Comparison of different definitions and the number of pixels

Format	Number of Pixels
HD 1080i (1440x1080)	0.8 megapixels per field
HD 720p (1280x720)	0.9 megapixels per full frame
HD 1080i (1920x1080)	1.0 megapixels per field
tele-TASK (720x576p + 1280x960p)	**1.6 megapixels** per full frame (both videos combined)
HD 1080p (1920x1080)	2.1 megapixels per full frame

Our solution records two videos with 25 frames per second (FPS) at the same time. Keeping in mind that all the data is encoded live (during the recording) and no encoding from raw data is necessary (what TV stations

offering HD material would have to do), tele-TASK provides high quality and resolution. It just does not fit in the typical naming pattern 720p/1080i/1080p.

We should not forget about the student's Internet connection and how a web browser can handle several megabits of video per second. At HPI we record both videos with a rate of 1.5 megabits per second. This is a good compromise between bandwidth and quality. So a total data rate of 3 megabits per second has to be transferred. In addition, we have to take into account that there is some overhead produced by network control information. So students should have an Internet connection of at least 5 (better even 10) megabit/s in order to play the recordings without necessity to buffer and wait. For lower bandwidth there is still the one-video fallback alternative where users can download the lectures as video podcasts.

2. Further Components

Even though the main focus of this paper is on the recording system and its application to e-learning, we would like to give a short overview over the other components of the tele-TASK portfolio. The project tele-TASK consists of the recording system, a web portal, a postproduction tool, analysis and transcoding servers, live streaming, distribution of podcasts (on iTunes U, among others) and more. A few of these components shall be looked at here in a brief way.

2.1. Web Portal and Video Player

Through recording many lectures on a daily basis, we have gained a huge number of lectures that should be offered to the students in a comfortable way. A simple blog is not enough anymore due to the big number of lectures and the students' wish for enhanced functionalities such as search, social features, etc. Today more than 10,000 hours of lectures on computer-science are available at the tele-TASK online archive with some 30 hours of new material added weekly (Linckels et al., 2013). The web portal is a kind of electronic lecture library enhanced by social and community

features and efficiency tools like key frame and keyword navigation functionality (Grünewald, et al., 2013).

2.2. Postproduction Tool

Even though all the postproduction steps can be fulfilled on the recording system itself we thought of another additional software for normal office computers. Our lecture recording team prefers to do the postproduction work on the computers in their office instead of staying longer in the lecture hall. So we have developed a tool that actually brings the recording system's functionalities to cut, create or edit chapter marks, export lectures as podcast videos, etc. into a clear desktop software that is being operated with mouse and keyboard on a big screen. So the requirements are quite different from working on the small touch display (10 inch) on the recording system.

The postproduction tool gives our recording team the flexibility of doing the postproduction steps later and so they can make important phone calls or answer emails from within their office before they continue with the lecture's postproduction.

3. Improvements to Traditional Learning Methods

In comparison to traditional learning methods such as lecturing students on a black board or reading books from the library our approach is to enrich traditional learning scenarios by the availability of lecture recordings and live streams. In this chapter we touch on a few aspects of how traditional learning and teaching methods are enhanced by using tele-TASK.

These times we are living in with fast Internet connections and the wish for mobile connectivity, are a breeding ground for mobile e-learning. The development in the last years shows that nowadays' learning style and habits tend to move a bit away from within the classrooms and lecture halls as main place for consuming knowledge and more to independent flexible places of individual learning. Lots of students prefer to learn at home or together with others in small learning groups instead of going to every single lecture of their curriculums.

3.1. Conservation of Knowledge

An important point for doing lecture recording is that whatever is being recorded can be kept in an archive forever. For years the prices for hard drives have decreased whereas the capacity has increased and will do in the future. That makes it very cheap to save lots of lectures, even though each of them consumes around one Gigabyte. A few years ago it would not have been possible to store more and more Gigabytes of data every day. But today we are able to offer all of the ever recorded lectures online. There is no necessity to delete old lectures or store them on DVDs or tape drives in an archive room in the basement.

3.2. Flexibility of Learning

As the lectures are available all the time without any limitation of age, the students can enjoy the comfortable situation of being able to learn with the lecture recordings whenever they want to. Different people have different learning styles and so we want to support as many different learners as possible. Not only the availability of lectures in general is important, but also the availability of different file formats. Currently we offer our lectures as full lectures with our tele-TASK video player. So the students can browse both of the lecture's videos (presenter and slides) synchronously. The video player has a few useful features like slide preview, chapter marks, steplessly adjustable ratio between the two videos, and more. Besides, the learners can download the lecture as one-file video podcasts. So they can watch them with a smartphone or another small device independently from time and location. As most of the university lectures are held for many years with – often with only minor changes – it is even possible to watch the lecture recording from last year in order to apply a flipped (or inverted) classroom scenario as described by Carlisle (2010) or by Strayer (2012).

3.3. Transfer of Implicit Knowledge

With the growing availability of high-speed Internet connections there are much richer user experience scenarios which are more efficient than just

downloading the Professor's slides as a PDF file and more time-saving than reading all the suggested books for the lecture.

When students only learn with the lecture slides as PDF files, a lot of knowledge is missing. A lecture consists of much more than just text on presentation slides. In fact, in our opinion the amount of text on average presentation slides should be reduced much more. Often the most important thing for students in order to understand the topic are the lecturer's spoken words. These help combine the bulletin points on the slides and associate the important terms so that the students can understand the context and gain a richer knowledge of the whole topic than just being able to enumerate terms.

Implicit knowledge is something you cannot really describe with words. And it is not easy to transfer implicit knowledge as described by Cavusgil (2003) and others. It is somewhere between the lines and maybe can be understood much easier by hearing and watching the lecturer explain a topic rather than only reading the slides or the book. tele-TASK is not able to make the implicit knowledge explicit. But it is able to transfer the implicit knowledge given in a university's lecture.

3.4. Accelerate Online Research

With the help of the tele-TASK web portal it is much easier and faster for students finding relevant information. They can use helpful tools such as slide preview, key word extraction, speech analysis and more. Yang, et al. (2013) demonstrate how much more efficient online research tasks can be through the usage of the offered features.

4. Conclusion

We have given a brief overview of the components of tele-TASK and shown a few aspects of how it can enhance traditional learning and teaching scenarios. It is not only a method of capturing – even implicit – knowledge, but in addition to it, a tool for accelerating online research and a diverse enhancement enriching the learning process.

References

Grünewald, F., Yang, H., Mazandarani, E., Bauer, M., and Meinel, C. (2013). Next Generation Tele-Teaching: Latest Recording Technology, User Engagement and Automatic Metadata Retrieval. *Proceedings of SouthCHI 2013 International Conference on Human Factors in Computing Informatics*, pp. 391-408

Kandzia, P., Linckels, S., Ottmann, T., and Trahasch, S. (2013). Lecture Recording – a Success Story. *it 3/2013 Vol. 55*, pp. 115-122.

Wolf, K., Linckels, S., and Meinel, C. (2007). Teleteaching anywhere solution kit (tele-TASK) goes mobile. *Proceedings ACM SIGUCCS User Services Conference*, pp. 366–371.

Liu, Q., Rui, Y., Gupta, A., and Cadiz, J. J. (2001). Automating camera management for lecture room environments. In *Proceedings of the SIGCHI conference on Human factors in computing systems - CHI '01*, pp. 442–449.

Yang, H., Siebert, M., and Luhne, P. (2011). Automatic lecture video indexing using video OCR technology. *2011 IEEE International Symposium on Multimedia (ISM).*

Carlisle, M. (2010). Using YouTube to Enhance Student Class Preparation in an Introductory Java Course. *SIGCSE '10 Proceedings of the 41st ACM technical symposium on Computer science education*, pp.470-474.

Strayer, J. (2012). How learning in an inverted classroom influences cooperation, innovation and task orientation. *Learning Environments Research*, pp. 171-193

Cavusgil, S., Calantone, R., Zhao, Y. (2003). Tacit knowledge transfer and firm innovation capability. *Journal of Business & Industrial Marketing*, pp. 6–21.

Yang, H., Grünewald, F., Bauer, M., Meinel, C. (2013). Lecture Video Browsing Using Multimodal Information Resources. *The 12th International Conference on Web-based Learning (ICWL2013)* (to be published in October 2013)

tele-TASK: tele-TASK Homepage. http://www.tele-task.de/