Part 5: The Hems Lab

The DMP system and physical architecture

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Summary

The Hems Lab is a realization of a networked virtual collaboration space, intended for virtual music and musical theatre education, design, rehearsal and performing arts. The quality of the scenes intends to approach 'near-natural quality' in the long term, but to start with, soa[1] equipment will be installed.

The Hems Lab needs a minimum space of height * width * depth = 9 * 12 * 7 meters. In addition, a separate control room of 15 square meters is needed.

The goal is to establish the basic lab, and to run educational and arts performances combining virtual (from digital library and remote collaborators) and live musical theatre drama elements and sequences, including actors/singers playing/singing roles, and scenography, selected from musical theatres/operas such as Thora på Rimol (Borgstrøm) and Pagliacci (Leoncavallo).

Using an *action research* approach, in-depth knowledge will be obtained in an iterative way. Drama sequences and the technical environments can gradually be elaborated to improve the total performance (pedagogical, artistic, psychological, and technical performance).

The budgets for the establishment of the Hems Lab are preliminary and incomplete.

The use of the Hems Lab is not limited to music, and for non-music applications the quality requirements might be substantially reduced.

The Hems Lab

The Hems Lab is a realization of the DMP architecture, and is part of the ongoing research at the Caruso Lab, Dept. of telematics.

[1] state-of-the-art

Goal: Extend the Hems lab/DMP test facilities to a 5-surface stereoscopic collaboration space for audio and video, optimizing the use of multi-camera arrays integrated into the screens, multi-projector edge blending and correction problems, projection wall forms, and audio systems when applying DMP in virtual music and musical theatre education, design, rehearsal and performing arts.

Figure 5-1 shows six building blocks. The central block (red top) is the virtual Collaboration Space, CS. Seen from inside the CS, five of six surfaces are combined back-projection displays and multi-camera arrays. This arrangement provides spatially true, multiview, autostereoscopic shooting of video, and single view, stereoscopic presentations (later to be extended to multiview autostereoscopic). To start with, surround sound shooting and presentation shall be provided by head-sets.
The blocks LP (left projection), RP (right projection), TP (top projection), BP (bottom projection) and FP (front projection) encompass arrays of projectors and cameras.
A surface including both camera arrays and projector arrays, are here denoted a collaboration surface.
FP includes at least 12 projectors, with edge blending and warping, and shadow correction for cameras and light-guides for cameras.' A 6 x 3 meter Clusterwall (Cyviz) provides a passive stereoscopic wall with with spatial resolution of about 9 Mpixels.

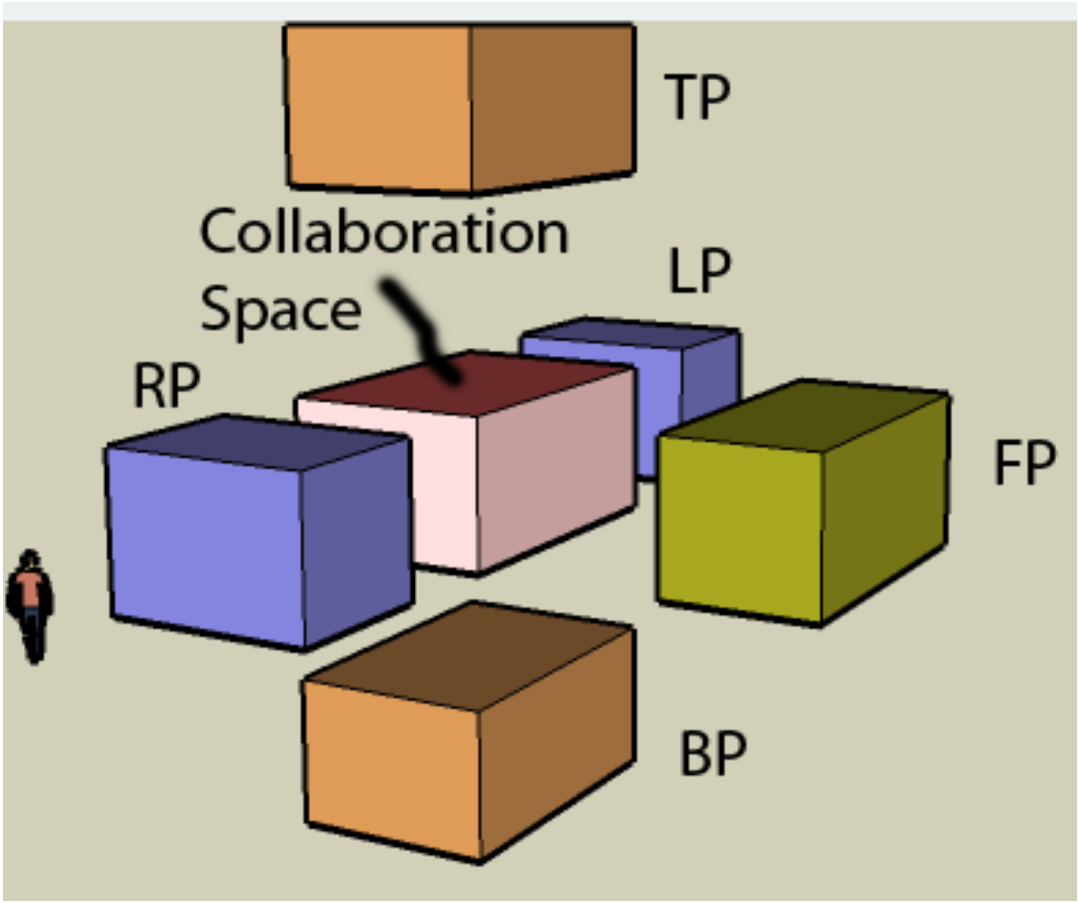

Figure 5-1. The Hems Lab building blocks.

The size of the six blocks assembled is height * width * depth = 9 * 12 * 7 meters. A control room with servers and network nodes should acoustically be isolated from the building blocks.

Figures 5-2 show the building blocks assembled, from two different views.

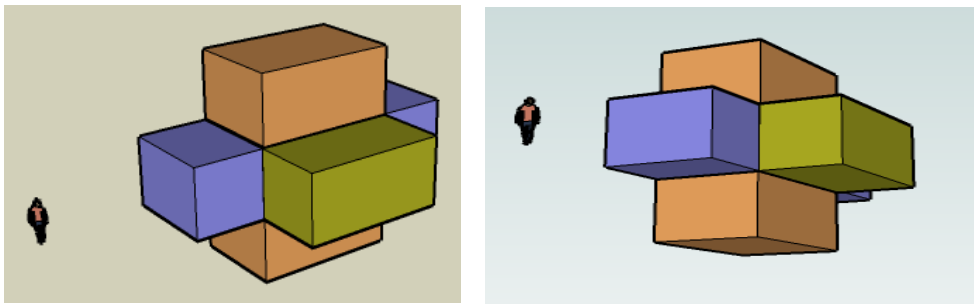

Figure 5-2. The Hems Lab assembled, two views.

Figure 5-3 illustrates a possible case, the Hems Lab is built on the mezzanin under the glass roof of the ‘Elektrobygget’ (the measures are not to scale).

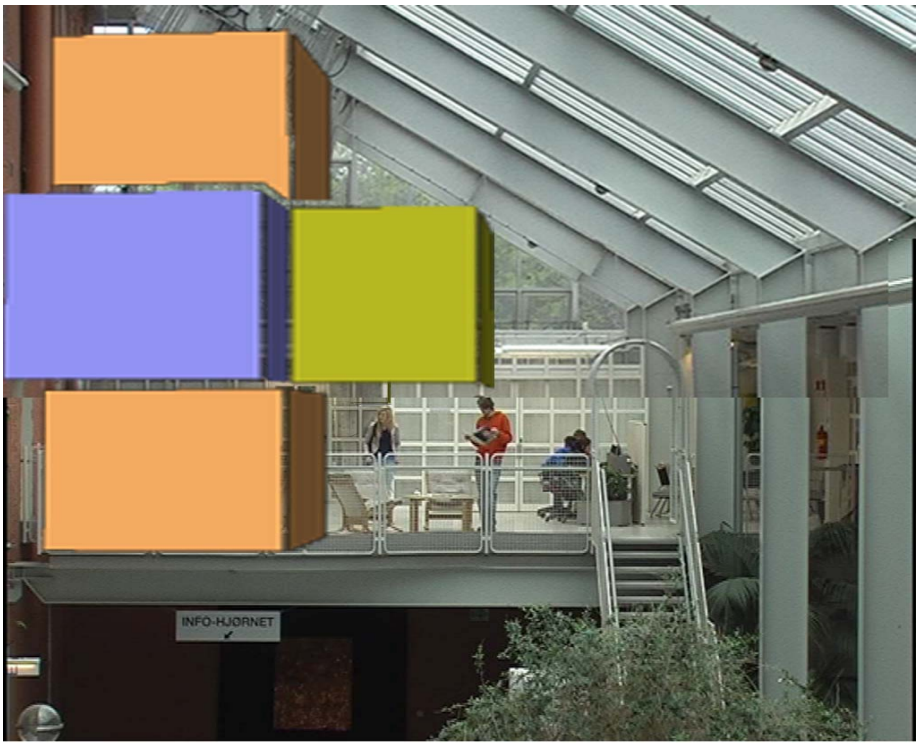

Figure 5-3. The Hems Lab in the ‘Elektrobygget’.

Research approach

The research challenges of establishing and using the Hems Lab are multidisciplinary, including pedagogy, arts, psychology and technology. Soa theory and practice shall be used as a starting point.

An *action research* approach will be used, to give in-depth knowledge of a few test cases. Action research is chosen because, in an iterative way, the drama sequences and the technical environments can gradually be elaborated to improve the total performance.

In order to generalize, 20 test cases should be run after the total test environment is stabilized. Groups of singers (students and professionals) shall repeat the experiments as described below, selecting different drama sequences. Qualitative and quantitative interviews will be carried out.

Simulation methods will be used to study behaviour and traffic performance. The DEMOS and NS2 simulation environments are good simulation tools.

Technological research

The technological research is in networking, collaboration space design (video-based rendering), video and audio coding/decoding, service management, and Quality Shaping.

The main long-term goal is to approach the near-natural quality of the collaborations.

Simulation will be applied to study the performance of the Quality Shaping scheme and the AppTraNet protocol. Scene Profiles will be derived from the Hems Lab, and general formats will be studied and specified. Forms for Quality Shaping Profiles shall be specified. Simulation results shall be compared with the results from the action research.

The Hems Lab application requires extremely high audio quality (multi-channel, real surround, 100 kHz sampling, 24 bits resolution) to be successful. This is partly given by the ‘near-natural’ requirements, but also from the fact that the collaboration may end up as a HD DVD (or similar). Besides, time delays are critical for networked music collaborations (less than 10-20 ms). To start with, head-sets will be applied to obtain the ‘position-realistic’ surround sound. Later, arrays of microphones, sound processing, and arrays of loadspeakers will be introduced, and integrated in the collaboration spaces.

The Ercim postdoc Training Programme

Dr Minh-Son Dao has been awarded an Ercim postdoctor fellowship at NTNU, Dept. of telematics, duration 12 months, starting 1st of January 2008. Dao’s research background strengthens and completes the overall competence needed for establishing

DMP test facilities. The fellow's research will be part of the ongoing research activities of the Caruso Lab/Hems Lab, related to establishment of a test system for DMP music applications. The fellow's duties will be restricted to the research programme outlined here and he will not be called upon to undertake other tasks. He shall contribute to

- the state-of-the-art description of theory and practice for networked collaborative virtual environments and related systems, and do research beyond in order to approach the near-natural virtual scene quality requirements of DMP in musical theatre applications.
- extending the Hems lab DMP test facilities to a 5-surface stereoscopic collaboration space for audio and video, optimizing the use of multi-camera arrays integrated into the screens, multi-projector edge blending and correction problems, projection wall forms, and audio systems when applying DMP in virtual music and musical theatre education, design, rehearsal and performing arts.
- the study of multi-view techniques for DMP.
- documenting and publishing the research results in globally recognized media.

Some Technical Research Challenges

- Lighting
- Shooting by means of
- multiple micro cameras, integrated into the screens
- Edge blending
- Corrections
- Sound shooting, sound leakage removal
- Realisation of DMP network node
- Object behaviour analysis
- Object movement tracking
- Eye tracking

DMP in education, design, rehearsal and performing arts

Users of the system are geographically distributed groups of (opera) singers, pop musicians, jazz musicians, chamber musicians, players in large symphonic orchestras, stage directors, scenographers, other arts designers, and the audience. The system enables the various users to experience the virtual environment as seen from their individual viewpoints in real scenes.

Applying the Hems Lab, experiments will be carried out to evaluate system quality performance, and establish user requirements and system quality specifications when applying DMP in virtual music and musical theatre education, design, rehearsal and performing arts. Combined virtual (from digital library and remote user groups) and live musical theatre drama elements and sequences, including actors/singers playing/singing roles, and scenography, will be selected from musical theatre/operas such as Thora på Rimol (Borgstrøm) and Pagliacci (Leoncavallo).

Panoramic video and sound sequences will be planned and shot from the views of the current users. The sequences will be stored in the DMP digital library. The sequences can be modified off-line using editing tools. Tests will then be carried out by streaming the pre-stored contents from the digital library, while groups (one ore more participants) of singers/actors play their roles live.

Test groups: 20 groups of 1-5 soloists, professional singers/actors/players and song students.

Production for live TV and stored media

Several distributed virtual groups play together in real time, using also stored material in digital libraries. The collaboration is composed as one scene, and can be played out live as HDTV, or be stored on media such as HD-DVD, Blueray DVD, or HD Streaming Server.

Arts research

Action research is chosen because, in an iterative way, the drama sequences and the technical environments can be elaborated to improve the total performance (pedagogical, artistic, psychological and technical). Reductive analyses is a tool that can be used to shape and enhance arts performance. The quality of the DMP drama sequences will be measured against the quality of corresponding real sequences. Critics and professional opera singers shall participate as audience, and shall be interviewed about their experiences. The participants perceived adaptable scene quality shall be evaluated. From the experiments, the user requirements and the requirements to the technical system from all participants shall be derived, using in-depth structured interviews and observation of behavior (own and others behavior).

In order to get more experience with applying the DMP architecture in musical theatre education and design, groups of singers (students and professionals), shall repeat the experiments as described above, selecting different drama sequences. To get experience with DMP in rehearsals and performances of musical theatre with audiences in concert halls, sequences stored in the digital library shall be played out and used as the virtual part of the play (actors and scenery), together with a group of live actors/singers and physical scenery.

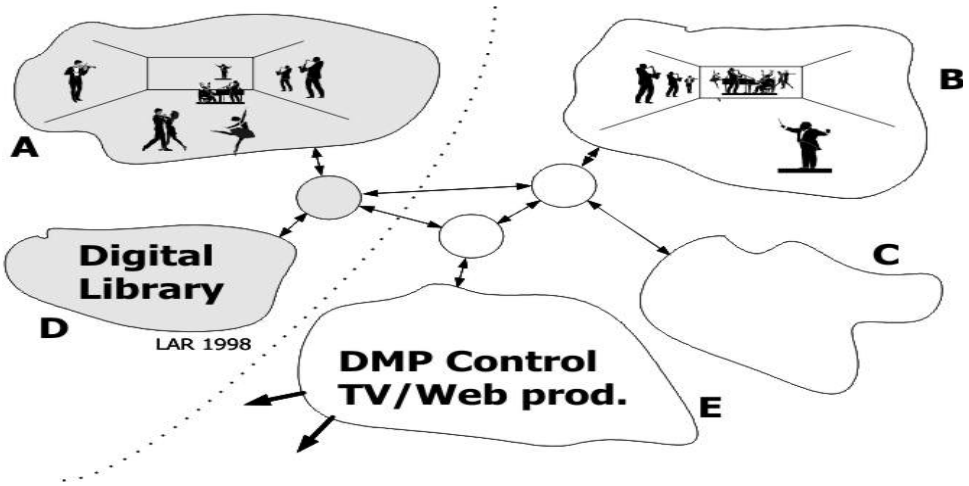

Figure 5-4. Collaborating groups A and B, and Digital Library D

Video equipment budget

Visualization and streaming equipment budget, three collaboration surfaces, one site. (vat not included).

A main 6 * 4 meter Cyviz Clusterwall, with backprojection glass, using 12 F30 projectors, with mechanical framing, costs € 0.33 millions.

Two other collaboration walls (using standard projectors) cost together € 0.13 millions.

Camera equipment cost for all three walls together is € 63,000.

Streaming technologies such as QuickTime on Fast PCs with Raid, or Playstation 3 cluster, € 50,000.

Total equipment cost for the video part of the main front wall and two side walls is € 0.573 million.

Participants, suppliers

Project leader: Leif Arne Rønningen, Dept. of telematics.

NTNU, Dept. of telematics (DMP, musical theatre). L A Rønningen, Erlend Heiberg (master student), two PhD students (Verdikt, EU FP-7 ICT), Minh-Son Dao (Ercim postdoc), master students, EiT – Experts in team.
NTNU, Dept of electronics and telecommunications (audio), Jan Tro, master students.
NTNU, Dept. of music (musical theatre, song, jazz, etc), Kåre Bjørkøy, Carl Haakon Waadeland, song students, music students.

NTNU, Music technology (audio)
UiB, The Grieg Accademy (musical theatre, song), Harald Bjørkøy, song students.
Q2S (audio), Peter Svensson, PhD students, master students
Cyviz (developer, video walls)
Tandberg (developer, videoconferencing)

Related projects, theory and practice

The research on future generations networked multimedia systems to be carried out in Hems Lab shall be based on the state of the art research and design of digital scenography (such as Intermedia, UiO [MOR05] , University of Århus [CAV07] , Telematics, NTNU [RON03]), the participant's extensive experience from staging and acting in opera performances [RON06], the ongoing work on DMP (including simulations and performance evaluation), the research on digital libraries performed by Ercim [SØL06], action research (learning) methodology [DIC99] and experience (Experts in Team) [EIT06]. The state of the art of multimedia streaming systems (such as QuickTime), is presently far from satisfying the severe requirements of future DMP, and shall be extended.

The Thora opera was staged using a combination of live actors/singers on a physical stage (proscenium) and projected video showing both scenic elements and actors. The participants (NTNU, UiB) were heavily involved in the staging and performance of Thora [RON03].

At the University of Sydney, Australia, researchers have investigated the role of the '3D virtual place', its effect on the activities, discourse and learning of students using a 3D virtual learning environment that encourages collaboration and constructivism. The study shows that locating students and facilitator (as avatars) is important for identity, presence, discourse, and learning [CLA06].

Immersive 3D videoconferences provide immersive tele-presence and natural representation of all participants in a shared virtual meeting space to enhance quality of human-centered communication [KAU02].

Telepresence refers to a set of technologies which allow a person to feel as if they were present, to give the appearance that they were present, or to have an effect, at a location other than their true location [WIK07].

A Virtual learning environment (VLE) is a management system for educational courses. An example is it's learning [ITS07].

A Virtual Collaborative Environment (VCE) is one that actively supports human-human communication in addition to human-machine communication and which uses a Virtual Environment as the user interface [VCE07].

Spatial faithfulness [NGU07] simply means that the viewer should see no difference between a virtual scene and a real scene. This complies with the near-natural concept of DMP, see below. The position of cameras is critical. The cameras should ideally be placed behind the object of a scene a viewer is focusing on. This can be obtained by

using a semi-transparent mirror, moderator. A moderator was used in a two-way video conference between the University Colleges of Lillehammer and Gjøvik, Norway. The total system evaluation shows that the time delay is critical, the overall quality was too low, and the naturalness was not satisfactory [VOL06].

The multi-camera array project at the Stanford University has contributed significantly to the knowledge of video-based rendering [WIL04].

The textbook, Video-based rendering, by Marcus A. Magnor, gives an excellent introduction to camera- and projector arrays, and to image- and video-based modeling and rendering [MAG05].

Tandberg is a leading vendor of videoconferencing systems worldwide. Their products represent the state of the art [TAN07].

The company Cyviz designs and markets advanced products for visualization. Their Clusterwall provides excellent stereo in ultra high resolution, e.g, 9 Mpixels on a 2 x 1.5 meter screen, in a configuration using 12 true state of the art F30 projectors with Intensity Transfer blending. The intention is to use a Clusterwall configuration for the Hems Lab [CYV07].

Other Multimedia Spaces

State of the art visualization systems
The Cave and Rave 3D visualization systems were developed by the University of Illinois (1992), and later commercialized by Fakespace Systems, now a Mechdyne company. The Extended C6 visualization system delivered by Fakespace to Iowa State University's Virtual Reality Applications Center, represents the present state of the art. The system gives 100 Mpixels presentations, using 96 graphical processors from HP and 24 projectors from Sony [IOV07].

See also ***3D Globe and 3D Room*** [3DR07] and ***Second Life*** [SEC07].

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