

# REALTIME EXCHANGE OF DATA WITH AN IMAGE-GUIDED SURGERY SYSTEM

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**Abstract**—The aim of the VIRTUE project is the synchronization of virtual endoscopy with intraoperative navigation. In the final application, a virtual endoscopic image corresponding to the current optical endoscopic view will be generated in realtime. To achieve such a synchronized view, current tracking information has to be received from the intraoperative navigation equipment.

In order to make the exchange of data with an image-guided surgery system possible, a specialized data interface is used. Using this network-based communication layer, many different types of information can be downloaded from and uploaded to the image-guided surgery (IGS) device. We demonstrate the realtime exchange of tracked surgical tool information, volume datasets, operation plan information and 2-d bitmaps.

**Keywords**—Virtual Endoscopy, Network Communication, Image-Guided Surgery, Realtime Display, Minimally-invasive Surgery

## Introduction

Virtual endoscopy is a method of virtual medicine, in which 3-d images of anatomical structures imitating the view through an optical endoscope are generated. Our virtual endoscopy software VIVENDI is capable of displaying medical datasets with a very high geometrical complexity [1]. Figure 1 shows a virtual endoscopic view rendered by VIVENDI. In the image, a representation of the human bronchi with an additional display of blood vessels and tumour tissue can be seen.

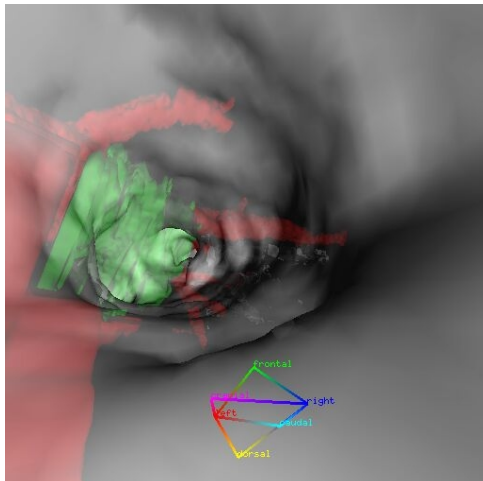


Figure 1: Virtual bronchoscopy in VIVENDI

The long-term objective of project VIRTUE is to provide the surgeon with a navigated virtual endoscopic view during interventions [2]. This means that images are generated by virtual endoscopy, which have exactly the same viewpoint as the optical endoscope. In order to achieve this type of synchronization, the exact current position and orientation of the optical endoscope has to be known. Since the optical endoscope is often tracked by an image-guided surgery (IGS) system, we harness this information by downloading it into our software framework.

The navigated virtual endoscopic images can provide the surgeon with an additional means for spatial orientation in the patient's anatomy. This is even more important if blood vessels are accidentally injured. In the case of such a "red-out", navigated virtual endoscopy might provide the only remaining, and critical, method of orientation.

## Methods

Our prototype system communicates with the *VectorVision* image-guided surgery device by the BrainLAB company. In order to exchange information with the IGS device, the specialized *VectorVision Link* library is employed [3]. An overview over the types of data that can be transferred from and to the *VectorVision* system is given in Figure 2.

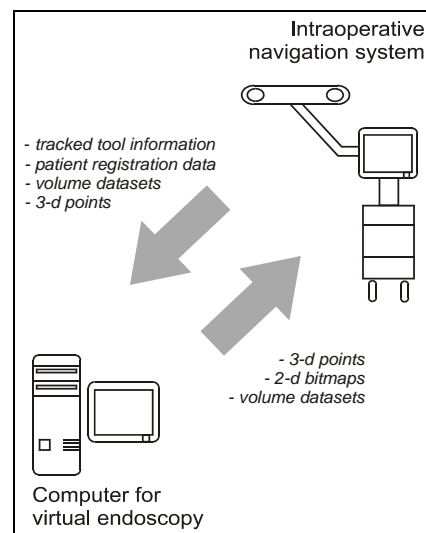


Figure 2: Information exchange using VectorVision Link

VectorVision Link uses the standard TCP/IP network protocol for the communication between client and image-

guided surgery system. Since both computers are connected to the existing local area network, no additional hardware is required for the data exchange, and setup time is very short.

## Results

We have implemented a common framework for supporting software which uses the VectorVision Link connection. Several test and demonstration programs were developed for examining different aspects of the interface's capabilities.

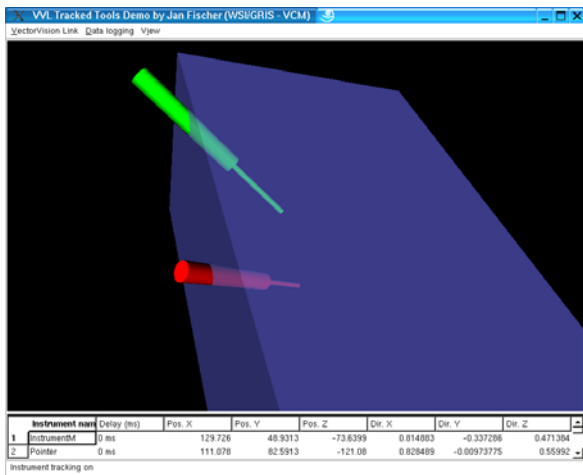


Figure 3: Realtime display of tracked surgical instruments

The "Tracked Tools demo" was implemented to illustrate the realtime download of tracked tools information (see Figure 3). The spatial position and orientation of all surgical instruments currently tracked by the IGS system are received by the software. Graphical representations of these tools are then rendered in relation to the volume containing the patient dataset. In addition to graphical and numerical display of the data, the entire session can be stored in an XML file and later be replayed.

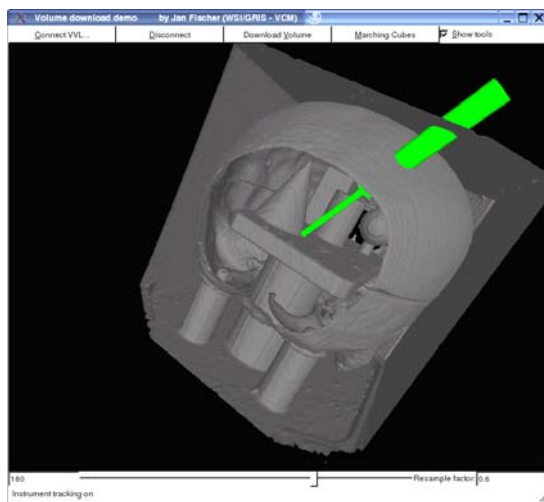


Figure 4: Triangulated patient dataset with tracked tool

Another program demonstrates the download of the current volume dataset in use by the image-guided surgery system.

The volumetric dataset is converted into a polygonal representation using the standard Marching Cubes algorithm and then displayed. The software can also render graphical models of tracked surgical instruments in relation to the patient dataset. A screenshot of the program is shown in Figure 4. The patient dataset used here is a MRI scan of a plastic phantom skull.

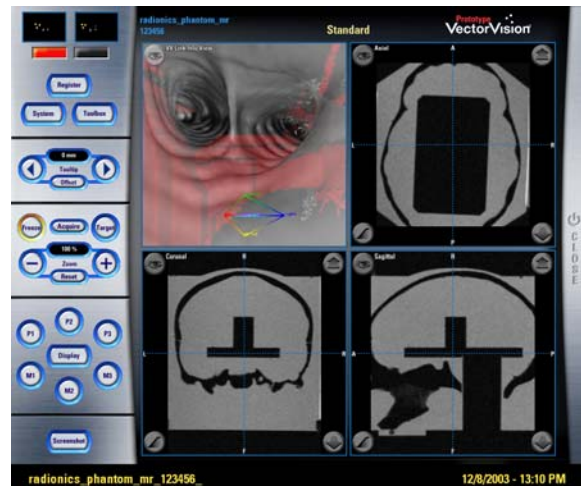


Figure 5: Virtual endoscopy image within the IGS system

Finally, we have tested the upload of 2-d bitmap images generated by our software. A virtual endoscopy view rendered by VIVENDI (without synchronized viewpoints) was displayed within the image-guided surgery system's user interface (see Figure 5). Note that a different dataset was used for the virtual endoscopic image.

## Discussion

We have implemented a software framework for realtime communication with intraoperative navigation. The exchange of different types of data was tested successfully. This constitutes an important milestone on the way towards navigated virtual endoscopy.

## Acknowledgements

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## References

- [1] Bartz, D., Skalej, M.: VIVENDI – A Virtual Ventricle Endoscopy System for Virtual Medicine, *Proceedings of IEEE Symposium on Visualization*, 1999
- [2] Bartz, D., Fischer, J. et al.: VIRTUE: A Navigated Virtual Endoscopy System for Maxillo-Facial and Neurosurgery, *Proceedings of 3D Modelling*, Paris, 2003
- [3] Neff, M., Diepold, K.: Design and Implementation of an Interface Facilitating Data Exchange between an IGS System and External Image Processing Software, *Diplomarbeit*, TU München, Mai 2003