

# Realistic and Illustrative Visualization for Augmented Reality

*Aktion OE-CZ number 64p11*

## 1st year project report

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### Overview

The project Realistic and Illustrative Visualization for Augmented Reality took place in the period between 1.7.2012 and 30.6.2013. The coordinators of the project were Ing. Jiří Bittner, Ph.D. on the Czech side (Katedra počítačové grafiky a interakce, FEL ČVUT) and Associate Prof. Dipl.-Ing. Dipl.-Ing. Dr.techn. Michael Wimmer on the Austrian side (Institut für Computergraphik, Technische Universität Wien). The total budget of the project was 61.000 Kč on the Czech side and 3.210 Euro on Austrian side. The cooperation has been scheduled as a three years project, while this report constitutes the first year of the project.

### Progress of cooperation

In total there were 4 visits of Czech participants of the project in Vienna and 5 visits of Austrian participants in Prague.

**1. visit: 11. 9. – 15. 9. 2012, Ing. Ladislav Čmolík, Ph.D.**

The topic of the visit of Ladislav Čmolík at TU Vienna was to design a methodology for integration of illustrative transparency (method allowing to reveal hidden structures of complex 3D meshes) to the Volumeshop tool used in research and teaching at TU Vienna. In addition, meetings with researchers of TU Vienna were conducted to share and discuss new ideas how to advance the field of illustrative visualization.

**2. visit: 22. 10. – 26. 10. 2012, Ing. Peter Mindek, Dipl.-Ing. Johanna Schmidt**

The topic of the visit of Peter Mindek and Johanna Schmidt at CTU Prague was to integrate illustrative transparency to Volumeshop. This task was successfully completed. The result of the work will be used for further research at TU Vienna.

**3. visit: 26. 11. – 30. 11. 2012, Ing. Jiří Bittner, Ph.D., Ing. Tomáš Barák (28. 11. – 30. 11.)**

During this visit at TU Vienna, we presented the latest results in real-time indirect illumination computation achieved in Prague, particularly the adaptive sampling of virtual point lights (VPL) suitable for augmented reality applications. We discussed new methods combining the latest results achieved at both partner institutions.

**4. visit: 11. 12. – 12. 12. 2012, Dipl.-Ing. Reinhold Preiner**

During his visit at CTU Prague, Reinhold Preiner discussed progress in extending the existing real-time methods of computing indirect illumination based on instant radiosity

using adaptive VPL sampling techniques. Reinhold Preiner also presented his recent work on Auto-Splats for high quality rendering of unstructured point clouds.

**5. visit: 17. 12. – 21. 12. 2012, Ing. Ladislav Čmolík, Ph.D.**

The topic of the visit of Ladislav Čmolík at TU Vienna was the design of a method allowing automatic calculation of suitable positions and orientations of a virtual camera. The problem has been formalized as an optimization problem.

**6. visit: 6. 3. – 8. 3. 2012, Ing. Martin Ilčík**

During this visit at CTU Prague, we formulated proposals for using shape grammars together with binary space partitioning trees targeted at the animation of articulated models. We targeted two possible approaches - one for generating the whole model and using it in a rasterization pipeline, the other for generating the model on the fly using ray tracing based approaches.

**7. visit: 27. 5. – 31. 5. 2013, Ing. Peter Mindek, Dipl.-Ing. Johanna Schmidt**

The topic of the visit of Peter Mindek and Johanna Schmidt at CTU Prague was the preparation of a publication dealing with virtual camera position and orientation calculation discussed in a previous visit. Peter Mindek also presented a talk entitled “Contextual Snapshots: Enriched Visualization with Interactive Spatial Annotations”.

**8. visit: 5. 6. – 7. 6. 2013, Dr. Przemyslaw Musialski**

During this visit at CTU Prague, we addressed the problem of efficiently creating of high-quality building models, particularly detailed facades. We discussed the possibility of using the iterative hierarchy optimization method recently developed at CTU Prague for the grammar-based façade modeling techniques developed at TU Vienna. Dr. Musialski presented his recent research on the topic to the institute members.

**9. visit: 23. 6. – 25. 6. 2013, Ing. Jiří Bittner, Ph.D.**

During this visit at TU Vienna, we addressed the problem of efficient computation of real-time indirect illumination in augmented reality setups. We planned further research steps in combining the adaptive sampling of virtual point lights recently developed at CTU Prague with the virtual area lights-based method developed at TU Vienna.

## Project results

The results of the discussed visits and continuous common research in the area of realistic and illustrative visualization were the verification a new ideas and the preparation of common scientific publications. Below is a summary of the main project results achieved during the first year of the project:

### Publications

- Peter Mindek, Stefan Bruckner, Meister Eduard Gröller. Contextual Snapshots: Enriched Visualization with Interactive Spatial Annotations. In Proceedings of the 29th Spring Conference on Computer Graphics. May 2013.
- Peter Mindek, Stefan Bruckner, Peter Rautek, Meister Eduard Gröller. Visual Parameter Exploration in GPU Shader Space. Journal of WSCG, 21(3):225-234, 2013.

- Johanna Schmidt, M. Eduard Gröller, Stefan Bruckner. VAICo: Visual Analysis for Image Comparison. To appear in IEEE Transactions on Visualization and Computer Graphics, 12(19), December 2013.
- Peter Mindek, Ladislav Čmolík, Ivan Viola, Stefan Bruckner, Eduard Groeller. ManyCams: Parallel Visual Narratives using a Flock of Cameras, to be submitted to Eurographics conference in September 2013.
- Ladislav Čmolík, Peter Mindek, Eduard Groeller. Selection of Complex Spatial Regions Utilizing Connectivity Information (in preparation, to be submitted to EuroVis 2014).

## **Presentations**

- Reinhold Preiner - Auto Splats: Dynamic Point Cloud Visualization on the GPU (12/12/2012)
- Peter Mindek - Contextual Snapshots: Enriched Visualization with Interactive Spatial Annotations (29/5/2013)
- Przem Musialski - Facade Reconstruction: An Image-Based Interactive Approach (6/6/2013)

## **Master and bachelor theses related to the project**

- Daniel Šimek. Deferred shading based extensible rendering pipeline. CTU Prague, supervisor J. Bittner (defended 1/2013).
- Markéta Štětovská. CTU Prague, supervisor L. Čmolík (in progress).
- Hartwig Wutscher. Mesh-splitting in image space. TU Vienna, supervisor P. Mindek (in progress).

## **Conclusion**

The Aktion OE-CZ is a very important incentive to build new and intensify existing collaborations between our partner institutions. What is especially important for our institutes is that the Aktion allows the exchange of PhD students and researchers. The presentations and discussions of the project members also allowed a broader audience to get acquainted with the latest research results at partner institutions. The effect of the bilateral visits goes far beyond the benefit of achieving progress in an individual project: during those visits, new research ideas are born, and new collaborations are established. We expect that the results of the cooperation will form a steady platform for further cooperation and will lead to new common publications on the researched topics.