Artistic Screening
V. Ostromoukhov, R.D. Hersch

Eric Blais
Outline

- Introduction/Motivation
- Halftoning
- Artistic screening
- Summary/Conclusions
Introduction

Bella Vignette, by V. Ostromoukhov

McGill COS767 Winter 2004
Introduction

- Printing images in black & white introduces artifacts.
- Generally try to avoid artifacts to reproduce the original image as faithfully as possible.

SmartCar, by C.Naylor
Introduction

- Artistic halftoning does not try to remove all artifacts
- Instead, control the artifacts to add another layer of information!

Detail of *Bella Vignette*, by V. Ostromoukhov
M.C. Escher

- Sky and Water
  - woodcut
  - Shows tiling of shapes... but also:
  - Gradient of white to black
  - The birds & the fish give the gradient

Sky and Water, by M.C. Escher
Islamic Art

- Alhambra (Spain)
  - From a distance: rich textures on all the walls
  - Up close: textures are created by finely-detailed tiles

Alhambra Detail, by Blair Fraser
Outline

- Introduction/Motivation
  - Halftoning
- Artistic screening
- Summary/Conclusions
Halftoning

- Method of simulating gray levels using only black & white

- Illusion of gray levels provided by individual shapes that “blend together” when seen from a distance
Halftoning

Three methods:

- Traditional
  - “Newspaper”-style halftoning
- Threshold
  - Sometimes known as dithering
- Pattern
  - Will be used for artistic halftoning
Traditional Halftoning

- Can be seen by looking closely at newspaper images
- Gray levels created by dots of different sizes
- Best for printers with low resolution but variable dot size
Traditional Halftoning

- First Step: divide the input image into tiles
- Individual tiles are called screen elements
  - In this example, each grid square (about 16x16 pixels) corresponds to one screen element
Traditional Halftoning

- Second step: add one dot per screen element
- Size of the dot determined by the average colour of the screen element
Traditional Halftoning

- Quality of results depends heavily on the output resolution
- Edges are not really sharp
- Can improve results with diagonal grids, non-circular dots
Threshold Halftoning

- Alternative to the traditional method
- No colour averaging within the screen elements
- Gives a more accurate picture
Threshold Halftoning

- First Step: divide the image into screen elements
  - Same as before
Threshold Halftoning

- Second step: define a threshold for each pixel in the screen element

- Only pixels darker than their associated threshold are drawn in the output image
Threshold Halftoning

- Creates sharper edges than traditional method
- Dots are not always complete!
Pattern Halftoning

- Gets rid of the threshold function
- Instead, uses pattern images to create illusion of gray levels
- Much more flexible!

Warrior, by V. Ostromoukhov
Pattern Halftoning

- Additional pre-processing step is required:
- Create a screen element pattern for each gray level
  - Any pattern is possible, as long as similar gray levels have similar pattern images

V.O. & R.D.H.
Pattern Halftoning

Next step:

- Once again, divide the image into screen elements
Pattern Halftoning

- Last step: use the patterns to form the final image
- A pixel's colour determines which pattern image is sampled at that position
Pattern Halftoning

- Results can be much more interesting than traditional or threshold halftoning methods!
- If pattern images are stored in a library, this method is about as fast as the other two methods.
Outline

- Introduction/Motivation
- Halftoning
  - Artistic Screening
- Summary/Conclusions
Artistic Screening

- Creation of artistic pattern images
- Edges smoothing
- Multiple patterns
- Screen distortions
Creating pattern images

Creating the pattern image for each gray level by hand is possible...

- Tedious
- Very time consuming
- Difficult to change the number of gray levels afterwards
- Cannot adjust the screen element shape or size afterwards
Creating pattern shapes

There is a better way:
- The artist defines the contour of the pattern for specific gray levels
- Can be done in any commercial shape drawing application

V.O. & R.D.H.
Interpolating pattern shapes

- Shape blending algorithm used to interpolate between the defined contours
- Can blend between any number of gray levels

Two fixed predefined contours

Interpolated contours

V.O. & R.D.H.
Creating pattern images

- Discretization
  - Pattern images are created from the contours for each gray level
Creating patterns - review

V.O. & R.D.H.
Edge Smoothing

Problem:
- Sharp edges cause discontinuities in our patterns
Edge Smoothing

Solution is simple
- Simply blur the original image
- Lose the sharpness of edges, but now the patterns are continuous

V.O. & R.D.H.
Multiple Patterns

- Can also use multiple patterns on the same image

V.O. & R.D.H.
Multiple Patterns

Detail of the Ibn Tulun Mosque, by R.&S. Michaud

McGill COS767 Winter 2004
Screen Distortion

So far, we have applied the patterns to the image in a simple grid pattern
Screen Distortion

- Can also use a non-linear mapping between the screen elements and the pattern shapes
Screen Distortion

- Original image is unchanged – only the pattern shapes are distorted
Outline

- Introduction/Motivation
- Halftoning
- Artistic Screening

⇒ Summary/Conclusions
Summary

- Artistic Screening is a new halftoning technique that lets designers freely create custom halftone pattern shapes
- New types of images possible with 2 layers of information
Conclusions

- Interesting technique

Some of the places where it can be useful:
  - Event posters
  - Billboards
  - Improved security features for banknotes
Kabuki event poster

Kabuki actor, by Toshusai Sharaku

McGill COS767 Winter 2004
Jeremias Gotthelf billboard

Gotthelf portrait, V. Ostromoukhov
Safety features for banknotes