Computational Fabrication

Programming Assignment 4: The Finite Element Method

In this assignment you will implement the finite element method for triangular meshes in MATLAB. We will provide skeleton code and you will be responsible for filling in critical, excised sections.

In particular you will implement:

1. A formula for computing **F** (the deformation gradient) of a triangle
2. A Neohookean material model which will be used to compute the stress acting on the object
3. A formula for converting the stress into a force

All the relevant formulae have been presented in lecture

The remainder of this document is organized as follows:

1. Getting Started
2. Starter Code and Implementation Notes
3. Extra Credit
4. Submission Instructions

1 Getting Started

The skeleton code is provided as a MATLAB .m file. The file has been tested under MATLAB version 2012b. To run the code, copy the .m file to your default MATLAB directory, start MATLAB and type **fem2D** at the command prompt.

The fem2D code automatically draws your dynamic FEM simulation. **Make sure the display window is not hidden behind your MATLAB desktop**.

2 Starter Code and Implementation Notes

We provide skeleton code for the assignment. Critical sections of the code have been removed, these are clearly labelled with %%%%%%%%%ASSIGNMENT %%%%%%%%, followed by appropriate comments. You will be responsible for implementing (at minimum) the components specified previously. The starter code provides the following features

1. The main Finite Element Loop discussed in class
2. A method for generating a 2D, triangulated square (createSquareMesh)
3. A gravity force which is automatically applied to deform your model

3 Extra Credit

There are three opportunities to gain extra credit for this assignment.

1. Triangulate and simulate a non-square object
2. Implement the St. Venant-Kirchhoff material model.
3. Implement plasticity, as described in the class lecture (HARD)

4 Submission Instructions

Please provide a report with your submission (PDF). The report should include the following:

- Images of the final frame of your FEM simulations at 3x3, 5x5 and 10x10 grid resolutions.
- Were there any references (books, papers, websites, etc.) that you found particularly helpful for completing your assignment? Please provide a list.

- Are there any known problems with your code? If so, please provide a list and, if possible, describe what you think the cause is and how you might fix them if you had more time or motivation. This is very important, as we're much more likely to assign partial credit if you help us understand what's going on.
- Did you do any of the extra credit? If so, let us know how to use the additional features. If there was a substantial amount of work involved, describe what how you did it. Provide at least one example for each extra feature implemented.
- Got any comments about this assignment that you'd like to share?

Remember, these assignments are to be done on your own. Please do not share code or implementation details with other students.

Submit your assignment on Stellar by **December 1st by 11:59pm**. Please submit a single archive (`.zip` or `.tar.gz`) containing:

- Your Matlab .m file
- The `PDF` file.