The Institute of Computer Graphics and Algorithms

W. Purgathofer[1] and E. Gröller[1] and M. Wimmer[1]

[1]Vienna University of Technology, Austria
http://www.cg.tuwien.ac.at/

Abstract

At the Vienna University of Technology, the Institute of Computer Graphics and Algorithms is one of seven institutes of the Faculty of Informatics. It consists of groups on algorithms, computer graphics and image processing. Here we only describe the computer graphics group. We are focused on two main research areas: Visualization (Eduard Gröller, Ivan Viola + 8 researchers) and Rendering & Modeling (Michael Wimmer + 13 researchers).

1. Introduction

The 400 m^2 of offices and labs are located in the city center of Vienna. Our equipment are mostly high-end PCs with newest graphics cards, some color measuring devices and a large stereo projection wall. Further special equipment is obtained through funded research projects according to their need. In addition we have access to all installations at the VRVis research center, with which we closely collaborate. Currently we have about 30 employees:

- 4 Professors
- 5 Post-Docs
- 16 PhD students
- 5 Administrative

1.1. History

The history of CG in Vienna started in 1977 with Prof. Wilhelm Barth supervising the initial CG research. In 1988, Werner Purgathofer became the professor of a small working group, including assistants like Michael Gervautz and Eduard Gröller. The Institute of Computer Graphics was founded in 1990, which obtained its current name ten years later. In these years, many talented students such as Robert Tobler, Dieter Schmalstieg, Helwig Hauser and Michael Wimmer formed the basis of successful research. Until 1995, the graphics group never had more than 10 people, but then the era of third-party projects started.
Our first successful spin-off company – Imagination – was started in 1998. It is focused on augmented-reality research and applications. Only two years later, the VRVis Research Center was founded. Very close coupling of the basic research topics at our institute and applied research areas of the VRVis has proven to be very beneficial for both partners.

In the past decade, more and more international PhD students were attracted, leading to a total output of about 70 PhD theses in 17 years. Today, there are three working groups running projects of about 1 Million Euros per year. Several large graphics conferences were organized, several graduates became professors, and the scientific ranking of CG from the Vienna University of Technology is among the best in Europe (Microsoft Academic Research).

2. Collaborations

We have intensive international cooperations with experienced researchers from: Arizona State University, University of Bergen, University of Bonn, TU Darmstadt, Delft University of Technology, University of Girona, Italian National Research Council, KAUST, Linkoping University, Concordia University Montréal, Paris Institute of Technology, ETH Zürich, University of Zürich and research companies like Christian Michelsen Research or GE Vingmed Ultrasound. Guest professors, such as Torsten Möller, Francois Faure and Joaquim Jorge are also involved in teaching courses.

3. Research Highlights

Virtual story-telling Inter-domain communication or communication between experts and non-expert users (e.g. doctors and patients) is often difficult. Our goal is to improve their understanding and efficiency of information exchange by using the visual channel. This leads to the development of novel illustrative visualization techniques for interactive presentations of medical and technical datasets.

Ultrasound imaging Each parent's most exciting moment is the first look on his or her child. Fetus visualization from

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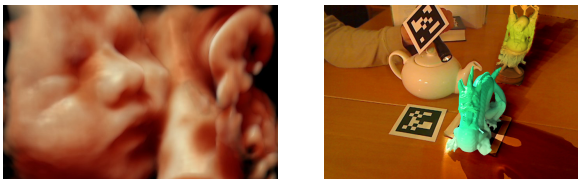

Figure 1: *Left: A rendering of an ultrasound fetus scan. Right: Light interaction between real and virtual objects.*

ultrasound data (Fig. 1) is just as exciting as that! A fully automated method was developed that can recognize, register and render the fetus without occlusion. The highest priority is to achieve an unobstructed view of the fetal face. The improvement of visual quality achieved over existing systems is immense. This method has been successfully integrated in state-of-the-art ultrasound imaging systems. It is in daily use in many prenatal imaging centers around the world.

Reshading Artificial objects added to AR applications can be easily spotted if they are not correctly lit. [KTM*10] focuses on the mutual light influence between real and virtual objects. This means that virtual objects may cast shadows on real objects and vice versa. The light simulation also takes global illumination effects like indirect color bleeding in both directions into account (Fig. 1).

Point clouds Laser scans often produce datasets far bigger than the capacity of the graphics memory. We are able to render a 75 GB dataset in real-time. Interactive manipulation and editing of huge point clouds is made possible by our out-of-core editing system [SW11].

Gaze tracking A novel attention-mapping system [BSW10] for tracking in object space was developed. Having the importance weights for all objects allows perceptual optimization of stereoscopic 3D, focus determination for depth-of-field and attention-aware LOD selection.

4. Behind the Ordinary

Motivated researchers also worked on transforming common consumer hardware into highly specialized equipment at minimal additional costs. These solutions are more than 30x cheaper than equally performing commercial products.

Spectral DSLR Using a custom system of lenses [HKW12] with a diffraction gel element, the spectrum of the incoming light rays gets spatially distributed over the camera sensor. This reconstruction method allows reassembling the original image in low resolution, but with up to 54 bands per pixel.

GeigerCam Measuring radioactivity with cheap webcams [AHM*12] is possible and reliable. Particle impacts can be detected in the background noise of the image sensor. Using these results, everyone can create his own simple detector.

5. Teaching

The Vienna University of Technology offers a 4-semester master *Visual Computing*, within which our institute teaches ≈30 different courses. Almost all aspects of CG and visualization are covered, including external and guest lecturers. In addition to the obligatory curriculum, we provide some students exclusive experience for their future academic careers: Around a dozen of the most talented Master students are accepted into the Computer Graphics Club of our institute. There they conduct own research, assist with teaching and take part in the social life of the institute.

CESCG We invite all European universities to participate at the annual Central European Seminar on Computer Graphics organized together with the Comenius University in Bratislava. The unique three-days event is a student scientific conference with 100 participants and allows undergraduate students to publish and present their first academic papers.

6. Future of the Lab

Research at our institute is thriving and frequently considers new directions. Its volume depends on the acquisition of funding and third-party money. In 2013, two important, large research projects will start and will even let our group grow a little bit:

Visualization of processes Ivan Viola received a top-level grant to build up a new research group, which will search for novel illustrative visualizations of complex structures and processes and investigate why the methods are successful from the perspective of human perception and cognition.

Harvesting 4D data Michael Wimmer will coordinate a new EU FP7 FET research project on the management of large amounts of time-dependent graphical data.

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