CSE621 Programming Assignment

Physical Simulation of Mass-Spring Models

The goal of this program assignment is to permit graphics modelers to directly manipulate and interactively sculpt *physical* surfaces using "force" tools in 3D. The geometry of any physical surface in 3D is simplified using polygonal models. Its physical behavior is approximated using a set of mass-points and springs (with rest length). In particular, this assignment considers a 8×8 regular mesh, please refer to Figure 1 for its configuration. Please note that we are considering 3D objects! The basic geometric and physical features of your software should include:

- Read the geometric data and their physical quantities of any 8×8 control mesh from a file;
- Allow users to interactively modify (1) mass quantities of any point(s), (2) the rest length of any spring(s), and (3) the stiffness coefficients of any spring(s);
- Display (1) the wireframe model, (2) the smoothly shaded model, and (3) the texture-mapped model, you can design and choose any texture map for this assignment;
- Allow users to interactively select arbitrary mass-point and apply forces to deform (sculpt) the physical surface using mouse; and
- After all physical sculpting procedures are finished, save the new (geometric and physical) data of the mass-spring mesh into a file.

Please feel free to add any necessary features in order to make your system interface user-friendly. **You should refer to my lecture notes for the technical details and algorithms for physical simulation using a mass-spring model. These notes can be found from supplementary material in our course website.** Alternatively, you can read relevant papers on physics-based modeling, you can find the detailed information about these papers at the bottom of our course website, too. If you still have any questions, please feel free to consult with the instructor.

After you finish the above part, please further refine your algorithm and program so that your software system allows users to interactively sculpt a more sophisticated mass-spring model (refer to Figure 2 for the new configuration). In Figure 2, we assume that **a** is an arbitrary mass-point, and **b**, **c**, **d**, **e** are **a**'s

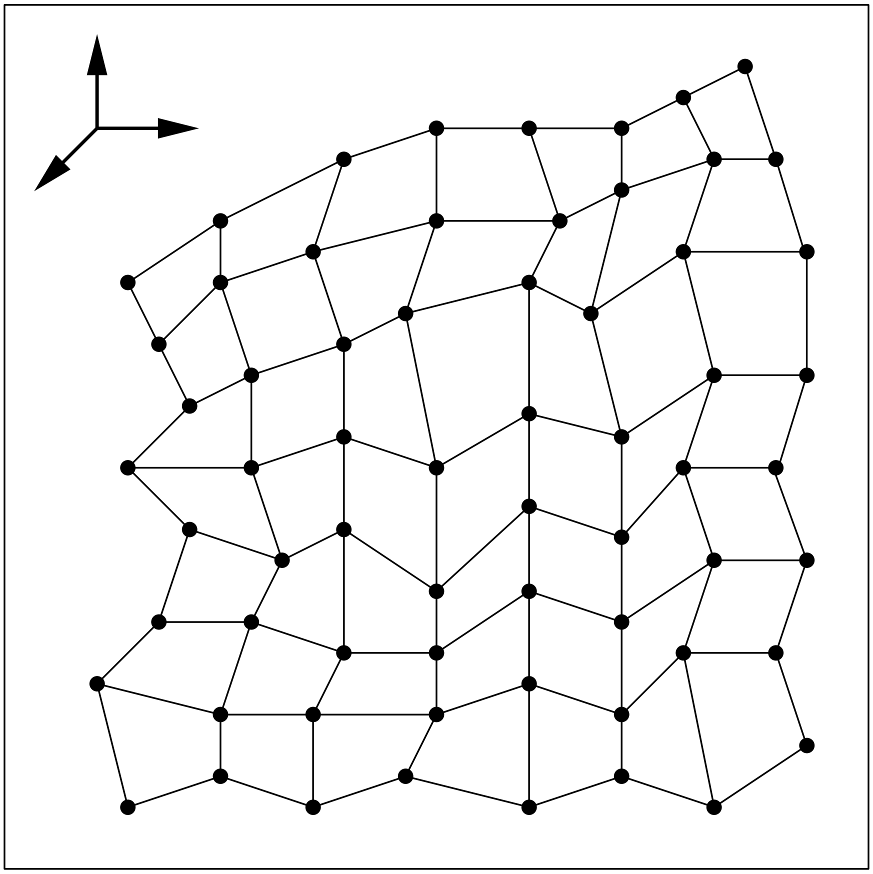

Figure 1: Physical manipulation of a mass-spring mesh.

four neighboring mass-points. In a nutshell, first we keep all mass-points and springs appeared in Figure 1, in addition, we add two more *virtual* springs for each non-boundary mass-point shown in Figure 2. Special cases include: (1) no spring of this type is attached to any corner mass-point; and (2) only one spring of this type is attached to any boundary (non-corner) mass-point. Here, we emphasize *virtual*, because the model is still a surface, not a solid (volume), i.e., these new springs only take parts in physical simulation and dynamic sculpting, the geometry of this refined physical model must not be changed. Your refined software should have the same functionalities as explained above to handle this advanced model. Before you actually start to work on this bonus part, I suggest that you should give a thought about (1) why it is necessary to add these new springs on top of the original mass-spring model; and (2) exactly what purposes this type of springs serves. After you finish this part, I also suggest you to think about (1) whether it is possible to model and simulate other typical (maybe more complex) behaviors using mass-spring models; and (2) what new types of springs are necessary to be added into the existing system.

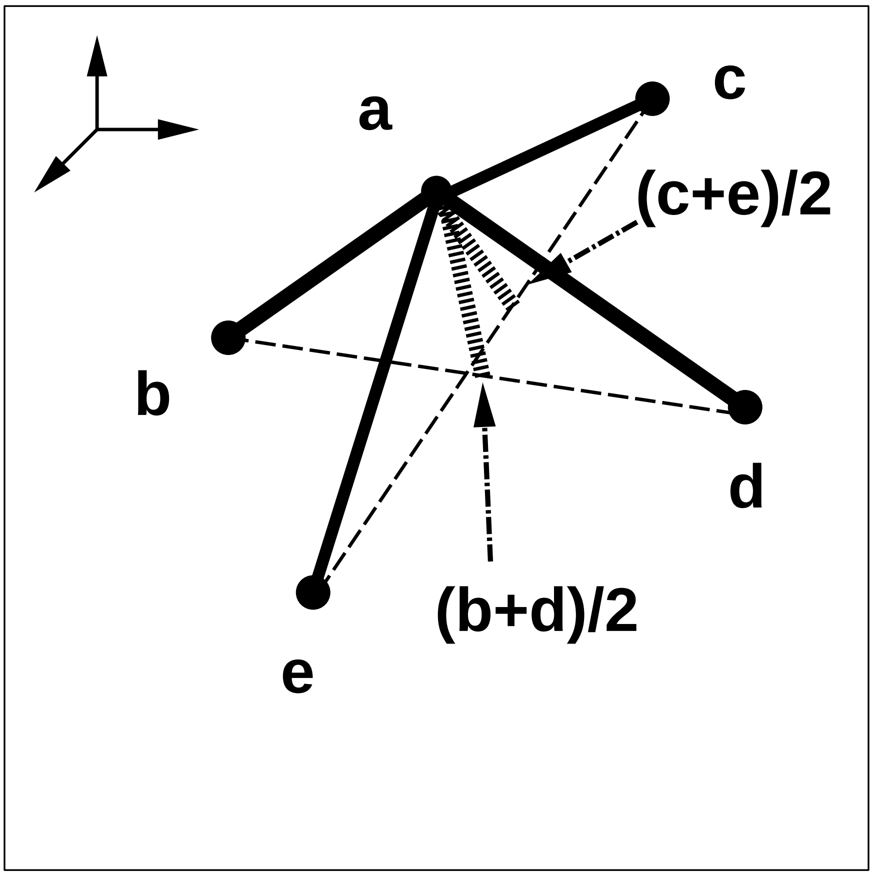

Figure 2: Physical manipulation of a refined mass-spring mesh.