A Support System for Multimedia Management in Teleteaching Scenarios

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Introduction

Broadband communication systems and enhanced tools for transmission of video/audio and multimedia data pave the way for new concepts of distance education. Especially ATM-based networks allow online teleteaching applications of high quality. In various countries there are strong efforts to establish a broadband communication infrastructure for education and research, e.g. the Internet-2 project in the United States. In Germany the Federal Department of Education, Science, Research and Technology promotes a nationwide Broadband Scientific Network which started working in 1996 with the secretary of education and research cutting the virtual red ribbon at the CeBit fair in Hannover. The German Scientific Network is based on ATM technology and connects nearly all of the 70 universities of unified Germany as well as several research institutions (see Fig.1). The ATM backbone operates at 2.4 Gbit/s. Most universities are hooked up by 155 Mbit/s. Thus, a Gigabit communication platform for universities and other institutions concerned with education and research is at hand. There are also links to the public ISDN network used as a ramp to that information highway, for instance by high schools. The German Scientific Network is linked to the European ATM backbone called TEN155 (Trans European Network, 155 Mbit/s) as well as to networks in other continents like North America, Asia or Australia. Based on this infrastructure several universities in Germany are offering ‘virtual courses’ at the moment. At the University of Erlangen-Nuremberg pilot applications have been run since 1995. Now, teleteaching is in routine operation. Powerful and stable audio and video tools are crucial to realise a teleteaching environment which is accepted by teachers and students. Here, the technical environment for distance education is outlined and a sophisticated tool for media control is introduced.

Figure 1. German Broadband Scientific Network

Teleteaching Scenarios

Since 1995 various scenarios for teleteaching have been developed at the University of Erlangen-Nuremberg. Meanwhile teleteaching applications have become an integral part of the curriculum and are being conducted routinely.

Teleteaching scenarios include (but are not limited to):

? Virtual lecture
A lecture is being transmitted to several remote access points. Students can interact with the lecturer and among themselves by using audio/video conferencing tools. The lecturer may use various presentation systems to show digital and physical material. High quality video is particularly important because of the need to transmit conventional instructional material (e.g. writings on the blackboard) electronically.
Virtual practising course
In virtual practising courses the high degree of interaction between students and lecturer is a particular challenge. Groups of students using PCs or workstations share a tele-instructor by audio/video conferencing tools and specific groupware tools. Whiteboard systems and/or distributed applications are more often used in virtual practising courses than in virtual lectures.

Virtual seminar
In this scenario lecturers and audience are spread out over various locations. Different groups of students are linked in a virtual seminar environment transmitting talks from each remote access point to another. This means that conferencing tools have to support many-to-many relationships.

Virtual excursion
Virtual excursions are especially conducted in co-operation with companies. They are designed to save time and money for students and company employees. In this teleteaching scenario a company is virtually visited. For example this is done by video transmission of a guided tour within the company.

Multimedia devices
Figure 2 illustrates the setup of a teleteaching theatre which supports different kinds of teaching media. Teaching environments of this kind have been realised at the School of Engineering and at the School of Economics and Business Administration of the University of Erlangen-Nuremberg. Speech and sound are captured by various microphones and transmitted to the control center which provides the connection to the broadband network. Gesture and other physical media (e.g., transparencies or writings on the blackboard) are filmed by multiple video cameras, which are mounted at different locations in the theatre and remotely controlled. A specific teleteaching terminal has been developed to support the lecturer during teleteaching events as well as for the enrichment of conventional lectures with multimedia material. The goal was to integrate most devices needed for multimedia based teleteaching into a single easy to use entity (see Fig. 3).
Media Control

The coordination of different presentation material (e.g., slides, video, animations) is a challenge to the lecturer. An integrated and configurable media-control tool for serial control of several devices has been developed to support the lecturer and give him/her the possibility to focus on the contents of the presentation. Figure 4 shows the architecture of the media control tool. The service layer between JINI and the hardware allows to embed device interfaces in JINI-services. The service layer creates additionally service objects which read the device parameters for the JINI-service. The user interface is programmed in JAVA with well-defined interfaces to JINI. The graphical interface provides all available electronic devices in a media pool. The media control tool also offers standard configurations which are pre-configured for particular teleteaching scenarios. The lecturer has of course the opportunity to configure his/her own media environment.

For high-quality teleteaching ATM has been proved an efficient transmission mechanism. ATM enables high transfer rates which are required for videoconference applications or download of video files. Advantages of ATM networks include the definition of a quality-of-service parameter, thus reserving bandwidth for real-time applications. ATM transfer mode, with its ability to transmit point-to-multipoint and a principally smooth scalability meets the main requirements for synchronous teleteaching. For transmission and reception of high quality audio/video streams, ATM codecs are provided in the teleteaching environment that are able to code analogous signals directly into native ATM cells. The receiver decodes the ATM cells back to audio/video signals.

Thus, the underlying hardware in the system structure is controlled in different ways. On the one hand you have to trigger ATM codecs, on the other hand devices with serial interfaces have to be operated. In this context it is also possible to use infrared remote controls for hardware control. The direct integration of JINI-devices is one possibility. The service layer between JINI and the hardware enables to embed device interfaces in JINI-services. The service layer creates additional service objects which read the device parameters for the JINI service. The interface of the media control with the underlying system occurs with the JINI-technology.

The graphical user interface of the media control tool is programmed in JAVA with well-defined interfaces to JINI. The media control tool provides the lecturer with a summary of all available electronic devices in the media pool. Besides online control the media control tool also offers standard configurations which are pre-configured for particular teleteaching scenarios. The lecturer has the opportunity to configure a media selection for the presentation on the graphical user interface. The connection will then be made automatically by the system. Figure 4 shows the graphical user interface of the media control tool.

The media-control-tool provides comfortable usage of available electronic devices without knowledge of location, configuration or even performance of the devices. This is an helpful add-on for the lecturer during the presentation and gives the possibility for a comfortable, effective, and high-quality service.

Conclusions

As a result of the research work done a sophisticated technical environment for distance education is at hand. Discussions with involved students revealed that best quality is very important for video streams and even more important for audio streams. Shortages in this field lead to dropping motivation and decreasing acceptance. One overall result coming from the survey is that teleteaching/telelearning applications are highly accepted. Particular attention is paid to network technologies which enable the demanding multimedia-oriented applications. While upgrading the German Broadband Scientific Network with additional ATM based services more high quality scenarios are being tested. For teachers the handling of the technical equipment and the coordination of multiple multimedia devices is demanding. Given the necessary bandwidth the quality of multimedia based teleteaching is highly influenced by user-friendly applications, i.e. the comfortable use of available electronic devices with advanced multimedia presentation material. The multimedia control system integrated in a teleteaching terminal as depicted in fig. 3 shows one feasible approach to support the teacher in a sophisticated way.
References


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