# CSCI 520 Assignment 3: Constrained Particle System

## Due Thursday Apr 14, 2016, by 11:59pm

## Instructions

Please download the [assignment writeup here.](http://run.usc.edu/cs520-s15/assign3/cs520_assign3.pdf) You can use your OpenGL setup from Assignment 1 as a starting point.

Useful (free) software for solving linear systems (you are not bound to using any particular solver software, listed or not):

* [GNU Scientific Library](http://www.gnu.org/software/gsl/manual/html_node/Linear-Algebra-Examples.html) (recommended)
* [CLAPACK](http://www.netlib.org/clapack/)

You can find a writeup corresponding to the Constraints lecture [here.](http://run.usc.edu/cs599-s10/scribeNotes/michael_carrol_CS599-Scribe-2-16-10.pdf)

Some hints for solving linear systems in the assignment:

* The system of equations in this assignment is symmetric, but not necessarily positive-definite. In some isolated configuration, the system matrix can be singular. You can handle these singularities using singular value decomposition. See Chapter 14.4. Singular Value Decomposition in the GSL library, in particular, the routines gsl\_linalg\_SV\_decomp and gsl\_linalg\_SV\_solve. After calling SV\_decomp and before calling SV\_solve, you should filter the singular values: You should truncate to 0 any singular value that is less than eps \* largest singular value. You can use, for example, eps=1E-6.
* Note that the assignment requires the particles to stay in the xy plane, i.e., z=0 for all particles for all times. Therefore, you may simplify your simulation by omitting all the z degrees of freedom.
* Baraff and Witkin's course notes give an alternative system version, formed by conjugation of the mass matrix. You may use this version in your assignment if you wish.

## How to submit the assignment

Upload your entire solution as one zip file to the Blackboard. Don't forget to include your README file, the compiled executable (Windows or Mac, include all the required DLLs), the animation frames, and any other material required by the assignment writeup. For the animation, use the same format as with Assignment 1. Please submit JPEG frames (assumed frame rate is 15 fps), **at the 640x480 resolution**. Do not exceed 600 frames.

## Example screenshots

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| http://run.usc.edu/cs520-s15/assign3/cs520-assignment3-screenshot-small.jpg [Click for larger image](http://run.usc.edu/cs520-s15/assign3/cs520-assignment3-screenshot.jpg) | http://run.usc.edu/cs520-s15/assign3/pic_A1.gif |

## Extra credit ideas

* Implement a time-varying random force field. For example, you can use [Perlin noise.](http://run.usc.edu/cs520-s15/assign3/perlinNoise.zip)
* Make a screen-saver (driven by the time-varying random force field).
* Implement a higher-order integrator, e.g., Runge-Kutta 4th order.
* Any creative extra credit contributions are encouraged.

Jernej Barbic, USC