Numerical Simulation for Graphics and Animation

Advance Topics in Computer Graphics 236628

Spring 2016 - Orestis Vantzos (*ovantzos@cs.technion.ac.il)*

Summary

A (2 hour/week for 13 weeks) practical course on the various methods, challenges and applications of modelling the motion of physical objects and the evolution of physical processes in the computer, with a focus on the kinds of phenomena one encounters in graphics and animation. We will work through a number of interesting examples; from their mathematical modelling, to the discretisation and numerical solution of the resulting model, all the way to the visualisation and study of the results.

Potential topics, with examples, include:

- *Particle systems*: Flame simulation, Formation of snow flakes
- *Rigid-Body Motion*: Quadcopter simulation, Realistic spaceship flight
- *(Inverse) Kinematics*: Deformable & tearable cloth, Rag-doll physics
- *Elliptic PDEs*: Buckling of bars and shells, Radiosity, Fluid/gas flow through a maze
- *Parabolic PDEs*: Heating things up, Tiger stripes and giraffe spots formation
- *Hyperbolic PDEs*: All kinds of waves!

Most of the algorithms we will use can be found in
Numerical Recipes: The Art of Scientific Computing by W. H. Press et al., Cambridge Uni Press

Prerequisites

Being comfortable with **Linear Algebra** (vector spaces, matrices, linear systems), **Analytic Geometry** (coordinate systems, equations of lines, circles) and **Calculus** (derivatives and integrals, preferably in many dimensions). A familiarity with Linear systems and Differential equations would be useful, but is not required. We will work with a relatively small subset of **Python**, so a basic knowledge of the language would be useful. A working knowledge of Matlab or Mathematica is not required but might be helpful with the exercises.
Some related courses are: Intro to Computer Graphics, Numerical Analysis, Visualisation and Animation (EE).

Assignments and Grading

A number of exercises/mini projects will be suggested based on each topic, typically asking for the numerical simulation of a phenomenon via a given algorithm and the visualisation of the result. The final grade will be a combination of:

1. Solving a certain number of the exercises.
2. Presenting in the class an animation video based on one of the exercises.

The language of instruction is **English**.