Einreichungsfassung VE, 2/98

AkuVis: Interactive Visualization of Acoustic Data*

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1 Introduction

The AkuVis (Interactive Visualization of Acoustic Data) is a joint project involving the Artificial Intelligence as well as the Visualization Laboratory at the University of Bielefeld, government researchers from the Institute of Public Health NRW and the Local Environmental Agency Bielefeld as well as the German TÜV (Börner 1997). The project seeks to create a highly interactive virtual environment of modelled acoustic data in order to sensitize and improve human decision-making in real world tasks. In particular, it attempts to enhance the integrated understanding of noise data as a basis for governmental decisions about noise protection regulations for new streets, industrial areas etc.

2 Motivation

Environmental noise exposure is a well-known risk factor (Jansen & Notbohm 1994). Negative implications for human health include, e.g., sleep disturbance and cardiovascular morbidity. In many areas, emissions from road traffic are the major source of environmental noise pollution. Actual levels of noise exposure depend on a variety of factors, including traffic density as well as spatial distance between sources and receptors. In spite of accumulated knowledge on negative health effects, it is often difficult to implement noise abatement measures. Environmental noise is seen as one of the major environmental health problems still awaiting a satisfying solution.

Noise exposure is an everyday experience, but the exact relationship between determinant factors and exposure levels is not always obvious. A better understanding of noise exposures should be helpful for an adequate assessment of the local situation, especially for the selection of noise abatement measures. Therefore, this project aims to provide decision-makers and the public at large with a very vivid demonstration of local noise levels, using acoustical as well as visual information.

*This research was partially supported by the Institute of Public Health NRW. Project partners in AkuVis are University of Bielefeld, Institute of Public Health NRW, Project Quantitative Risk Analysis (QRA), and Local Environmental Agency Bielefeld.

3 Interactive Visualization

A well established method of visualizing data of environmental noise pollution are 2D plots. However, decision makers are often uncomfortable with the conventions used and the complexity inherent in these plots. In AkuVis, acoustic data are mapped into a 3D visual and acoustic space that provides a much higher "bandwith" and can be explored interactively. Noise pollution data modelled by the German TÜV are mapped onto the three dimensions (x/y for position, z for dB level) of an "acoustic landscape".

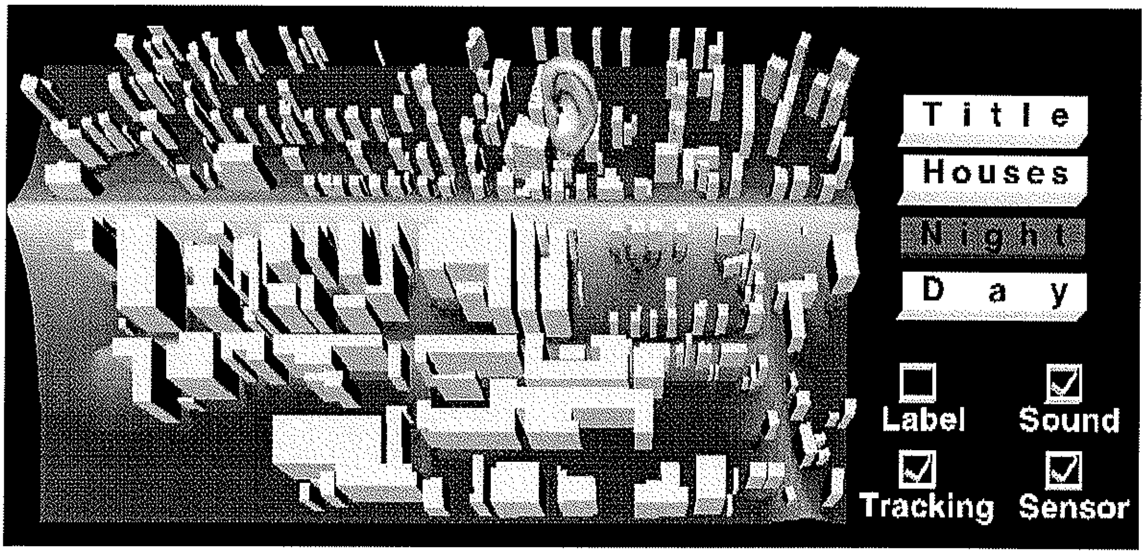

Figure 1: Acoustic landscape and interaction elements

Visually, users experience a richly detailed, interactively changeable landscape illustrating the noise conditions in a city district of Bielefeld. The landscape is rendered in real time as high-resolution stereoscopic images for a tracked user.

Acoustically, the landscape can be explored by way of a "virtual ear", i.e. a virtual sensor in the shape of a human ear. The "ear", as shown in the middle of the landscape in Fig. 1, is controlled by a tracking device. It can be moved across the "acoustic landscape" and lifted up in the z dimension. Its position determines the sound level, frequency, and kind of sound samples played to provide an acoustic impression of the noise conditions in the modelled city environment.

Figure 1 depicts a view on the acoustic landscape at night as well as the interaction elements. The buttons on the right hand side allow for the selection of either the `Title`, i.e. information about the project name and project partners, the `Houses` view presenting the houses and streets only, and the `Night` and `Day` view projecting the dB values for night and day conditions in terms of an "acoustic landscape" respectively. Additionally, the user is free to activate (check-mark):

- `Label`, inserting the street names.
- `Sound`, turning the street noise on.
- `Tracking`, replacing active head tracking by a standard normal view.[1] or

[1]This option is especially helpful if the required frame update rate of 30 Hz can not be achieved due to the

- Sensor, inserting the "ear", as a kind of virtual sensor for acoustical exploration, in the landscape.

In such a way, user actions are instantly reflected in 3D graphics and stereo sound.

4 Setting

Figure 2 shows the general setting used for human-computer interaction in AkuVis. Position sensors – one at the side of a pair of shutter glasses and one on the back of a stylus-glove respectively – keep track of the users eye and hand positions. One user acts as an active viewer, controlling the stereo projection reference point. The other users are passive viewers. Instead of using a mouse or keys the user handles this environment by manipulating virtual objects.

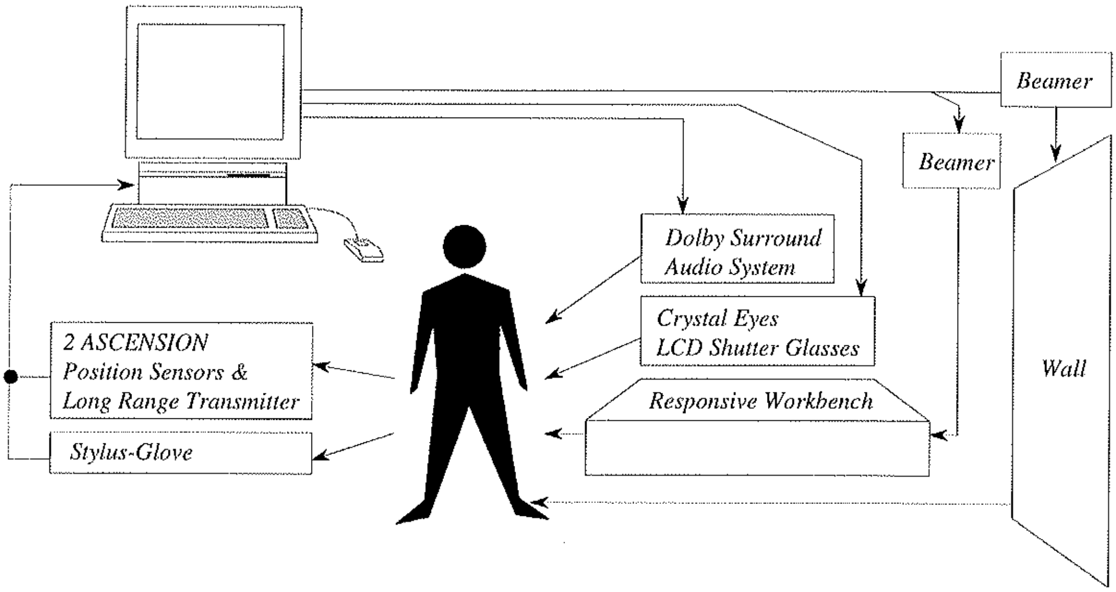

Figure 2: General setting used for human-computer interaction in AkuVis

The Responsive Workbench (Krüger & Fröhlich 1994), developed by the German National Research Center for Information Technology (GMD), is used as output device. It allows to fuse a real workbench – used as projection plane for the acoustic landscape – and virtual objects, i.e., the landscape itself as well as interaction elements, i.e., the ear, buttons, and check-boxes. Users, wearing LCD shutter glasses, can take advantage of 3D vision in a field of about 170cm x 120cm size. Additionally, the acoustic landscape may be projected on a larger screen of about 250cm x 250cm size, named Wall, allowing to reach a larger audience but for the cost of interaction. Sound samples are played via a stereo audio system.

limited computing power of the SGI machine used.

5 Outlook

In a next step, the project aims to implement more detailed noise modelling, allowing, e.g., for the demonstration of different noise abatement scenarios. Using appropriate dispersion models, the approach can be extended to include chemical emissions and resulting exposures. It will be interesting to gather evidence if this type of visualization does indeed improve the understanding of exposures and abatement measures for the sake of environmental protection and human health promotion.

6 Acknowledgements

We would like to thank GMD's Digital Media Lab for furnishing our Lab with the Responsive Workbench. The authors are grateful to Heiko Rommel and Timo Thomas who did substantial work on the implementation of the system. Additionally, we thank Elke Bernauer for providing data material as well as Peter Serocka and Marc Latoschik for giving technical advise.

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