

mesh

Notes

This project is implemented in Rust. It can be compiled on department machines. To build, run `cargo build --release` which will place the `mesh` binary under `target/release/mesh`. I have also included a binary in the `bin/` directory.

If extra arguments are supplied for a command, that will lead to an error. For instance, `./mesh inp.obj out.obj subdivide 1 0.38838 3 4` would error because only one argument is expected. `./mesh inp.obj out.obj subdivide 1` would work.

Data Structure

I implemented a half edge data structure. Rather than allocating each half edge/vertex/edge/face individually, I store them on vectors and mark each vertex/edge/face invalid when it is removed. This is $O(1)$ removal and is effectively the same as allocating using a slab allocator. It should be more efficient, because memory access can make better use of the cache. To add an element, I just append to the appropriate vector which is amortized $O(1)$. If a large number of collapses are run, and then further operations were conducted, it might improve efficiency and memory usage to purge invalid items. None of the operations here are probably substantially improved by this, so I didn't bother; however, this could be done by rebuilding the data structure (invalidating the meaning of any stored indexes). Periodically rebuilding the data structure still leads to amortized $O(1)$ insert and $O(1)$ removal because building is $O(n)$. Building uses a hashmap to keep track of which vertices and half edges have already been inserted, and hashmaps are amortized $O(1)$ insert and $O(1)$ look up.

Features

- subdivide
 - $O(n)$
 - I think my implementation is pretty fast because of data structure choices, but I don't really know
- simplify
 - $O(n \log n)$
 - Uses priority queue (binary heap) and a separate vector which stores the current “iteration” of a given edge. If an edge is popped with iteration less than the current iteration, the edge is discarded. Each time the cost for an edge is updated, the iteration is incremented and a new element is added to the heap which stores the current iteration and edge index. Thus, “removing” from the heap is $O(1)$ (this doesn't include the cost to pop from the heap, which is still $O(\log n)$)
- denoise

- $O(n)$
- Subjectively pretty slow
- noise
 - $O(n)$
 - Adds noise to a mesh for testing denoise
 - Adds random value drawn from normal distribution with standard deviation given by command line argument.
 - For example: `./mesh meshes/bunny.obj noise_bunny.obj noise 0.01`
- remesh
 - Additional function/extra credit
 - $O(n)$
 - Some times edge collapse and edge flip can lead to worse results depending on number of iterations and the smoothing weight from what I have seen, so I added optional arguments to disable these. To disable edge collapse and/or flip, run with the optional arguments `–no-collapse` and/or `–no-flip`

Results

All results are in the **results/** directory.

input	output	command	args
meshes/cow.obj	subdiv_cow.obj	subdivide	2
subdiv_cow.obj	simp_subdiv_cow.obj	simplify	87060
meshes/cow.obj	simp_cow.obj	simplify	5000
meshes/bunny.obj	simp_bunny.obj	simplify	15000
meshes/bunny.obj	noise_bunny.obj	noise	0.01
meshes/noise_bunny.obj	denoise_bunny.obj	denoise	5 0.02 0.02 2
meshes/peter.obj	remesh_peter.obj	remesh	10 0.5