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A NOVEL APPROACH TO E-LEARNING CONTENT CREATION

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Modern information technologies are transforming the way people learn. E-learning provides new possibilities for personalized learning at home or in the workplace, reduces the need for costly classroom training, and enables an optimal balance between traditional and innovative forms of knowledge transfer. But facts have proven that content creation for online courses are time-consuming and costly. Also most of them are not easy to call up. A simple and efficient solution of content creation for online courses is strongly required. Our new system, tele-TASK [2] - Teleteaching Anywhere Solution Kit, paves the way for these requirements. It opens up a new world of learning opportunities to learners, trainers, course authors, companies and educational institutions. With the help of the new developed system tele-TASK a new, drastically simplified entrance technology for on-line lectures has been reached. From his apartment or office each PC user with a suitable Internet connection can follow online lessons comfortably. Not only contents of teaching, which are presented to the students in the lecture-room by either a whiteboard or a video beamer are delivered but also video and audio of the lecturer. For tele-TASK a special hardware (t-Cube) is now available, which permits the creation of Real or Mpeg4 streams in different bandwidth ranges on the fly. Thus a pre-installed standard player can be used.

1 Introduction

The 21. Century is defined by a rapid, medial based development of our communication culture and our knowledge- and information-organization. Against the background of the described developments, also a change of the forms of knowledge transfer as well as acquirement is taking place. Multimedia based arrangements increasingly supplement traditional training forms. Thereby, the self-study will become very important in the future. Today, after graduating from school or university, people are not able to avoid further studies. Lifelong learning is getting inalienable. Parallel to their occupation, people have to do their further studies. By using teleteaching systems like the here presented tele-TASK, those people could be reached. Complete classroom situations can be delivered live and on-demand to the internet including video, audio and the desktop of the lecturers' computer. The system was originally deployed for recording, transmission and archiving of the computer science lecture "Information security in open networks" at the university of Trier in the summer semester 2002. High access numbers express the perfect problem-free and easy possibilities of using tele-TASK. In this semester another lecture titled "Internet Security I – Internet Technology" is being offered at the University of Trier and simultaneously transmitted to Beijing University of Technology, China. Here Chinese students take part in the lecture via Internet together with students in Germany. Practical testing proves that our solution is successful. In the following, we would like to introduce the new "easy to use" internet based teleteaching package tele-TASK, which accomplishes all requirements to modern teleteaching systems. Furthermore, we will present the complete all-in-one solution "t-Cube", which allows you to create online-courses on the fly without previous training for students and operators(!).

2 Online Lecturing Needs

Past teleteaching systems limit operators and users to various ways. On operator's side the lecturer is often rigidly bound to an operating system or to necessary bandwidths. Also widely spread is the restriction in using special presentation systems [3], e.g. PowerPoint, which finally leads to the lecturer's degradation to a slide commentator. Today, a good lecture should contain dynamic contents, such as animations and demonstration programs, as well as arbitrary information from the WWW. An unrestricted use of all usual operating systems is also desirable.

On the users' side, students and other interested persons, who want to retrieve courses via the Internet, should not be subjected to the torture of complicated installation and operating steps. In the winter semester 2001/2002 for the first time teleteaching systems [4] were tested and used at the local chair. All applied systems were very difficult to install and to use, due to the need for Java or other software packages. In addition, a lot of programs were very instable. The experience showed that even computer science students were not able to furnish and operate such special software packages correctly. Proceeding from these observations, we improved the development of a less limited, better applicable and at the same time more efficient teleteaching software system. Apart from the requirement of easy to use, a transmission of the lecture should be possible down at the modem speed, since not every student has a wide-band Internet connection. The use of standards, the permission of any operating system and any presentation software are also required for the development of a new teleteaching system. The following list shows the requirements of a modern tele-lecturing system in order of their importance:

- Complete mapping of the classroom situation (Beamer, Video, Voice)
- Simple usage for the student. Most desired is:
 - Use of standard pre-installed software
 - Platform independency
- Simple usage for lecturer. Most desired is

- "One-Push-Button" technology
- Integrated all in one solution
- Usage of own equipment (e.g. Laptop)
- Web integratable
- Modem speed is enough for a transmission
- Online (live, on-demand) and Offline (CD,DVD, Download) capable

At the University of Trier, at the chair "Theoretical concepts and new applications in computer science", a new teleteaching concept has been developed and tested, which grants an entrance to on-line lectures in the simplest possible way and breaks down the barriers for producing and accessing distance learning content.

Tele-TASK represents itself as a result of these considerations and developments. The experiences in the field use in the summer und winter semester 2002/2003, the reactions of the users and the high access numbers confirm the quality of our concept.

3 The tele-TASK Concept

3.1 Possibilities for Content Creation

Today, there are several ways of electronic content creation for online courses. The most common way is to create the content of the lecture for web-use by means of creating static or dynamic web pages with HTML or PHP. The disadvantage of this method is the extremely high cost for development. On the average, one can calculate one person working for a half up to a full year for the preparation of electronic learning content for only one course. By assuming that course data, esp. in computer science, changes very fast, costs for updating will occur.

Other possibilities for content creation are the specific application development (e.g. Java applets for web-use) or the use of multimedia production tools (e.g. Multimedia Toolbox [5]), Macromedia Flash [6]. But these solutions all have one thing in common: *high costs*.

3.2 tele-TASK Content Creation

Based on the above considerations, we thought about electronic content creation with the needs of online lecturing and the reduction of the traditional costs in mind. Our basic idea is to use the original lecture to produce e-learning content on the fly. The complete classroom situation including the desktop of the presenters computer, the video and the audio should be mapped into electronic course material. We desire to transfer the complete course live and on-demand to the internet. Also for offline usage, the course data should be saved. Figure 1 shows the structure of the tele-task system.

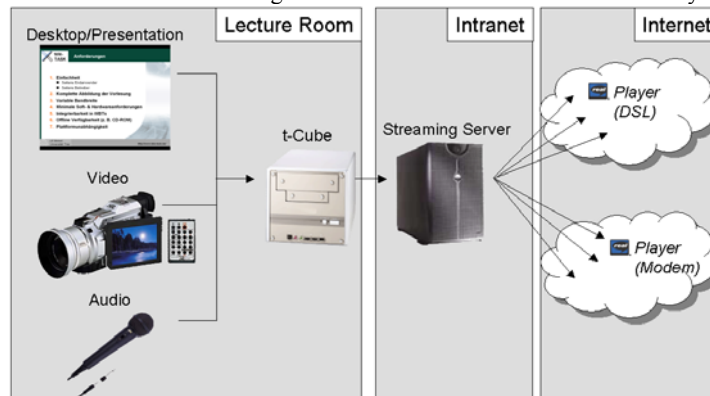


Figure 1. Structure of tele-TASK

In the following we show the different parts of the system.

3.2.1 Transmission of the desktop

Various online lecturing systems (see Real [7], Microsoft [8], AOF [3], ...) have to run on the presenters computer. In these cases special requirements are claimed to the presenters computer. Often, those solutions call for special operation systems, special presentation software or high CPU power. In the case of non computer science lectures this presents a big problem. Most lecturers are unwilling to install anything new on their computer, or they do not have permission to do so. The solution is to deliver the desktop to another computer. This transmission is done with VNC [9]. VNC allows to transfer a desktop, no matter which operation system, to another computer without the loss of quality. The transmission is done over the network using the UDP [11] protocol. Because of the minimal protocol overhead, UDP is very good for time critical transmissions. To reduce the bandwidth we are using tightVNC [10] which transfers less packets than original VNC and it also compresses the packets.

On the encoding machine, the desktop is processed further more.

3.2.2 Capturing Video and Audio

tele-TASK supports two different ways of accessing videos. The first solution is to use a video device connected directly to the encoding machine. By using the Microsoft DirectX library [12], we can access any video device connected to the encoding machine. This could be e.g. a cheap webcam, an analog video camcorder or firewire videocamera. The system supports multiple video devices which could be switched on the fly. Video resolution can be set up for each device separately. Audio can be delivered via Firewire over the videocamera to the encoding machine, or by the analog or digital audio input.

The second way of transferring the video is to send it over the network. tele-TASK provides a tool for transmitting and receiving video and audio over the network. In those cases, the encoding machine can be set up in different locations.

3.2.3 Synchronisation of the streams

The encoder consumes altogether three streams (video, audio and desktop). The developed tele-TASK software package combines the three input streams. Figure 2 shows an example for the arrangement of 4 Streams (Video, Audio, Desktop and Table of Content). The arrow shows the coherence between the video and the desktop stream. A student is easily able to recognize the actual discussed part of a slide by comparing the slide to the video.

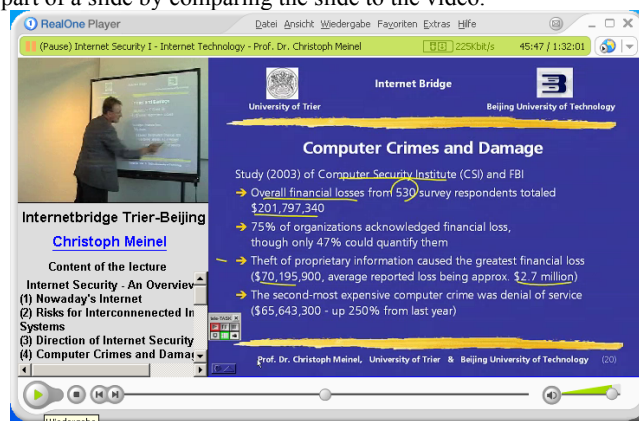


Figure2. Lecture Playback in the RealOne player

Video and audio are synchronized to each other and then treated as one stream. The synchronisation between audio, video and Desktop is thus guaranteed. A text stream can contain additional information in the form of e.g. links or tables of contents. The operator of tele-TASK can position and dimension the streams freely.

Usually the video stream is put to the upper left corner, the desktop stream in the right side located field and the text stream below the video. The composition of the streams is done by SMIL (Synchronized Multimedia) [13]. By supporting multiple input devices (Video, Audio and Desktop) it is possible to change the layout dynamically. In case of presenting high quality video scenes during the presentation, the desktop can be hidden and the video can be set up to fullscreen mode. Such cases often appear in medical presentations.

3.2.4 Output Formats

After assembling the input streams, tele-TASK encodes them into a standard format. Currently 3 different formats are supported:

- Real [14] output
- Special low bandwidth format
- MPeg4 [15]

The Real output directly supports the Real streaming server [16]. Real streams can be set freely to arbitrary bit rates. Praxis has shown that 250 kBit/s is enough for high quality online lectures including video, audio and desktop. The software computes the Real stream in real-time, saves it to harddisk and streams it live to a streaming server.

Parallel to the real encoding, tele-TASK encodes a special version for very low bandwidth. With only 38Kbit/s it is possible to provide video, audio and a perfectly rendered desktop. The only drawback is that animations on the presenter's computer cannot be shown. During a normal slide presentation the desktop doesn't change a lot. The idea is to scan the desktop for changes and only the changes are saved and sent to the client in a compressed way. Figure {fig:slide} shows a slide in which two new lines have appeared.

tele-TASK grabs out the changed area and computes the exact difference between the old and the new state. Only the changed areas are saved and sent in a compressed way. For 90 minute slide presentation including annotation we save and send about 200 to 300 desktop updates. In total we need about 1 Megabyte for the complete high quality (about 600*400 Pixel) desktop. [17] shows an example.

Currently we are working on a MPEG4 output. The software computes MPEG4 streams in real-time. Like the Real output the MPeg4 stream can be saved to harddisk and sent to a streaming server. Apple provides the free and open-source MPeg4 streaming server Darwin [18], which can be used directly.

For each output format the usually pre-installed standard players like Realplayer, MS Mediaplayer, Quicktime Player can be used.

3.3 t-Cube - All in One

The tele-TASK system is integrated into one easy-to-use device, the t-Cube. The t-Cube is a small computer in the shape of a cube. The t-Cube has two network devices. One is for connecting to the local network and the second for the presenters computer. The interface for the local network has to be configured once by a system administrator. The second one provides a direct connection to the local intranet, not depending on the network settings on the connected laptop. This feature is also done by tele-TASK. It masquerades the range of all IP-addresses including the faking of all possible gateway IPs. The big advantage is that every lecturer can use his own laptop without configuration. The laptop can be connected directly to the t-Cube and has access to the local intra-/internet without having to be adjusted. This is very important for conferences where presenter want to use their own laptop.

Once connected to the t-Cube, a small software is started on the laptop via a web-interface. This software allows to export the desktop and to control the t-Cube. By the use of a small control panel (see figure 3), the lecturer can start/stop/pause the lecture. Also, he is able to change the view. He can set to (Video, Audio and Desktop), (Fullscreen Video and Audio) and (Fullscreen Desktop and Audio). By using the integrated solution the lecturer doesn't need much knowledge about the system in use. He can easily start and stop the session by himself.



Figure 3. tele-TASK Control Panel

Cameras and microphones can be connected directly to the t-Cube. The streams can be sent to the streaming server and saved on a local harddisk parallel. After a presentation a CD/DVD with the recorded content is burned automatically. The configuration of the tele-TASK software can be done by a webinterface or by an external program. The t-Cube does not need a monitor, keyboard or mouse. It is just a black box which can be switched on and off.

4 tele-TASK in practice

4.1 On operator's side

tele-TASK is a complete program suite for providing high quality teleteaching. The package contains all necessary programs and tools for generating streaming material for the web. The whole system works like a one push button automat. It takes less than five minutes to set up the t-Cube and the technical environment. The complete equipment fits into only one small bag, so that it is possible to offer teleteaching anywhere you are at. In practice, the streaming server is not at the same place as the encoder.

Once tele-TASK is installed, nearly any lecture can be recorded. A lot of universities are talking about offering tele-lectures. But if you want to find something in the web, you will have to prepare for a long search. With a system like tele-TASK a university or an institute for further education can allow the students to access and replay all courses they want to see. Also, it is very easy to make the lessons available offline. Only one CD-ROM contains about 6 hours of recorded courses including video, audio and the desktop of the lecturer.

The intuitive use of tele-TASK makes unnecessary to train the lecturers. By the use of an electronic whiteboard (e.g. Smartboard [19]) the lecturer can easily anotate his slides with electronic pencils. At the University of Trier in summer semester 2002 a lecture about cryptography was recorded and delivered into the internet. For this kind of lecture a lot of annotations and hand written mathematical proofs were needed. The quality of the recorded lessons was so high, that lots of students all around the world joined the lessons via the internet. Currently another lecture about internet security is being hold together with the University of Beijing (China). Chinese students are joining a course which is held in Germany [20].

Another big advantage for the lecturer is the kind of copyright on his lectures. By making scripts of a lesson available online, the copyright trademarks are not protected. Everyone can copy and paste the text to his own documents. With streaming data, it is much more complicated to do this.

4.2 On users side

By integrating tele-TASK documents into webpages makes a calling up very easy for the consumer. By clicking on the corresponding link the player starts up automatically and plays the lesson. In comparison with other teleteaching systems, tele-TASK is very easy to use. Even laymen are able to access the lectures through the internet. The experience with other teleteaching software, which was complicated to use on operator and viewer side, taught us to provide an "as easy as possible" technology for the consumer side. The positive feedback and the high access numbers (about 40.000 calls on the online lectures in 7 months) shows the effectiveness and efficiency of tele-TASK.

5 Conclusions and further work

With tele-TASK it is possible to provide high quality teleteaching without a large technical and financial expenditure. The use of standard pre-installed players makes an access of contents independent of time and place easy. The past users emphasized the simple applicability of the system. Especially the high-quality and the smooth transmission of the Desktops speak for an expansion of the employment on the range of further training (e.g. training courses for Linux, Word, or other programs). Two big advantages make tele-TASK very useful for further education. Online courses can run separately from and simultaneously to traditional forms of courses. The number of potential attendees increases dramatically. Further, after a course CDs with the recording can be given to the participants.

Currently we are developing automatic content extraction for tele lectures. With the help of XML and RDF we are building semantic networks of words and topics. Once having such semantic networks, new possibilities for learning, searching and accessing of information are given.

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