Advanced Computer Graphics: Non-Photorealistic Rendering

Introduction and Overview

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What is NPR?

- Non-Photorealistic Rendering and Animation
- as opposed to Photorealistic Rendering
  - simulation of light interaction with surfaces
  - heuristics to achieve good results with as little effort as possible
  - dictate of the photographic camera
Photorealism in Artistic Depiction

Ralph Goings: *Hot Fudge Sundae Interior*, 1972 (oil on canvas)
Art or Traditional Depiction as Example

- 1\textsuperscript{st} (photographic) camera: camera obscura ca. 1020
Art or Traditional Depiction as Example

• photographic camera
  – first permanent picture in 1826
  – now: video cameras and digital cameras
  – dominating today’s visual world
Art or Traditional Depiction as Example

- painting
  - up to 32 000 years old (French cave paintings)
  - up to quite recently dominated visual depiction
Art or Traditional Depiction as Example

- drawing and similar techniques
  - less visually vivid depiction, possibly with color
  - often used for illustration
  - abstraction and emphasis
Art or Traditional Depiction as Example

- drawing and similar techniques: modern examples
  - in medical illustration
Art or Traditional Depiction as Example

- drawing and similar techniques: modern examples
  - in technical illustration

courtesy of Kevin Hulsey
What is NPR?

- computer graphics inspired by non-photographic techniques, thus, non-photorealistic rendering

Saito & Takahashi (1990)
NPR as a Diverse Field

- inspired by traditional techniques
  - very realistic simulations of traditional media
  - heuristics to achieve similar effects, e.g., faster
  - traditional techniques taken to new levels (e.g., video)

- completely new methods
  - interactive techniques
  - non-realistic modeling
  - possibly many other

- application-oriented techniques
  - illustration in various domains (medical, technical, etc.)
  - visualization techniques (medical, technical, etc.)
  - support for other fields, e.g., sketch-based modeling
Different Sub-Fields of NPR

- pixel manipulation
  - halftoning and screening
  - image processing techniques
  - image mosaics
  - texture sampling and synthesis
Different Sub-Fields of NPR

- silhouettes and feature strokes
  - simple silhouette rendering
  - static feature lines
  - dynamic feature lines (suggestive contours etc.)
  - hidden line removal
  - “sparse line drawings”
Different Sub-Fields of NPR

• pen-and-ink rendering
  – black-and-white only
  – pen-and-ink style
  – dot primitives: stippling
  – line primitives: hatching
Different Sub-Fields of NPR

- simulation of natural material
  - pencil drawing on paper
  - wax crayons
  - wet paint on paper
  - oil painting
  - etc.
Different Sub-Fields of NPR

- stroke-based rendering
  - considering the stroke as the fundamental NPR primitive
  - abstraction through strokes
Different Sub-Fields of NPR

- lighting models and shading
  - cel shading
  - Gooch shading
  - line shading
Different Sub-Fields of NPR

- distortion techniques
  - image-space distortion
  - object-space distortion
  - understandable and intentional distortion
  - distortion for animation
Different Sub-Fields of NPR

- real-time rendering techniques
  - real-time heuristics for many previously mentioned areas
Different Sub-Fields of NPR

• interaction with or for NPR techniques
  – dedicated hardware simulating the traditional tools
  – dedicated hardware for novel interaction
  – general-purpose hardware
  – emotional interaction
Different Sub-Fields of NPR

- evaluation of NPR techniques
  - comparison with depictions created by people traditionally, asking people or statistics
  - impact of the created images
Different Sub-Fields of NPR

• application of NPR techniques
  – why is NPR important in practice
  – different application domains: entertainment, architecture, medicine, general illustration, visualization
Remainder of the Class: 1st Half

- lectures on a selected subset of areas:
  - black-and-white techniques (pen-and-ink)
  - stoke-based rendering
  - NPR and interaction
  - evaluation of NPR
  - applications of NPR
Remainder of the Class: 2nd Half

• student lectures on selected topics
  – topic: 2–3 high-quality scientific papers
  – papers from suggested list or own suggestion
  – about 25–30 minute lecture on the topic
  – about 5 minutes for questions
  – goal: overview of the topic plus some details on specifics
  – slides provided for all students

• gives overview of the rest of the field
# Class Schedule

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**Next classes:** (start on time)

- December 12, 2011 (Monday): 14:00 – 17:45
- December 13, 2011 (Tuesday): 09:00 – 14:15 (if necessary)
Assignment Overview

1. lecture on topic in 2\textsuperscript{nd} half of the class
2. implementation of technique within chosen topic
3. summarizing research paper about topic and implementation (8–10 pages in IEEE VIS style)

- details about assignment topics on class web page: http://www.cs.rug.nl/~isenberg/advanced-graphics/
Assignment Procedure

- choose topic today or by end of this week (e-mail)
- questions about topic: Skype meetings possible
- send in slides 1 week prior to lecture for feedback (e-mail url of slide package)
- implementations due January 16
- appointments for demoing implementations on January 17 or 18
- papers due February 6 (start 3rd exam week)
- strict deadlines
Assignment Topics (Suggestions)

- specific simulation of natural material
- silhouette extraction and rendering
- view-dependent feature lines
- NPR lighting models
- NPR in (medical) illustrative visualization
- real-time techniques w/ GPU programming
- non-photorealistic modeling
- NPR and abstraction
- distortion for artistic applications & visualization
- application of NPR techniques in games
- self-chosen technique from NPAR/SIGGRAPH/VIS
Grading and Rules

• grading and rules:
  – 25% from presentation, 10% from participation, 25% from implementation, 40% from paper
  – for each part at least 50% of points necessary
  – at least 60% of total to pass the class
  – presence in lectures is mandatory
  – individual results only valid for current year
  – cheating: no points
  – sick during class: call/e-mail beforehand
Further Information: 2 Books on NPR


Questions?
Sources:

- lecture “Non-Photorealistic Computer Graphics” by Stefan Schlechtweg, Thomas Strothotte, Tobias Isenberg at the University of Magdeburg, Germany
- many images from numerous NPR papers
- otherwise as noted