HW6: Project Proposal

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I will create an interactive CAD modeling tool for 3D printable object design. The user interface should look like the existing design tools such as SolidWorks, AutoCAD, or Rhinoceros. As a first step, the user should be able to load the existing 3D objects as an OBJ or STL file, and show the 3D mesh geometry in the viewport. The tool will allow the user to interactively change the parameter of the geometry or deform the shape to their desired form. For the deformation, I'm thinking to adopt the as-rigid-as-possible (ARAP) deformation algorithm [Sorkine 2007]. The resulting objects should maintain the water-tightness so that it can be 3D printable later on. I may also want to implement constructive solid geometry (CSG) operations such as union, subtract, and intersection. This is a minimum implementation goal.

As a target goal, I'd like to implement the parametric interface which leverages the visual programming interfaces like Rhinoceros Grasshopper plugin. To this end, I will implement a programmable pipeline of geometry editing or animation API and then implement a graphical user interface to modify the program. This could be helpful for parametric modeling. See https://en.wikipedia.org/wiki/Grasshopper_3D for more information.

As a stretch goal, I may implement a finite element analysis for the 3D printed soft material simulation [Chen 2015]. The final goal is to provide a computational tool to design and simulate a soft material 3D printed objects [Skouras 2012, Skouras 2012].

For the technical perspective, I'll use GLFW instead of GLUT since I find GLFW more sophisticated and up-to-date library. I will write with C++ and use CMake and Ninja as a building pipeline. I will implement the core component by myself as much as possible, but I may plan to take advantages of the existing computational libraries such as Eigen, GUI component libraries such as imgui or nanogui, and geometry editing libraries such as CGAL to avoid reinventing the wheel.

References

* Chen, Desai, et al. "Data-driven finite elements for geometry and material design." ACM Transactions on Graphics (TOG) 34.4 (2015): 74.
* Sorkine, Olga, and Marc Alexa. "As-rigid-as-possible surface modeling." Symposium on Geometry processing. Vol. 4. 2007.
* Skouras, Mélina, et al. "Computational design of rubber balloons." Computer Graphics Forum. Vol. 31. No. 2pt4. Blackwell Publishing Ltd, 2012.
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