Assignment 1: Bilateral Mesh Denoising

January 28, 2009

1 Introduction

In this first assignment, you will implement Fleishman et al.'s *Bilateral Mesh Denoising*, a technique for removing mesh noise published at SIGGRAPH 2003. The paper is available on the author's website:

- http://www.sci.utah.edu/~shachar/Publications/bmd03.pdf

You will implement this technique using Szymon Rusinkiewicz's *trimesh2* library, available on the author's website:

- http://www.cs.princeton.edu/gfx/proj/trimesh2/

trimesh2 offers a wide variety of operations that will make this assignment simpler, like adding noise to meshes, creating simple models and simple mesh input/output. It also comes with a nice mesh viewer. In this assignment, you will familiarize yourself with simple operations on meshes, like taking averages of vertex positions and traversing neighborhoods. If you don't know LaTeX, this is also a great chance to learn the basics. LaTeX is the *lingua franca* of academic publications, and you will be expected to produce a paper manuscript using it by the end of the semester.

2 Important Points

- The assignment is due on the midnight of Sunday, February 15th. No late submissions will be accepted.
- You will submit your source files (see below for details on that) and a writeup in PDF, using LaTeX. We are working on the details, and will let you know how exactly to turn in your work.

3 The assignment

The implementation will be, primarily, a function that will take a pointer to a `TriMesh` structure and the three relevant parameters: σ_c, σ_s and the number

of iterations (see paper for details). This function will remove noise from the mesh in a way that preserves features: if there are sharp corners in the mesh, this algorithm will to preserve them. This is in contrast to simpler smoothing operators such as Taubin's lambda-mu.

Implementation details The paper describes an interactive tool to let the user pick σ_c and σ_s. You are not required to implement this. We do, however, encourage you to try extending `mesh_view` for this purpose: it will make testing much easier, and you will possibly reuse this knowledge for your final project. Having a powerful and flexible set of tools makes it much easier for you to quickly explore problems, and interactive manipulation is one very convenient tool. The simplest way to use trimesh2 for this assignment is to write a new function in the file `libsrc/diffuse.cc`, add the declaration to the file `include/TriMesh_algo.h`, and an extra command-line option to `utilsrc/mesh_filter.cc` (copy the many examples in that file).

Writeup In your writeup, provide a description of your implementation, and examples of outcomes of your algorithm. You can use `mesh_view` to generate screenshots of before and after. To test the algorithm with different noise levels, you can use `mesh_filter` with the *noisify* option. More importantly, you will compare this method to the one described by Thouis Jones et al in their SIGGRAPH paper (Jones, Durand, Desbrun. Non-iterative, Feature-Preserving Mesh Smoothing. http://people.csail.mit.edu/thouis/JDD03.pdf). Which implementation is faster? Why? You can inspect the implementation of Jones's filter to investigate (it's the function `bilateral_smooth_mesh` in `libsrc/diffuse.cc`). Try meshes of different size, different amounts of noise, and different iteration counts (notice that Jones's filter is not iterative, so Fleishman's filter has an extra parameter).

Datasets There are many datasets publicly available. The two websites to start are the AIM@SHAPE repository (http://shapes.aim-at-shape.net/), and the Stanford 3D Scanning repository (http://graphics.stanford.edu/data/3Dscanrep/). trimesh2 has support for many different file formats, and you should have no problem finding files for your examples. You can also get started using `mesh_make`, which is a trimesh2 utility to create simple meshes. A combination of `mesh_make` and `mesh_filter` with the `subdiv` and `noisify` options will allow you to quickly try out many different meshes.

4 LaTeX

There are many good LaTeX books. The classic freely available book is "A not-so-short introduction to LaTeX (or, LaTeX in 141 minutes)", available here:

http://tobi.oetiker.ch/lshort/lshort.pdf

Many other links to books and online material are here:

http://www.ams.org/tex/publications.html

Downloading and installing LaTeX

- Mac OS X: http://www.tug.org/mactex/
- Linux: look for "latex" in your favorite package manager.
- Windows: Download and unzip the network-based installer:
  http://mirror.ctan.org/systems/texlive/tlnet/2008/install-tl.zip