Texture Synthesis by Non Parametric Sampling

Alexei Efros

Thomas Leung

** Figures for this presentation were adapted from the original Efros and Leung presentation
Texture Synthesis

- Texture Synthesis aims to solve the problem of covering Big Things with tiny scraps of paper.
- Previous methods are totally inadequate.
- Large research area, but little success.
The Problem

- It’s easy to find a small texture.
- Mapping a large object with a small texture requires tiling or stretching.
The Solution

- Grow the tiny texture to the needed size.
- Given a representative segment of a texture, it should be possible to create any size required.
Growing a texture

- Use early work in language prediction
  - Probabilistic prediction of the next element well understood.
  - Build a probability function for the next element, and choose one at random.
  - “I spent an interesting evening recently with a grain of salt.”

- Require a sample image and do this in 2 D with the image
Growing a Texture

- We want to create the next pixel
- Based on the surrounding neighborhood, it should be easy to determine what goes here
Find the similar areas

- Find the similar regions
- Choose the next pixel
In Reality...

- This works well for simple textures.
- How big a window do you look at?
- In big textures, we wish to emphasize local structure.
- What about pixels that have few neighbors?
- What if you can’t find any regions like the sample region?
Fixing the holes

- Many of these problems can be solved by sadis... er statistics
- Instead of finding exact matches, build probability functions and select all points that match within some epsilon
- For pixels with few neighbors, normalize over the parts you have
- For each layer being grown, always grow the more matchable parts first
Building a PDF

- Use a weighted function
- Emphasize local points
Window Sizes

- What size window should be used?
- Depends on structure in the sample image
Window Size Examples
Results
Results
Results
Results

It becomes harder to laugh at itself, at "this daily running room," as House Deale and described it last fall. He fell, but he left a ringing question in the ears of Monica Lewind and Linda Tripp. That now seems like a political comedian Al Franck. The next phase of the story will...
Results
Results
Results
Applications

- What other problems can this approach solve?
- Fill in Texture gaps Just grow inwards
- Extend pictures to make them larger
Applications
Applications
Similar Work

- DeBonnet, ‘97
- Wei & Levoy ‘99
- Wei & Levoy ‘02
Problems

- SLOW at least the original algorithm
- Can get locked in to one part of a texture, producing garbage or overly regular images
- Larger samples can help this
Failures
Subsequent Work

- Harrison ‘01 GIMP Plugin for Synthesis
- Wei & Levoy Various
  - Smoke and Ocean videos
  - Mapping synthesized textures onto objects
Conclusions

- This was one of the original papers on texture synthesis
- For well ahead of everyone else in 1999
- Subsequent work has improved speed, but not quality