Interactive Graphics Lecture 18

Non-Photorealistic Rendering

Why Photorealistic?

Much graphics research is aimed at producing photo-realism. Techniques that we have discussed include:

- textures
- bump mapping
- environment mapping
- ray tracing
- radiosity

Modern research continues this quest.

Photorealistic Rendering
Cornell University
circa 1990

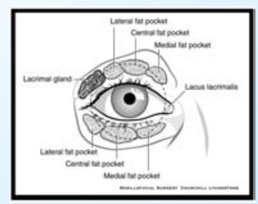
Non-photorealistic Rendering
Johannes Vermeer
circa 1660

Why Non-Photorealistic?

Schematic diagrams can show things that photos can't

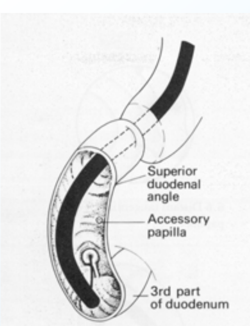
An artist is often able to (expected to) convey "expressiveness".

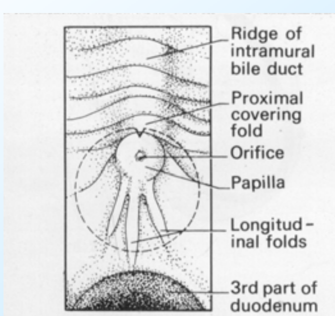
This has given rise to the field of non-photorealistic rendering



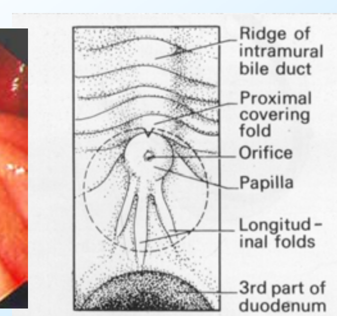
Medical illustration
From IBLS at University of Glasgow

Non-Photorealistic medical illustrations





Non-Photorealistic medical illustrations



Many NPR Systems Use Image filters

Start with a photograph

Blur - using the same techniques discussed for anti-aliasing

Quantise - Change colour or spatial resolution

Texture - combine texture and image by blending

Composite Filtering in different resolutions (more interesting)

Blurring is done using the anti-aliasing filter

Replace each pixel by a weighted average of its neighbourhood:

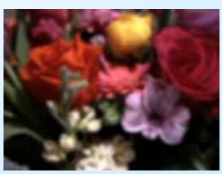
1/36	**1/9**	**1/36**
1/9	**4/9**	**1/9**
1/36	**1/9**	**1/36**

Use several applications for more blurring, or use a larger filter kernel

Blurring

Blurring images is fast and simple, but it doesn't really produce very interesting results.

It is important in combination with other filters



Quantising Colour Depth

Change the number of colours or grey levels used to represent a picture.

Can produce interesting effects

Quantising resolution and colour depth

Edge Enhancement

Like blurring but with a different filter

Vertical Edge

-1	**0**	**1**
-2	**0**	**2**
-1	**0**	**1**

Horizontal Edge

1	**2**	**1**
0	**0**	**0**
-1	**-2**	**-1**

Find the magnitude of the two components

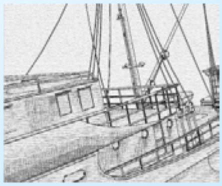
Change image depending on edge strength

Creating pen images

Edges are found and reinforced

Shading is replaced with textures

Pictures from Intel 3D Software Technologies pages



Composite filtering

Filtering in more complex manners can produce oil paint effects (Hertzmann and Perlin see http://www.mrl.nyu.edu/projects/npr/painterly/)

Outline Algorithm

Initialise the output image to blank

For a given brush size (eg 32,16, 8 or 4 pixels)

- Blur the source image using a filter size comparable to the brush size.
- Find a difference image between the blurred source image and the current output image.
- Threshold the difference image, so only large changes are retained.
- Find local maxima on a coarse grid
- Place a brush stroke on the output image at the local maximum using the corresponding image colour

First stages of the technique using circular brush strokes

Source Image

1. Circular brush strokes, radius 16

2. Circular brush strokes, radius 8

Images Angela Phuong IC 2006

Refinement using small circular brush strokes

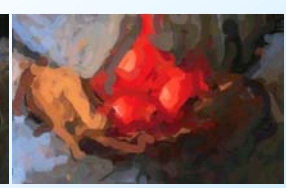
Source Image

3. Circular brush strokes, radius 4

4. Circular brush strokes, radius 2

Images Angela Phuong IC 2006

Hertzmann's original using elongated strokes



A lakeside scene using circular brush strokes

Images by Angela Phuong, (IC-DOC project 2006)

Creating effects by analogy

Work done by Hertzman Jacobs Oliver Curless and Salesin, University of Torronto (SIGGRAPH 2001)

The idea is to use effects created for one image on another image. Done using multi-resolution representation with local searches to find the best match.

The following examples are from:
http://www.mrl.nyu.edu/publications/image-analogies/

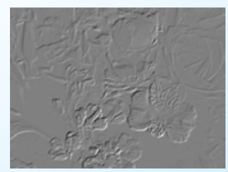
Original Image

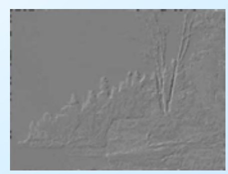
Image with a special effect

Take another image

Create an analogous effect

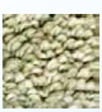
Analogies of basic filters -eg embossing





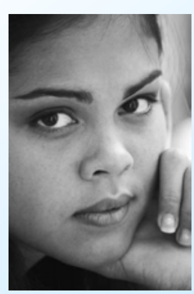
Textures - mapped by analogy

Blending textures into images can create interesting results



Textures

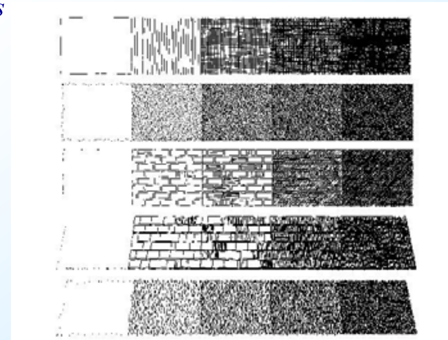
Different textures create different effects



Rendering Methods

Non photorealistic rendering can be applied directly to polygon maps

Different textures can be defined in different shades

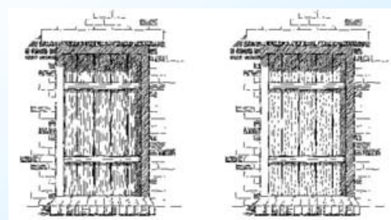


Textures simulating drawings

Strokes:
- Should have variation in width from pressure and direction

Tones and textures:
- Combining strokes creates tone and texture

Effects of different strokes, tones and textures



Stroke Textures

Collection of strokes to give texture and tone

Prioritised so that different tones can be achieved
- first only highest priority drawn
- to increase tone, lower priorities drawn

For example:
- highest priority to outline
- next could be horizontal lines
- then vertical, and so on

Indication

Texturing uniform areas uniformly does not produce good results.

Indication is the process of adding guidelines for texturing

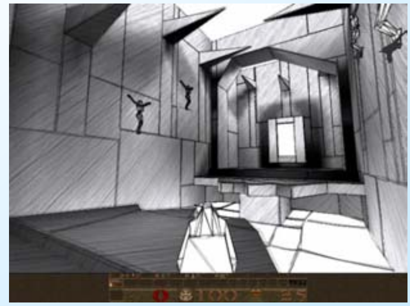
The distance of a pixel from the guide line indicates the amount of texture used

(Could be defined in the graphics scene)

Using Indication

Pencil Sketch - Quake

Main polygons shown - simple line shading - polygon edges rendered with stroke textures



Cell-Shading – Rendering a 3D scene as a cartoon. Used in video games (dreamcast)

Cell Shading - uses polygon rendering

Create a Light map: this is a 1-Dimensional texture map that indicates the shade of an object. It is set up using a few discrete regions.

Find a reflectance with Lambert's cosine law, use its value to select from the light map

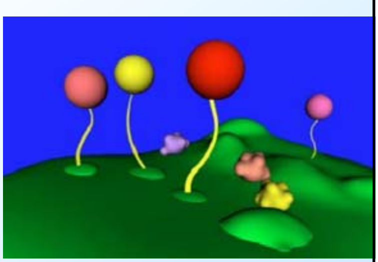
Add black lines at the visible polygon boundaries (or some of them)

Creating other "animator" effects

Remove shading

Outline strong edges

Add Embellishments



Work by Kowalski et al see:
http://www.cs.brown.edu/people/lem/research/kowalski-s99-preprint-300dpi.pdf

The possibilities are endless