[Stei93a] *Ralf Steinmetz;* **a Networked Multimedia Workbench: The Perspective for TV Video Production**; Proceedings of Electronic Publishing International '93, Oslo, 9.-11. Juni 1993.

A Networked Multimedia Workbench: The Perspective for TV Video Production

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1 Reasoning

Most people are accustomed to high quality television production. In particular short sequences often contain many effects and transitions that are not present in many full-length feature films. This is partly due to cost limitations and also to presentation of such rapidly changing material is not suited to productions of 2-3 hours. One of the most demanding 'applications' of video production is the popular music video. Almost mandatorily when a group records a song they will produce an accompanying video, in most cases the benefits of seeing a video played on a national network will outweigh the considerable production costs. Often 2-3 minutes in length they contain many transitions, with often elegant synchronization of the music and recorded clips. The production of these clips as well as short films demands specialized personnel to cut and edit the video material.

Video 'cutters' are trained personnel whose sole purpose is to use the given equipment to recreate what the director/producer has in mind. However, due to cost constraints and rapidly advancing techniques this dedicated equipment is a critical shared resource in most studios. For the production of video material. this resource is normally booked in advance and the users must cope with a restricted amount of time.

Some years ago the equipment was totally in the domain of the analog world, however digital processing is heading to take over one of the last remaining strongholds of analog technology. We still encounter dedicated devices today, however internally we find more often the audio and video processing being handled by dedicated computing units. These components are similar or even the same devices that are incorporated into multimedia-capable computers.

For some years now the computer industry has worked hard on developing multimedia systems. A multimedia system is characterized by the integrated computer-controlled generation, manipulation, presentation, storage, and communication of independent discrete (such as text and images) and continuous media (such as audio and video). A distributed multimedia system consists of four main building blocks which closely interact relate to specific system components:

- Audio Video technology - Based on digital signal processing technology, audio and video data are represented as PCM samples. The resulting data rates together with the expected quality imply the use of compression techniques such as JPEG, H.261, MPEG and DVI to

be performed by hardware and/or software.

- Hardware components - The workstation and high-speed network technology allow for multimedia computing while the main driving force in a local environment has been optical storage technology.
- System software - On such a multimedia platform audio and video make demands on the operating system, database software and communication services. The specific needs for real-time processing of these media are taken into account.
- Applications - Programming abstractions like object oriented environments allow the interface of the above mentioned services in a application friendly way. Applications for co-operative work, networked kiosks, tutoring and educational systems exploit the advent of the integrated new media in computing.

Based on these components a TV workbench as multimedia application on a networked platform has been prototyped.

2 A Networked Multimedia System as Platform

Information processing in traditional computing is done without any hard time constraints. The systems respond to a user interaction as soon as possible. The integration of audio and video into existing computer environments creates a new complexity in time-dependent data processing, i.e. 'Correctness' in real-time systems is determined by whether hard deadlines are met. We define the processing of time-dependent data in multimedia systems as the delivery of data in well defined intervals over a period of time, in our terms this process is called a continuous media stream. Multimedia communication deals with the transfer of discrete *and* continuous media over digital networks. Essentially the difference between audio, video and discrete media is the notion of real-time processing and correctness.

All dedicated studio components take into account this notion of correctness for the processing of audio and video data, the capabilities of effects indeed rely on this computing power. In principle it should be possible to provide a video editing facility with similar functionality as professional equipment by advanced multimedia workstations with well constructed interfaces. Such a multimedia system can be seamlessly integrated into a networked environment alleviating the burden of using a centralized video cutting station. This however does not means that overnight every user will become a perfect cutter at the hands of this new technology, it just allows for better sharing of the scarce resources. The same paradigm applies to photographers, even being the proud owner of a Hasselblad or top range Leica camera does not mean that she/he will take exceptional pictures. In this TV workbench area we developed an application to cope with the requirements of such a system.

3 The TV-Workbench Analysis

At the initial stage an analysis of the typical work procedures took place. This work was performed in close co-operation with a professional video studio. In principle we identified the following main steps:

1) A rough skeleton of the video clip is outlined. The producer decides on the major issues and requirements of the sequence to be produced. Often the producer will have consider the use of

some pre-recorded library material as well as new video material to be captured. The access to existing video material at the moment is too slow for use as a 'retrieval system' it simply takes too long to search, scan and retrieve unknown clips, the mechanism used by most studious is to find a hand-written catalogue of the archived material, request a set tapes from a librarian and then to start searching through a large set of video cassettes, and to scan through for some potentially interesting scenes. However, a video on demand retrieval application located at the producers office would encourage the producer to make use of already existing clips.

1) New video material is often produced and integrated into the video processing arena. For a computer based solution this means that the raw video material is digitized, named and categorized according to its content.

2) The cutting procedure is traditionally executed in various steps where audio is treated independently to video, and later both are merged into an AV clip. This step is the duty of a media composer which in our case would be a video editing facility.

3) The final cutting step assembles all audio and video information to a single clip in the final video delivery quality. The goal at this step is to build the clip by having an autonomous digital file which can be directly fed into the sending equipment. However this is still too futuristic and therefore an intermediate step will be where the clip is copied to a master video tape. One possibility is just the time code is delivered by the multimedia system and the final cut is performed by the professional equipment.

4) The final approval for using this clip is usually decided upon by the producer-in-chief who often looks at this clip together with some members of the production team. A shared simultaneous video distribution facility in the networked multimedia system would allow the clip to be viewed at different locations.

Out of this process analysis the major advantages of such a workbench in a networked multimedia systems are (1) the better reuse of existing clips, (2) the alleviation from a scarce resource, the video composer, (3) the avoidance of any introductions of unwanted artifact by multiple copy operations, and (4) the capability to allow for remote joint viewing.

As a project risk analysis, and due to former experiences, at this point we would also like to mention the most severe potential difficulty as being the satisfactory quality of compressed video. Most of the available technologies including motion JPEG, H.261, MPEG-1 and the proprietary Quicktime algorithms, IBM's Ultimotion, Intel's Indeo and DVI formats have been conceived for data rates around or less than 1.4 Mbit/s (suitable for data rates of that of a CD-ROM). By producing the clip with this reduced quality and making the final cut with the external dedicated devices this problem is temporarily overcome until the technology is available.

4 System Functions and Components

We have been building this workbench system and making use of available multimedia system components. These have been mainly drawn from the HeiTS [Herr92]] projects to construct the proposed workbench, key capabilities are:

- the guaranteed data throughput in a distributed multimedia system
- the multicast feature to distribute audiovisual data without any additional expense to a single point-to-point communication
- the interoperability between platforms across various operating systems leading to scalable solutions
- state-of-the-art in terms of audio and video quality

In the application domain the workbench distinguishes four major functions which can be performed by four independent applications:

- The digitizer: It allows the transformation of input data into an appropriate internal format, this format is seen as a file, which is a particularly important property for the other components. This program is available as part of the audiovisual equipment in the workstation.
- The data search, archive and retrieval component: This component relies on a database and (optionally) a multimedia capable file system. The database stores all type of media descriptive data and contains only references to the actual audiovisual data. The interface to this storage facilities was developed specifically for the workbench requirements and allows a fast and easy access to the on-line data.
- The networked audiovisual playback: Having selected a set of clips the user may want to play them back in his/her environment, skip data, fast forward and rewind as well as random access to defined positions. This application was developed for the use in the workbench scenario and is capable of video playback from remote data servers.
- The media composer: For the cutter this application is the most crucial. It should provide all digital editing capabilities of a traditional environment. The user interface should allow casual users to assemble a rough skeleton and experts access all available functions. A simulation of traditional video editing equipment will be needed, for this application in our system use was made of an existing video editor. Specific features can be added at a further stage of the workbench development.

The first experiences showed that a complete development of such a product would not satisfy all the needs for the envisaged customers, a later configuration with considerable changes will have to take place. Therefore we decided to develop an initial functional system composed of the main features and jointly push this development with some key customers according to their specific needs. The development is now in the stage of alignment with major customers, a functional full developed system is available on one proposed platform.

Acknowledgments

We would like to acknowledge for the extensive discussion we had with the TV producer studio crew and Dieter Huober who always pushed this idea of a digital TV workbench. Michael Pühlhöfer developed under the guidance and together with Peter Sander all specific components. Finally, Ian Marsh provided some final editing comments to this paper. Thank you.

Some further Reading

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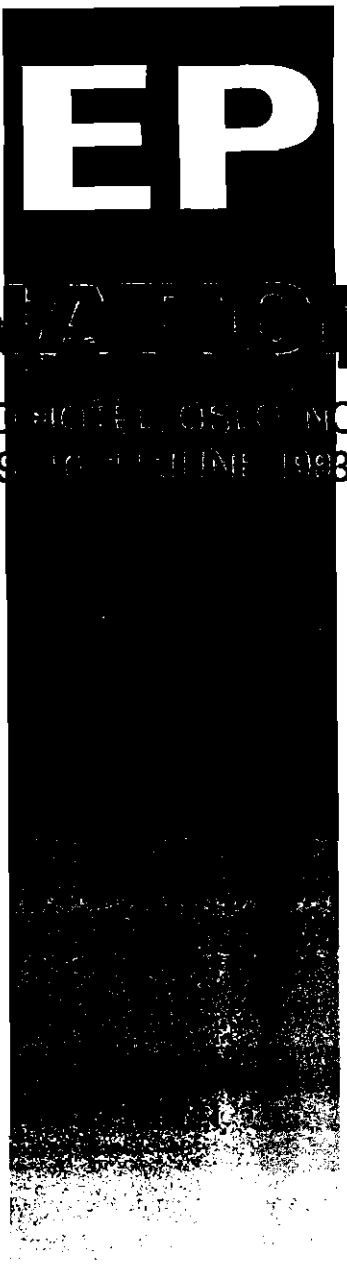

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