Simultaneous Projection and Picture Acquisition

Andreas M. Kunz — *kunz@imes.mavt.ethz.ch*

Christian P. Spagno — *spagno@imes.mavt.ethz.ch*

Swiss Federal Institute of Technology Zurich

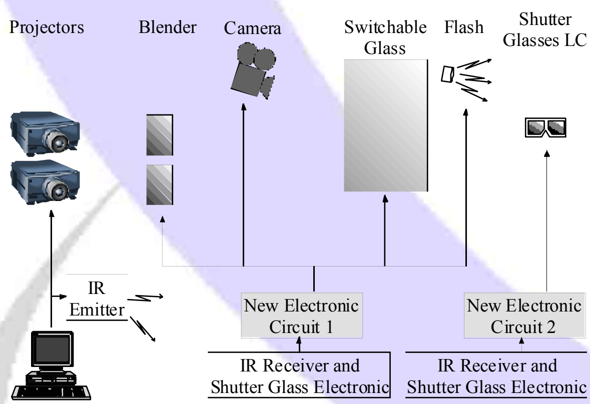
Center for Product Development

http://www.zpeportal.ethz.ch

http://blue-c.ethz.ch

Abstract

Virtual Reality allows simultaneous representation of three dimensional objects in different interconnected visualization installations. This offers new possibilities for distributed collaborative work. Up to now the user remained mostly without consideration. For efficient distributed collaborative teamwork the user should be visualized three dimensionally together with other virtual objects. A special projection installation is presented which allows simultaneous projection of virtual objects and acquisition of images of the user.

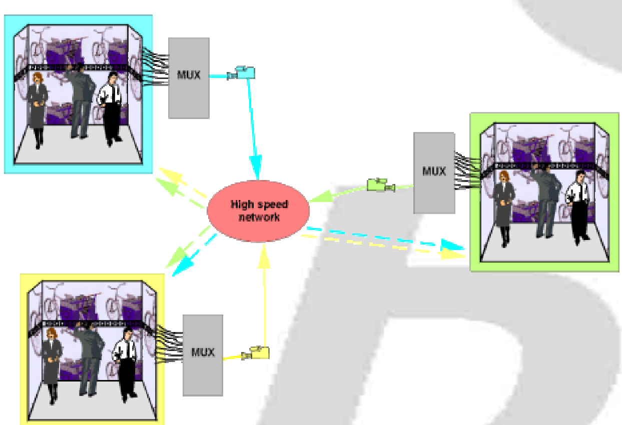


Introduction

For efficient communication not only the exchange of virtual models between visualization installations such as a CAVE® is necessary, but also the virtual representation of the user. The simultaneous picture acquisition of a user and a continuous projection cause major difficulties, for example:

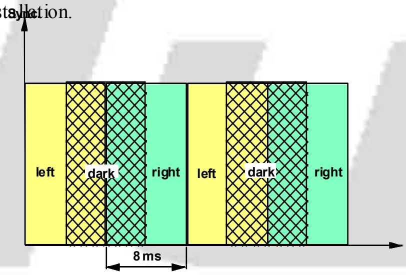
- Almost synchronously bright and dark phases must be available.
- For the complete acquisition of the user's texture he must be continuously in the field of view of several cameras.

In the presented paper a system solution is introduced by which the above problems can be eliminated. It allows the acquisition of textures of persons without lowering the immersion by the recognizable existence of disturbing cameras. The basic idea consists in placing the cameras behind the projection screen and outside of the beam path of the projector. The screen is alternately switched between an translucent and an opaque mode. During the opaque mode the projection is visible, while during the translucent mode the cameras can capture the texture of the person inside the CAVE®.



System setup

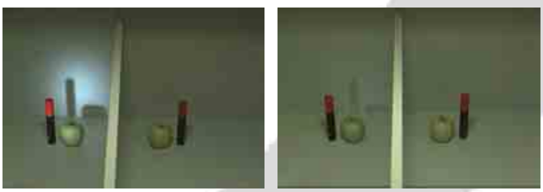
The system consists of two LCD- or DLP-projectors which are modified with external blenders. The cameras are camouflaged by the electrically switchable glass and the user can not perceive the flash through the modified shutter glasses. Additional electronic circuits produce the driving signal for the components. The synchronization is made via an infrared link. Apart from the use of new materials and elements, the system improvements are based on the implementation of a third step in the overall system. In this third step the whole picture acquisition takes place. This third step complements the 1st and the 2nd step which are necessary for the presentation of a stereoscopic picture. The following illustration shows the integration of the third step into the timing diagram. This third step is used to acquire the user's texture inside the visualization installation.



for a Distributed Collaborative Environment

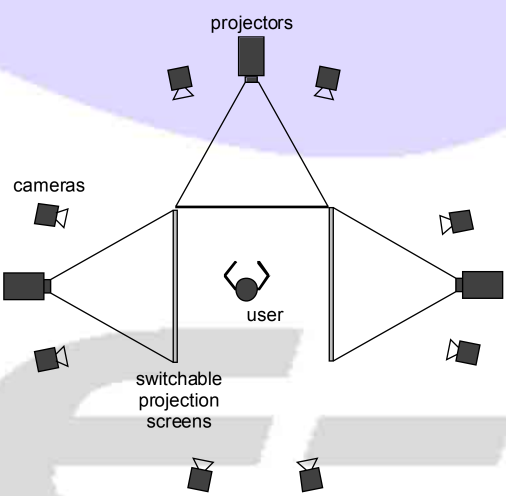
Efficiency of the third step

If this third step is held short enough and if it occurs in every picture sequence, it is not visible anymore due to the limited chronological resolution capability of human perception. It is held as short as possible in order to provide sufficient time for the picture recognition by the human eye (step 1 and 2). Thus, by the insertion of the third step, the general impression of the presented scene becomes slightly darker. However, this can be neglected compared to the brightness of the LCD- or DLP-projectors. This implies that CRT-projectors can not be used anymore within this new system although a shutter technology is used. Therefore additional devices have to be available that allow the use of active shutter glasses together with LCD-projectors.
In the left figure the illumination is shown as it can be seen without the third step; in the right figure the user's impression is shown after activating the third step within the shutter glasses. In each case the right half of the picture shows an object that is only illuminated by ambient light.



Test Setup

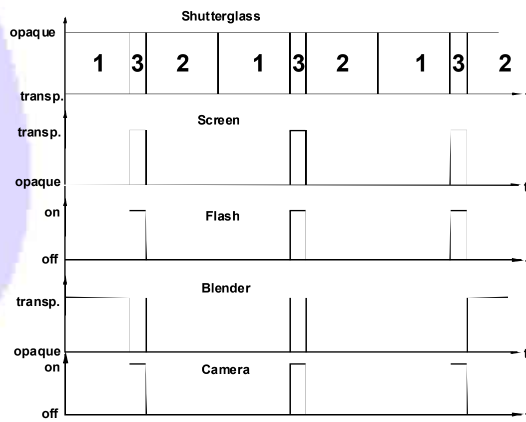
Through sufficient brightness it is now possible to achieve a satisfactory picture acquisition. The cameras that have to register the user's face must be placed in front of him without being in his field of view. Therefore the best position would be behind the projection screen where they can not be seen by the user. Similar to the combination of brightness and darkness it is necessary to have a projection screen that is translucent for the cameras but not for the user who wants to see a projection on this screen.



Results

The following figure shows the difference between transparency and opacity in the realized visualization room. It can be seen that the transparency of the electrically switchable glass is good enough to have a clear view of the user from outside. In the picture only the middle glass pane was triggered in order to have a clear comparison between both states.

While the picture is being presented for the right or left eye (stages 1 and 2), no voltage is applied to the electrically switchable glass and thus it is opaque. The blenders in front of the projectors are switched transparent and all active illumination is off. As soon as both eyeglasses are dark, the screen is switched transparent, the blenders in front of the projectors become opaque and the flash illumination is triggered. Simultaneously, the picture acquisition is done with the cameras.



Future work

Further work will examine how the complete installation can be modified and simplified in such a way that it can be realized with reasonable costs. In addition, it will be redesigned for portable use. In particular, investigations will be carried out which materials can be used instead of the glass panes without relinquishing the use of LCD-projectors. A feasible alternative could be the use of switchable perspex instead of glass, which would noticeably reduce the weight of the screen.