Augmentation of Volumetric Data in an Airplane Cabin

Holger T. Regenbrecht
DaimlerChrysler AG, Research and Technology
Virtual and Augmented Environments
P.O. Box 2360, 89013 Ulm / Germany
+49 731 505 4307
Holger.Regenbrecht@DaimlerChrysler.Com

Sönke Jacobsen
Airbus Deutschland GmbH
Virtual Reality Technology
Kreetslag 10, 21129 Hamburg / Germany
+49 40 743 711 52
Soenke.Jacobsen@airbus.dasa.de

ABSTRACT

In this demonstration we present an industrial Augmented Reality (AR) application in a miniature setup which allows the interpretation of computational fluid dynamics (CFD) data within a real airplane cabin. The information is displayed as volumetric data in form of voxels. The setup demonstrates the combined visualization of four domains: video see-thru, Virtual Reality (VR) data, phantom model, and voxel data.

This work is part of the governmental funded ARVIKA project [1] in Germany.

Keywords
Augmented Reality, CFD, Video See-Thru

INTRODUCTION
Non-visible physical properties of a real or simulated environment can become visible using Virtual Reality (VR) technology. In our case climate conditions within the cabin of an Airbus airplane have to be displayed as spatially distributed voxel data. These data represent e.g. air temperature, velocity, or pressure. The physical values are coded with different colors using 3D texture mechanisms available in rendering hardware today.

One main problem in interpreting such volumetric data is the loss of relationship to the real environment, for which the data sets were originally computed. Using the technology of Augmented Reality [6,7] seems to be the most promising approach to solve this problem. The volumetric data can be spatially aligned to the real world for appropriate interpretation.

Furthermore missing parts of the real environment, like seats not yet placed and compartments not yet built in, can be visualized using standard VR technology.

Finally both domains, CFD and VR, have to allow for the depth properties of the real environment for correct display. One very common approach is to render a VR model of the real world in a special way, so that the (static) occlusions between the real and virtual world look correct (model based approach).
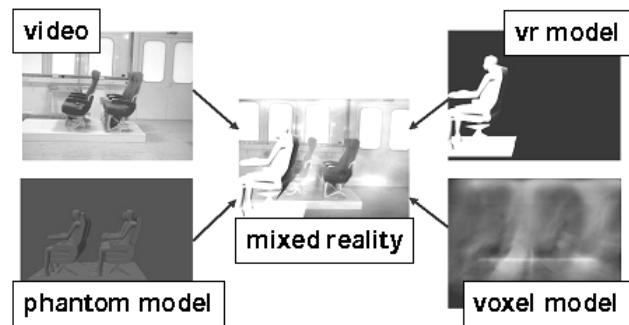
The principle is shown in figure 1.

Figure 1: Principle of combined display

Our system will demonstrate this combined display using a 1:10 scale model of the real environment (airplane cabin part).

SYSTEM SETUP
Until now we have implemented two versions of the system: (1) a stationary one in DaimlerChrysler's research center in Ulm (Figure 2) and (2) a mobile one with a scaled model going to be presented at the conference (Figure 3).

In both setups the user is wearing a head-mounted display (HMD, Sony Glasstron LDI-D100BE, 800x600 @ 60Hz) with a mini camera (Toshiba CM/KU-50, PAL, interlaced) mounted to it. The main difference is the tracking system used. Setup (1) tracks the user's head with an A.R.T. Dtrack system [2] with very high quality. This system tracks retro-reflective markers within the environment by self-flashing infrared cameras. The main disadvantage is the need to place fixed cameras (in our setup three of them) within the real environment, which is not suitable for the application in a real airplane cabin. Setup (2) uses a marker based tracking approach similar to [3]. This tracking is not very accurate but more flexible. The markers are detected using the video-see-thru camera already mounted to the HMD.

HMD and camera are connected to a standard PC (PIII-933) equipped with a graphics board capable of generating 3D textures (ATI Radeon or similar).

The software is especially designed and implemented for this application and is based on Open Inventor and DBView [4] technology.

The video see-thru mode is achieved by placing a video texture onto a very far backplane of the virtual

environment. This texture warps the video image according to the distortions of the camera. The camera parameters are measured using extra program components. The result is a very accurate video display with distortions almost not realizable. For the correct phantom model rendering a special sequence of basic OpenGL calls is applied.

All model domains can be switched on and off, the appropriate files can be loaded, and a basic virtual-to-real-world calibration is implemented using standard 2D GUI elements.

All data sets (CFD, VR, phantom) are pre-computed / -modeled. Because of missing hardware look-up-tables on the PC-based graphics boards unfortunately no interaction with the CFD data is possible, except for the self-movement around and thru the data.

Figure 2: Real cabin environment in stationary setup

Figure 3: Mobile (miniature) setup

FUTURE WORK

In the near future we are going to transfer the first system to its final destination in Hamburg/Germany. This system will use multiple, temporary placed markers within the airplane cabin for tracking [5] and will support the basic interactions needed for the interpretation of the CFD data by the engineer.

The whole system, including all hardware components needed (PC, helmet with HMD and camera, video-splitter, controllers, battery operated power supply, self-adhesive markers, interaction device), will be integrated into a portable unit (flight attendant trolley). In each session this unit will be rolled into the airplane cabin, markers will be attached to the environment, coordinate systems will be calibrated, CFD data interpreted, and finally markers removed.

The transferred system will be documented in the final report of the ARVIKA project.

REFERENCES

1. http://www.arvika.de

2. http://www.ar-tracking.de

3. Kato, H., Billinghurst, M., Marker Tracking and HMD Calibration for a Video-based Augmented Reality Conferencing System, Proc. of 2nd IWAR, pp.85-94 (1999). *Proceedings of 2nd Int. Workshop on Augmented Reality*. 1999. pp. 85-94.

4. Sauer, J. Virtual Reality in der Produktentwicklung [Virtual Reality in Product Development]. VDI-Berichte [Reports] Nr. 1614, 2001.

5. Baratoff, G., Neubeck, A., & Regenbrecht, H. (2002). Interactive Multi-Marker Calibration for Augmented Reality Applications. Proceedings of ISMAR 2002, September 30 - October 1, 2002, Darmstadt, Germany. IEEE.

6. Milgram, P., Takemura, H., Utsumi, A., Kishino, F., Augmented Reality: A Class of Displays on the Reality-Virtuality Continuum. *Proceedings of Telemanipulator and Telepresence Technologies*. 1994. SPIE Vol. 2351, 282-292.

7. Azuma, R., A Survey of Augmented Reality. *Presence:Teleoperators and Virtual Environments*, 1997. 6(4): pp. 355-385.