There is a growing interest in Non-Photorealistic Rendering (NPR) methods because of its expressive power for illustrating shapes and spatial relationships as well as for generating artistic drawings and paintings. How we choose to portray a data set can have a significant effect on how accurately and efficiently we communicate with the viewers the information we seek to reveal. In many cases, NPR has been shown to be more effective than photorealistic rendering in communicating subtle information about physical structures or phenomena. We shall see a growing use of NPR for scientific visualization and illustrations as realtime NPR becomes available. Recent advances in painterly rendering have demonstrated that certain artistic styles can be mimicked. The ability to automatically generate arts and illustrations for more effectively communicating with scenes, ideas, or actions would allow content creators for education, films or video games to attain a new level of creativity.

We thus believe a large SIGGRAPH audience will benefit from a course on non-photorealistic approach for scientific visualization and artistic rendering. Courses on NPR related topics have been offered before, two in SIGGRAPH ’99 and one in SIGGRAPH 2001. This course is unique since it addresses some of the most relevant aspects of the theoretical basis, software algorithms, hardware-assisted techniques, and applications for NPR. We have designed four concise lectures to motivate the audience, inform them with the state-of-the-art techniques and their applications, and offer them pointers for further research.

In the first lecture, Victoria Interrante will give an overview of the use of NPR rendering techniques in scientific visualization, followed by a presentation of the design, implementation and evaluation of several specific NPR methods drawn from her recent research. She will use hand-drawn examples from scientific application areas, such as medical line drawings and archaeological illustrations, as well as some examples from art/illustration to show when and how non-photorealistic representations can be effective in illustrating shapes and structures. She will present mathematical methods for calculating preferred stroke directions over a polygonally-defined mesh, and techniques for synthesizing a high-resolution oriented texture over a surface mesh. She will also discuss results from two controlled observer experiments intended to investigate the effects of surface texture characteristics on 3D shape perception.

In the second lecture, Aaron Hertzmann will describe stroke-based NPR methods. This area incorporates a wide variety of methods for pen-and-ink, painterly, and visualization renderings of images, 3D and video, and can be quite challenging to the beginner. In order to help make sense of things, he will present a unified framework for stroke-based NPR and draw attention to the common principles of the area. In particular, stroke-based rendering describes methods where discrete strokes are placed...
in order to match some predetermined constraints, such as matching a predetermined image color or intensity. The specific algorithms used depend directly on the form of these constraints.

In the third lecture, Aaron Hertzmann will describe recent advances in example-based NPR, where NPR algorithms are designed based on hand-made examples. For example, a painting image filter might be created based on a scanned painting made by a famous artist. This approach is far easier than explicit methods (such as stroke-based rendering), since it is very difficult to write a function that describes the technique of a famous artist; however, only some aspects of a style may be captured. He will survey several recent methods developed in this area, and describe the method of "Image Analogies" in detail.

Finally, Eric Lum will present a suite of hardware-accelerated NPR techniques, making extensive use of the advanced features of commodity graphics cards, for interactive visualization of volume data. In addition to the typical view and rendering parameters, each NPR technique adds its own set of parameters that must be specified. Often the user does not know what type of rendering style is desired, only through experimentation can parameters be found suited for their particular application. He will show how interactive NPR facilitate this parameter specification process, and how different rendering styles and NPR techniques may be freely mixed with interactive control. Both the benefit and cost of including each NPR technique will be discussed. He will also describe how to use a cluster of PCs to render large-scale volume while maintaining high interactivity and image quality for large-format display.

For the specific approaches covered in the lectures, examples and previous successes, as well as some of their limitations, are discussed. Where techniques are unavailable, or not yet proven, opportunities and promising research directions are offered. In this course notes, each chapter begins with a summary of the corresponding lecture. We also provide comprehensive bibliographies, as well as including a collection of technical reports and previously published papers relevant to the subjects discussed in this course. We hope you find this course notes helpful.

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