Computer-Generated Pen & Ink Illustration

G. Winkenbach and D.H. Salesin

Presented By: Michael Imbrogno

Motivation

- Communication of visual information often benefits from abstraction
- Example: architectural illustrations

Why Pen & Ink?

- Combines well with text
  - Same pen and paper
- Economy of expression
  - Tone and texture conveyed with strokes
  - Not necessary to draw all strokes

Goals

- Enhance communication of 3D architectural models using pen & ink techniques
- Survey traditional pen & ink techniques
- Incorporate these techniques into automatic rendering system

Overview

- Traditional Pen & Ink
- Computer-Generated Pen & Ink
- Related Work
- Conclusions

Overview

- Traditional Pen & Ink
  - Strokes
  - Tone and texture
  - Silhouettes and creases
- Computer-Generated Pen & Ink
- Related Work
- Conclusions
Strokes

- Thickness:
  - Too thin → washed-out
  - Too thick → detracts from detail
- Evenly-weighted lines look lifeless; vary thickness along stroke

Tone

- Tones created from lines of roughly equal weight and spacing

Texture

- Crisp, straight lines → glass
- Absence of detail → glare
- Materials:
  - Sketchy lines → old
  - Stippling → new

Silhouettes & Creases (Outlining)

- Crisp lines → hard objects
- Thick lines → shadow or contrast

Overview

- Traditional Pen & Ink
- Computer-Generated Pen & Ink
  - Rendering Pipeline
  - Strokes
  - Prioritized stroke textures
  - Silhouettes and Creases
- Related Work
- Conclusions

Rendering Pipeline

- Approach: Modify 3D pipeline
- Differences from traditional 3D pipeline:
  - Dual nature of strokes
    - Lighting and texture no longer separate
  - Need to combine 2D and 3D info.
    - Need 2D images to compute proper tone
    - Need 2D adjacency info. for proper outlining
Rendering Pipeline (cont.)
- Input: 3D model, textures, lighting model, visible surface algorithm, shadow algorithm
- Render strokes, not polygons
- Maintain two 2D spatial subdivisions:
  - Planar map (for outlining)
  - 2D BSP tree (for clipping)

Strokes
- Stroke definition:
  - A parametric path
  - A nib model as a function of pressure
  - A pressure function
  - A waviness function

Strokes (cont.)
- Stroke rendering:
  - Scan convert path after waviness added
  - Stamping copy of nib, scaled by pressure function

Prioritized Stroke Textures
- Collection of strokes that produce a particular texture and tone
- Each stroke assigned a priority
  - Strokes drawn in decreasing priority
  - Draw strokes until desired tone achieved

Prioritized Stroke Textures (cont.)
- Desired tone computed using reference image (i.e. G-buffer)
- Current tone computed as ratio of ink to polygon area

Stroke Texture Advantages
- Resolution dependence: Fewer strokes needed for low resolution devices
- Scale invariant: Maintain same tone at different scales
Stroke Texture Indication
- Use Beier and Neely control line approach

Expression of texture
- Indication
- Accent (thickening) for shadow
- View dependency

Expressing Outline Texture
- Stroke textures have associated boundary outline texture

Outline Indication
- No texture  
  Draw outline
- Texture  
  Draw outline of edge E when two adjacent faces to E have similar tone
  - Choose outline texture of closer face

Outline Accents
- Light direction determines accents
  - Edges that cast shadows are thickened
  - Illuminated edges not drawn at all

Outline View Dependence
- Stroke textures given an anisotropic bidirectional reflectance distribution function (BRDF)
Overview

- Traditional Pen & Ink
- Computer-Generated Pen & Ink
- Related Work
  - Interactivity
  - Parametric surfaces
  - Image representation
  - Orientable textures
- Conclusions

Interactivity


Parametric Surfaces


Image Representation


Orientable Textures


Overview

- Traditional Pen & Ink
- Computer-Generated Pen & Ink
- Related Work
- Conclusions
**Summary**
- Surveyed traditional principles of pen & ink illustration
- Described an automated 3D pen & ink rendering system
- Introduced the prioritized stroke texture
  - Resolution/scale dependent rendering

**Criticisms**
- Creating new stroke textures an involved process
  - Tone, outline, BRDFs, etc.
  - Programming required
  - Impossible for artist

**Questions?**
michael.imbrogno@mail.mcgill.ca