CSCI 520, Assignment 3

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<Description of what you have accomplished>

**0. Objectives:**

0.0 In this project, we use particle system to model a simple chain, with an emphasis on "hard" constraints.

**1. Folder Index:**

particle\_test: the visual studio solution folder for this project

video: the video folder for this project.

**2. What I have done:**

2.1 I create two classes to model this: Particle and ParticleSystem.

Particle: this is the class for individual particles.

ParticleSystem: this is the class for this constraint system.

2.2 I set dt = 0.001, the same value as HW1, and I set the viscous damping coefficient k\_damp = 0.5, which is stable. In addition, alpha is 5, and beta is 25/4 based on the equation: beta = alpha2 / 4.

2.3 Users could use key cursors to interact with the system by applying an additional non-zero acceleration . Press each key cursor (Left, Right, Up, Down) would add an additional 0.1\*mass force to the model. Users could press 'c' to clear all these external forces. Besides, they can also press 'r' to switch from Euler to RK4, or press 'e' to switch back.

**3. Relative Matrix:**

Constraint Matrix C:

There are 11 paticles in the system, we have 11 constraints

|  |  |
| --- | --- |
| 1 | + - |
| 2 | + - |
| 3 | + - |
| 4 | + - |
| 5 | + - |
| 6 | + - |
| 7 | + - |
| 8 | + - |
| 9 | + - |
| 10 | + - |
| 11 | + - |

Matrix dC / dq:

we have 11 constraints, so row = 11, col = 20



Matrix d / dq:



**4. Error Graph:**

graph 1: constraint error using BAUMGARTE STABILIZATION (b > 0)

graph 2: constraint error without using BAUMGARTE STABILIZATION (b = 0)

we can see at frame 300, the result without using baumgarte stabilization has a larger error value.

**5. Answers:**

* What b value works best?

- In my system, I set it as 2.5, I think it works pretty well.

* What happens when the damping parameter b is set too high, or too low?

- It will make the system unstable, if b is too low, the error would also be increased.

* Can you determine b automatically?

- I think we could use binary search to change the value of b, and put it to a function to check if the constraint error is too large or not.

* How much damping can you add before stability becomes a problem?

-In my system, if I set dt = 0.01, and I set the k\_damp is bigger than 18, the system would become unstable. If I set dt = 0.001, this value would increase.

<Also, explain any extra credit that you have implemented.>

**6. Extra Credit:**

For extra credit, I implement the RK4 integrator.