Intelligent Brush Strokes

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Figure 1. From left to right: original photograph, uniform stratified placement, non-uniform placement, Probability Density Function (PDF) from Sobel magnitude and facial detection, closeup of layered stroke image showing retained eyes and mouth detail.

1. Introduction

We present a fully automatic brush stroke placement algorithm for non-photorealistic rendering leveraging importance sampling techniques. Smarter brush placement enables creation of images using only a handful of well-placed strokes, avoiding the "textured" look common to prior techniques. We focus on the problem of converting source images to painterly renderings, but our technique could be extended to work on video source material or to generate abstract paintings without any source imagery. We leverage genetic search algorithms to evaluate the quality of the final images, guiding the solution through the large space of potential images.

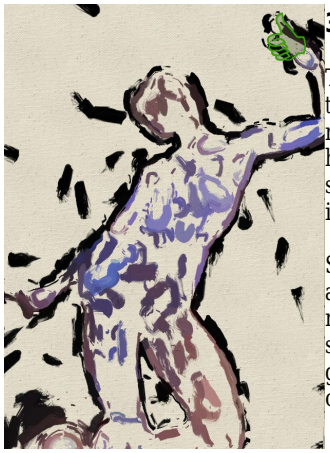
2. Prior Work

Our work builds on a large body of layered stroke-based rendering (SBR) research. Aaron Hertzmann's work on application techniques and the use of layered difference images to guide stroke placement and generation of curved brush strokes are core to our algorithm. Peter Litwinowicz work on brush placement and sizing and Zhao's work on detailed image analysis were inspirational. Our work builds upon these older SBR algorithms by adding genetic search and non-uniform sample placement techniques to place the strokes along key image features.

2.1 Intelligent Stroke Placement

Utilizing an importance map as a 2D Probability Density Function (PDF), we use the non-uniform sample generation technique described in [Pharr & Humphreys], originally developed to place importance samples on area light sources for Monte Carlo estimation of global illumination. The detail image is constructed via a heuristic combination of facial recognition data, gradient information from Laplacian filters, and difference algorithms comparing the painted result to a target image, usually the original source image. Non-uniform stroke placement facilitates non-uniform stroke sizing, useful for providing detail in critical regions, such as the eyes and mouth.

Difference images are computed either after rendering a subset of the total number of strokes, comparing the current image against the target, or after rendering all strokes, comparing the final image against other final images using a quality metric to guide a genetic search algorithm.



3. Results

The algorithm utilizes GPGPU techniques and can generate multi-layer images with hundreds of thousands of strokes in about a second on an iPad2.

Sparse brush placement can be achieved to provide a much more hand-drawn look while still retaining full automatic generation as seen in the image on the left.

References

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