CIT-644-Fall 2020 Scientific Computing : Coursework 2

Due Date : Sunday 31 January, 2021

Instructions

1. Read carefully project setup instructions in `readme.txt`.
2. This is a group coursework. So, you need to make a team of 3-4.
3. One member of the group should do the submission on Moodle. Also, make sure to add group members names and IDs to the report.
4. After submission, each team will have to demonstrate the program and have a detailed discussion with course TAs
5. Criteria for evaluation: understanding, correctness, functionalities, features, efficiency and utilization of object-oriented design principles.

Project Description

Enhance a cloth simulator that is based on mass-spring model by adding improved integrators. The basic simulator program with two integrators, Euler and Midpoint, will be provided. You should incorporate integrators based on:

1. Heun's method with iterations (propose stopping criteria)
2. Runge-Kutta order 4
3. Runge-Kutta order 5
4. Adaptive RK order 4 method with step halving.

Notes

- In `System.h`, you will find a class encapsulating a system of particles (each particle has its own mass, position, velocity, and acceleration/force). **Fill in the missing methods in this file.**
- In `PhysEnv.cpp`, you will find two provided integrators. **Implement the missing integrators in the same file**. You should use the class and methods developed in `System.h` for implementing your integrators. The code in `PhysEnv.cpp` should have **no explicit loops** except for the loop of `Heun's method with iterations`.
- You will find three files named `Test1.dps`, `Test2.dps` and `Test3.dps`. Load those files from `File` then `Open...` option in the simulation executable and report the accuracy of all integrators on the three test models.
- For this project you will need to install `Visual Studio` on Windows 10. This setup was tested on `Visual Studio 2019` and `Windows 10`.
- To launch the simulation, use the attached `OpenGL` library and follow the instructions in `readme.txt` to link `OpenGL` with `Visual Studio`.

Deliverables

1. You will need to electronically submit the source code of files that include your implementation, `PhysEnv.cpp` and `System.h`. Also, submit a functional executable of the project (.exe).
2. A detailed report is to be submitted that should explain how the program works and include justifications on how the new integrators lead to improved simulations.
3. You will need to provide comparison of used integrators and propose metrics for error.
4. You should investigate the effect of modifying the step size and spring stiffness (spring constant) on simulation behaviour and stability for each integrator.