Conforming Realistic, Procedural Tree Models to User-Drawn Shapes

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Introduction

This project focuses on the creation of three-dimensional tree structures that conform to user-drawn shapes in a realistic manner. To achieve our research goals, the base tree model (Fig. 1) is built upon to create a more natural-looking tree by including lighting, varying branch thickness, and natural randomness. Then, user input is incorporated to constrain the tree structure into three-dimensional shapes from graphically drawn two-dimensional sketches. All implementation was completed using C++, OpenGL, GL shading language, and the CImg library.

Natural Tree Methods

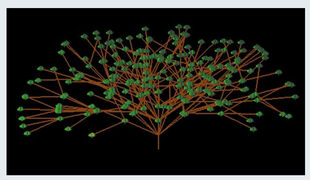

Figure 1: Base Tree Model

- Added geometry shader to pipeline (Fig. 2)
  - Created quads around branching points
  - Tapered ends of branches
- Generated more realistic leaves
  - Rotated leaves randomly
  - Added more leaves to the midpoint of each branch
- Added depth
  - Updated z-coordinate using random numbers

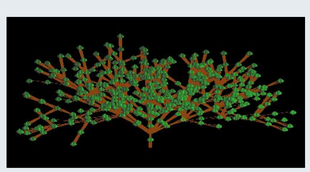

Figure 2: Natural Model

Shape Conforming Methods

- Drawing window created using the CImg library
  - User draws a shape for tree to 'grow' into (Fig. 3)
- Scanline algorithm determines inside/outside of shape
  - If edge is reached (Fig. 4)
    - Inside of shape, changes pixels to black
  - If another edge is reached
    - Outside of shape, changes pixels to white
- Determine if the branching point is within the shape
  - Conversion from shape image to tree plane (Fig. 5)
    - Shape image is 640 by 320 pixels
    - Tree is on a -1 to 1 coordinate axis
  - If branching point corresponds to a black pixel
    - Branching point is within the shape
    - Save to list of points
  - Else if branching point corresponds to a white pixel
    - Branching point is outside of the shape
    - Point is not saved
- Pattern manipulation for fuller tree
  - Rotated section of pattern around origin
  - Added longer trunk

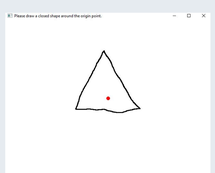

Figure 3: User-Drawn Shape

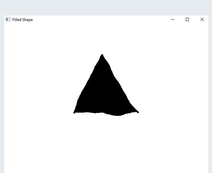

Figure 4: Filled Shape

Figure 5: Shape Conformed Tree

Results

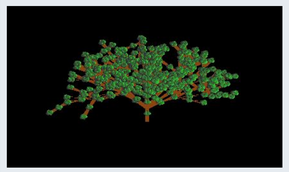

Figure 6: Hemisphere Tree

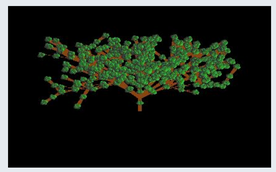

Figure 7: Cube Tree

The result of this project is a unique, realistic, procedurally modeled tree that can conform to user-drawn shapes. There are two main components of this project:

- Generating realistic tree structures
- Incorporating user input to conform the structure to sketches of shapes (Figs. 6 - 9)

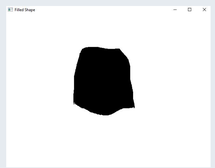

Figure 8: Filled Shape

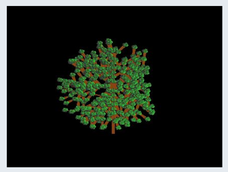

Figure 9: Shape Conformed

Future Work

Future work in this area of procedural modeling will focus on generating a forest of user-constrained trees rather than a singular tree structure. Furthermore, creating distinct species of trees for the user to choose from could prove to be an important improvement to this project.

References

[1] S. Longay, A. Runions, F. Boudon, & P. Prusinkiewicz, TreeSketch: Interactive Procedural Modeling of Trees on a Tablet, *Eurographics Symposium on Sketch-based Interfaces and Modeling*, 2012.

[2] A. Lindenmayer & P. Prusinkiewicz, *The Algorithmic Beauty of Plants*, Springer-Verlag, New York, NY, 1996.

[3] M. Okabe, S. Owada, & T. Igarashi, Interactive Design of Botanical Trees using Freehand Sketches & Example-based Editing, *Eurographics*, 24(3), 2005.