The Interactive Learning Lab: A Complex and Flexible but Easy to Use Multimedia Environment

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Abstract— To be able to create state-of-the-art eLearning offerings most universities maintain a central multimedia room for their members. A problem of such multimedia environments is that they have to meet the demands of many users and thus designing multimedia rooms is the more challenging the more the demands differ. Implementing easy to use equipment usually means that the user is only permitted to affect few parameters and the flexibility of the devices is limited in favor of lucidity. On the other hand, a researcher is interested in high flexible multimedia equipment which might at least result in a laboratory with a number of loose high-end devices that can be used in various configurations. For supporting non-technician users in such a laboratory operational staff is needed.
In this paper we present a new hardware and software concept for multimedia rooms that copes with the demands of non-technician users and researchers by reducing time exposure for operation and support.

I. INTRODUCTION

Multimedia technology has been gained more and more influence on education in universities over the past years. While in the beginning the lectures were augmented by only some electronic media like presentation slides or video clips, the growing Internet enabled a wide variety of new eLearning offerings. By using web-based distance learning technologies for example, universities are able to educate students even if they are not present locally [1]–[3]. To be able to create state-of-the-art eLearning offerings sophisticated multimedia equipment is needed. Because usually such software and hardware equipment is very expensive most universities maintain a central multimedia room for their members. A problem of such multimedia environments is that they have to meet the demands of many users and thus designing multimedia rooms is the more challenging the more the demands differ. In this paper we present a new hardware and software concept for multimedia rooms that we developed at Learning Lab Lower Saxony (L3S) [4]. Our concept copes with the demands of non-technician users who want to use multimedia equipment for regular lessons as well as the demands of researchers who want to develop and investigate new eLearning offers by reducing time exposure for operation and support concurrently. We implemented our concept in a room called Interactive Learning

Lab (iL2) [5]. First tests showed that the user acceptance is very good.

The rest of this paper is organized as follows. In section II we define the target group of iL2 and discuss resulting edge conditions as well as the goal of our concept in more detail. In Section III we discuss our approach for connecting the devices. In Section IV we present our concept for controlling the environment. For iL2 we enhanced the basic concept discussed in Section III and IV by some special features. We discuss these features in Section V before we conclude with Section VI.

II. REQUIREMENTS FOR iL2

The work of L3S includes research, consultancy and technology transfer as well as infrastructure and support in the field of innovative teaching and learning technologies. Thereby L3S aims at the permanent introduction and use of these new technologies into education. It was planed to use iL2 for all these application fields which means a target group with two extremes: non-technician users and researchers.

The focus of a non-technician user lies on his course and not on technical issues. As an example we can regard a lesson using slides for presenting the content of teaching. For this scenario a beamer, a PC, and presentation software are necessary. Using the software is even possible for non-technicians. But connecting the two devices, choosing a suitable resolution on the PC or selecting the correct input port of the beamer might cause problems. Regarding the example, the user only wants to have a button for switching on the whole equipment and start reading the lesson.

On the other hand, a researcher is interested in developing and evaluating new eLearning scenarios and usually has the necessary technical knowledge for reconfiguring and connecting the devices at his disposal. The multimedia equipment for this user must be high flexible which might at least result in a laboratory with a number of loose high-end devices that can be used in various configurations. An example for such a research environment is the iRoom of the Stanford Learning Lab presented in [6]–[8].

Fig. 1.   iL2 overview, more pictures can be found in [5]

Implementing easy to use equipment usually means that the user is only permitted to affect few parameters and the flexibility of the devices is limited in favour of lucidity. Because this is in contrast to the philosophy of a laboratory, satisfying the demands of both target groups in one room is not an easy task. One solution for this problem is to install a laboratory and use operational staff to support non-technician users. At L3s, this was out of the question because extra money for additional operational staff was not budgeted. To be able to operate an additional multimedia room at L3S with the existing staff, the concept for iL2 had to comply with the requirements mentioned above and reduce time exposure for operation and support concurrently.

III. HARDWARE CONCEPT

The iL2 environment is composed of about 50 devices that are installed in two acoustically decoupled rooms. Among other things, the main room is dimensioned for 20 persons and contains 4 video cameras, 2 touch-sensitive rear projection screens, 1 projection on the backside of the room, a grafic-tablet, 5 speakers, room micros, 15 micros for conferencing, and remote controllable lighting and spots lights. Further there is a mobile lectern with two embedded multi-functional displays, a PC and plugs for Laptops and a graphic-tablet as well as 2 speaker micros. The plant room contains all other devices. Among other things, we installed 3 video beamers, a video-mixer, a conferencing unit, a DVD-player, a DV- and a VHS-recorder, an audio-amplifier, 3 additional PCs, 2 multi-functional displays, 2 speakers and cordless micros. Fig. 1 shows an overview of iL2. To cope with the requirements of a laboratory the goal was to be able to connect any source with any sink where reasonable. For example: Considering a PC as a source we want to be able to display the graphic output on any display and beamer in iL2. Furthermore we want to be able to play-back the sound on any speaker in iL2.

Due to simplicity, in our concept devices are restricted to use only the following three signal types: stereo audio (Chinch), Y/C-PAL-Video (SVHS), and 1280x1024-PC-Video signals (VGA). For each signal type we implemented a cross-bar distributor. Each crossbar distributor is able to connect any source of a signal type with any sink of the same signal type. By adding a centralized control unit we are able to set any connections between devices via software.

The main problem with cross-bar distributors is their price because it heavily depends on the number of ports. In our case, this is especially true for the audio distributor because it is a 32X32 matrix with digital signal processing features for mixing. On the other hand choosing fewer ports than needed for full availability means that the flexibility will be reduced. One option would be to use additional ports of the devices to route signals. For example a video recorder usually has more than one input and output and can act as a switch. But this heavily complicates the software control because it is necessary to reconfigure the recorder for different scenarios. It also leads to bad lucidity because some devices can only be connected via other devices.
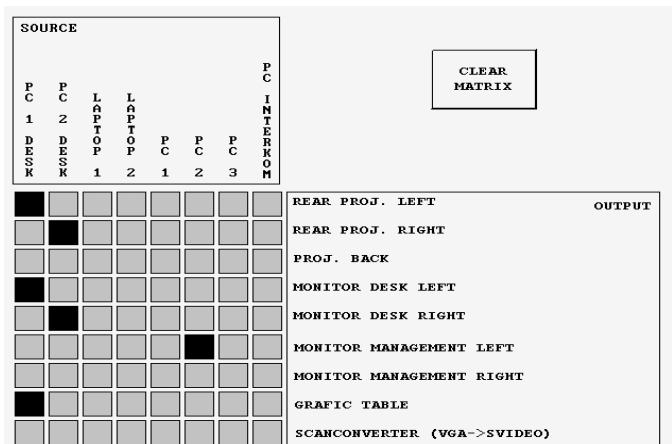

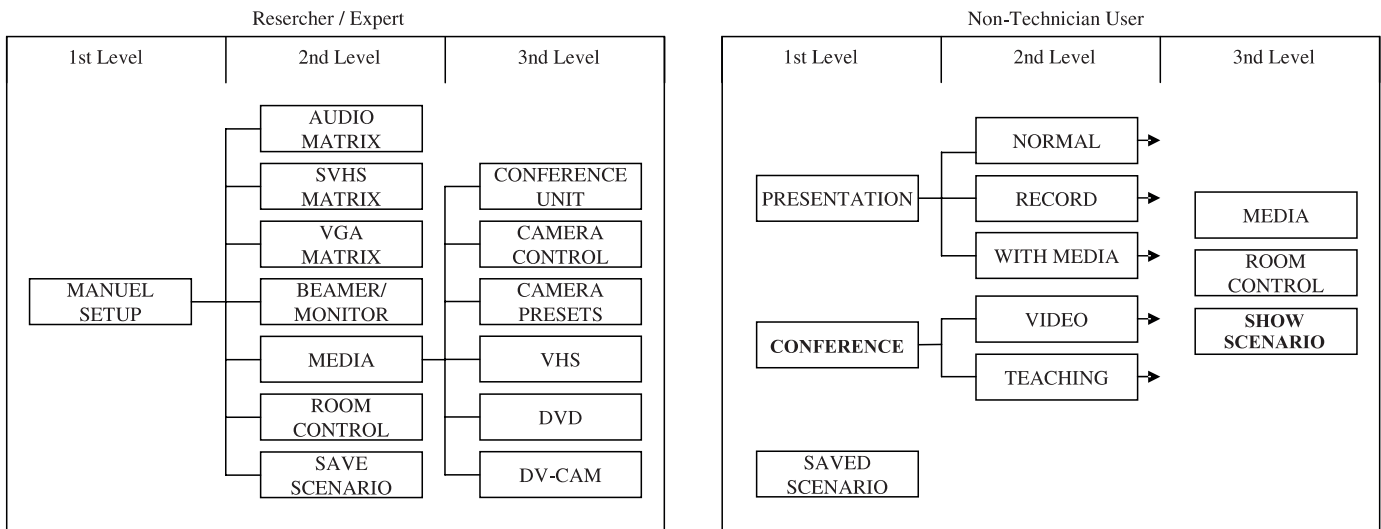Fig. 2.   Control panel for the VGA cross-bar distributor

Fig. 3.   iL2 interface structure

IV. SOFTWARE CONCEPT

Using cross-bar distributors with full availability allows us to easily connect devices. Fig. 2 shows the control panel for the VGA distributor. It is easy to see that the dual head PC of the lectern is connected to rear projection 1 and 2 and to the monitors embedded in the desk. Furthermore the left PC output is routed to the plug for the graphic tablet. Further, PC 2 is connected to one monitor in the plant room. The distributors for Audio and SVHS follow the same concept. However it still might be necessary to configure devices in some cases. For example, all displays and beamers of iL2 are able to display SVHS as well as VGA signals. In case of routing both signal types to such a sink it is necessary to select the desired signal. Other examples are DVD/DV/VHS devices which provide control functions like play, stop, fast forward, rewind and so on. The main problems in handling various devices in a multimedia environment arise from the different operation paradigms of the devices. Regarding our example, the input selection of a beamer is menu-driven while a monitor uses a single button at the devise itself or on its remote control. In case of many remote controlled devices, the user has to deal with a lot of different remote controls. While a researcher is able to deal with this problem this is not reasonable for non-technicians. For this, we implemented a centralized media control unit. This unit is able to control and configure any device of iL2 and abstract the functions of all devices in one consistent graphical user interface. This allows us to represent the whole multimedia environment as one big device for the user. By designing and implementing a sophisticated interface structure we are able to account for the demands of our target group.

The interface of iL2 uses the hierarchical tree structures shown in Fig. 3. Each leaf of a tree groups some functions provided by iL2. The tree structure is mapped into the graphical interface by using tabbed windows. If the user selects a tab which is not a leaf, the next tab level is shown. If he clicks on a leaf tab he gets the functions of this tab. Fig. 4 shows two examples. On the left, the user selected the tab for controlling the DV-CAM recorder in the MANUAL SETUP root. On the right, the user selected the tab for controlling the media in the PRESENTATION root. Thanks to the tabs, the user is able to see his position in the hierarchy at any time.

The MANUAL SETUP tab is for researchers. The functions of the leaf tabs are classified by devices and the user has access to all functions offered by iL2 (see Fig. 4, left). By selecting the tab VGA MATRIX for example he gets the matrix shown in Fig. 2 and can connect devices. After configuring the connections he can control for example the cameras by selecting CAMERA CONTROL and start the record by starting the DV-recorder with the DV-CAM tab. Thanks to the graphical user interface even a researcher does not need to go into details of the devices itself.

The tabs PRESENTATION and CONFERENCE are for non-technicians. By choosing one of the second level tabs of these trees the complete environment is reconfigured to a predefined scenario automatically. The third level tabs shown in Fig. 3 are the same for all scenarios. In contrast to MANUAL SETUP the tab MEDIA only contains the necessary controls for the chosen scenario. In other words: it is not device oriented but scenario oriented. In the most simple scenario (PRESENTATION sub tree NORMAL) this are just four buttons for choosing the source: the PC in the lectern or a Laptop (see Fig 4, right). After choosing this scenario the lecturer can start his presentation. By choosing the tab SHOW SCENARO the user can get a schematic view of the current configuration. The lightning in iL2 is controlled by the central unit as well. The control unit optimizes the light according to a scenario. However, with ROOM CONTROL the user can dim the lights steplessly.

All scenarios for non-technicians shown in Fig. 3 follow the concept mentioned above. In sceanrio PRESENTATION sub tree MEDIA additional media like DVD, DV or SVHS can

be used during presentation. With PRESENTATION sub tree RECORD it is possible to easily record a presentation on DV or as digital media stream with slides on the computer. It is also possible to broadcast a live stream of this presentation to the internet. With scenario CONFERNCE sub tree NORMAL the user can easily hold video-conference. CONFERNCE sub tree TEACHING is the most complex scenario and allows a video conference with slide presentation. The audience can use own conference micros.

The most innovative thing in our concept is the possibility of saving scenarios. Thanks to the central control unit, which can control all devices, we are able to save arbitrary scenarios generated in MANUAL SETUP. If for example a user generates a new scenario and wants to use this scenario in future again he can save the complete setting to one of nine memory spaces by using SAVE SCENARIO (see Fig. 4, left). A saved scenario can be recalled by using SAVED SCENARIO. After recalling this scenario iL2 automatically reconfigures all connections and devices following the saved scenario. This is very helpful if a specialized scenario is needed more than once.

V. Special Features of iL2

Using the hardware and software concept of Section III and IV provides a basis for a flexible but easy to use multimedia environment. In addition, we realized some special features in iL2 which enhance this concept.

At L3S the most frequently used scenario is the simple presentation. To make sure that a non-technician is able to use

this scenario, iL2 goes directly to the tab PRESENTATION sub tree NORMAL after starting. Starting and shutting down the equipment of iL2 is simplified to on-touch control. After pressing a button at the lectern all devices are started and stopped respectively. This even includes the PCs.

As already mentioned our goal was to reduce time exposure for operation and support. Therefore we implemented a web-based graphical user interface which allows us to use any PC in the internet with a java capable browser as remote control. For example the control panel shown in Fig. 4 is displayed in a Microsoft Explorer window. Beyond this, it is even possible to establish an audio-video connection to iL2 via the internet. The user only needs to configure the cross-bar distributors. If he routes a camera signal and a micro signal to the conference unit of iL2 he can connect to this unit via a standard video conferencing tool like Microsoft NetMeeting. He then can communicate with people in iL2 interactively. For example he can look around iL2 by controlling the camera remotely. Due to the fact that it is possible to open the control panel on different PCs in a synchronized way in parallel, the configuration can be changed from any place without any conflicts. By using remote desktop software the user is able to export the display of a computer in iL2. With this, it is possible to give support in using software applications. It is also possible to start and shut down iL2 from remote. Thus, starting and reconfiguring il2 for an event can be done completely remote.

To enhance the flexibility of iL2 we installed wireless

Fig. 4.   Left: MANUAL SETUP, right: PRESENTATION sub tree NORMAL

connections. Via a wireless local area network the user can access the internet. By opening the graphical user interface of iL2 on a Laptop with wireless connection the user can control the equipment. For the PCs we also use cordless input components. In iL2 two very compact keyboards and two mice are use for the PCs. The mice can be used on a desktop as well as in the air (Gyroscope technology). The components have a range of 30 meters which allows input to the PCs from any place in iL2. We connected one keyboard and one mouse to the PC in the lectern. The other keyboard and mouse were connected to three computers using a soft switch. If the user moves the mouse out of the left side of the screen of computer 2, he can control computer 1. If he moves out of the right side of the screen of computer 2 he can control computer 3. The advantage of this solution is, that no hardware switch is needed. In combination with the cross-bar distributors the user is able to route the picture of any PC to any display. Using the wireless keyboard and mouse enables the user to sit in front of the selected display while the computer is anywhere else.

We also implemented two special features for routing and mixing video signals. As mentioned above, we use VGA and SVHS signals which are inherently incompatible. To be able to convert a VGA signal to SVHS we installed a scan converter. As can be seen in Fig 2 the input of this converter is treated as a sink in the in the VGA cross-bar distributor. The output of the converter is treated as source in the SVHS cross-bar distributor. By using both cross-bar distributors the user can establish connection from VGA sources to SVHS sinks via the converter and for example record a PC screen on the DV-recorder. But it is also possible to convert SVHS signals to a PC format. For this we use a capture card in the PC of the lectern. The input of this card is treated as a sink in the SVHS cross-bar distributor. Routing a SVHS signal to this card enables the user is able to capture the video on the PC.

For mixing SVHS signals we installed a video-mixer which can be plugged in as a loop. The four input ports of the mixer are treated as sinks in the cross-bar distributor. The output of the mixer is treated as source. By routing signals to the inputs of the mixer the user can mix these signals. He then can route the output of the mixer (mixed signals) to any sink. For simplifying video conferences we implemented an automatic camera control. Each attendee uses an own micro. If somebody wants to speak, he presses the button. In our system we can set camera presets and save the names of attendees. In case of pressing the button a camera shows a closeup of th attendee and shows his name in the picture. This function enable us to hold video conferences with up to 20 attendees where it would not be possible to view all attendees in adequate resolution for a per-to-peer dialog.

VI. CONCLUSION

In this paper we presented a hardware and software concept for a complex multimedia environment. Our concept enables us to cope with the demands of a broad target group from researchers to non-technicians. We implemented our concept in the Interactive Learning Lab (iL2) at Learning Lab Lower Saxony (L3S).

First surveys show that especially non-technicians benefit from our concept. All tested users were able to start iL2 and use the presentation and conference scenarios after a short introduction. We assert that most benefit comes from the consistency of the graphical user interface. Even researchers benefit from this concept because it is not necessary to go into details of the devices. We also assert that even non-technician users are able to control iL2 with `MANUAL SETUP` after a short orientation phase. Thanks to the possibility to save scenarios we can hold different periodical events without large configuration effort. Even non-technicians were able to recall a scenario which was saved for them by the operation staff.

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