

## 1 Introduction

Non-photorealistic rendering (NPR) is a young research field that received an increased attention within the last fifteen years. In contrast to photorealistic computer graphics, which aims at a physically correct simulation of light transport and reflection, NPR produces a personal, artistic, and abstracted interpretation of the content, and thereby, it is able to communicate information in an expressive, focused, and idealized way. Various applications benefit from this form of depiction: Consumer oriented applications that traditionally prefer natural media and style, such as architectural and design sketches, benefit from the artistic reproduction of 3d content. Other applications benefit from the simplified and focused depiction of information such as technical illustrations and animations. Research areas cover the temporal coherence in NPR animations, abstraction techniques, the reproduction of natural media, and visual perception.

## 2 Reproduction of Watercolor

The reproduction of an artistic style such as watercolor [3] is a challenging problem, which aims particularly at the efficient and convincing reproduction of the visual attributes of the medium as well as a controllable temporal coherence during animation. The result allows various new applications ranging from contemporary, animated artwork, interactive design studies to real-time previews within high-quality rendering.



Figure 1: Snapshot Painter. To communicate the vision of animated content, this proof-of-concept turns 2d image data such as photographs or renderings into a computer generated, dynamic artwork: forms evolve in fluid patterns that turn the single image to a dynamic temporal process.

## 3 Stylistic Means

Artists achieve vivid and expressive results through the application of stylistic means: These exist in form of abstractions of shape and shading, as a visual level-of-detail mechanism, or as indication of contours, shapes, and details. Their integration and application is one key to the success of a non-photorealistic rendering algorithm. Thereby, abstraction and indication are two very important and often recognizable stylistic means in traditional paintings and illustrations. Abstraction is performed by simplifying shape and shading [4, 1], indication by emphasizing spatial relations or details of interest [2].

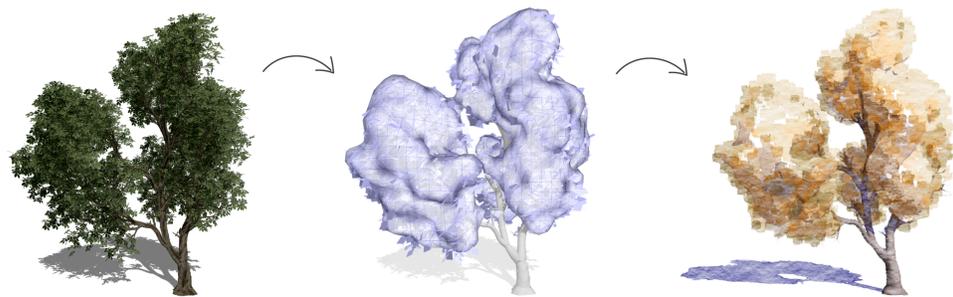


Figure 2: In NPR special consideration is given to the visual complexity, its simplification, and the modeling that differs strongly from that of the photorealistic rendering. We found implicit surfaces as a suitable means for the abstraction of shape and illumination of botanical data.

## 4 Applications

### 4.1 Project *aQtree*

A cooperation between the University of Konstanz, brainpets GbR, and the Filmakademie Baden-Wuerttemberg sets out to bridge the divide between technical research and practical film-making. The result is *aQtree*, a work-in-progress expressive rendering application focused on enabling animated 3D content of convincing coherent quality. The goal of the collaboration is both to allow artists access to NPR and to generate feedback with which to test and expand research theory.



Figure 3: Screens of the non-photorealistic 3d renderer *aQtree* used for the production of the animated short film *Love.Leech.Tomato*. The core of *aQtree* is organized as a 2.5d graphics solution: semi-transparent layers defined in camera space hold the individual graphical elements.

### 4.2 Project *paletteCAD*

An important step for NPR is the application and integration into modeling and rendering systems to provide styles beyond traditional photorealistic rendering. A cooperation between the University of Konstanz and *paletteCAD* GmbH, Stuttgart, aims at this goal by integrating a NPR pipeline into an existing CAD system [5].

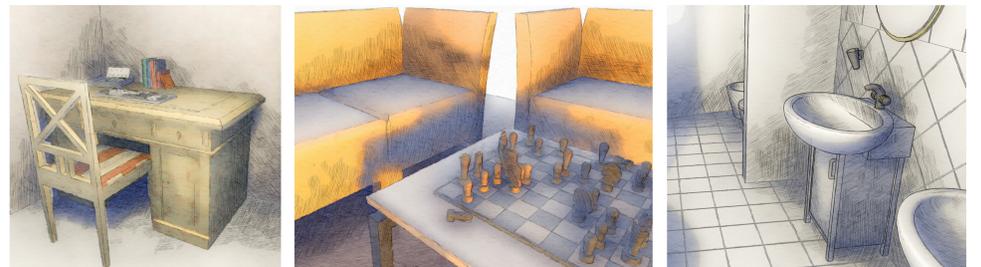


Figure 4: Watercolor illustration of CAD models rendered with our pipeline. A tone-based lighting model is introduced to realize a traditional color contrast scheme, while ambient occlusion introduces a perceptual level-of-detail, which is similar to stylistic means found in hand-made illustrations.

## References

- [1] T. Luft, M. Balzer, and O. Deussen. Expressive illumination of foliage based on implicit surfaces. In *Proceedings of Eurographics Workshop on Natural Phenomena*, pages 71–78, 2007.
- [2] T. Luft, C. Colditz, and O. Deussen. Image enhancement by unsharp masking the depth buffer. *ACM Transactions on Graphics*, 25(3):1206–1213, jul 2006.
- [3] T. Luft and O. Deussen. Real-time watercolor for animation. *Journal of Computer Sci. and Technology*, 21(2):159–165, 2006.
- [4] T. Luft and O. Deussen. Real-time watercolor illustrations of plants using a blurred depth test. In *NPAR 2006: Fourth International Symposium on Non Photorealistic Animation and Rendering*, pages 11–20, jun 2006.
- [5] T. Luft, F. Kobs, W. Zinser, and O. Deussen. Watercolor illustrations of cad data. In *Proceedings of Computational Aesthetics in Graphics, Visualization, and Imaging*, 2008. to appear.