

# Simulation in Computer Graphics - Exercises

Computer Graphics - Computer Science Department - University of Freiburg

## Rigid bodies

The goal of this exercise is to simulate rigid bodies that are represented with a set of mass points.

- Implement the initialization of a rigid body that is represented with a set of mass points. Compute the relevant quantities such as center of mass, overall mass, define the initial orientation and compute the inertia tensor that characterizes the reaction of a rigid body to torques.
- Implement Euler-Cromer to update position of the center of mass, orientation of the rigid body and linear and angular velocity. Therefore, the total force and total torque have to be computed first. Using force and torque, linear and angular velocity are updated. Using the velocities, position and orientation are updated. Finally, positions and velocities of the mass points that represent the rigid body are updated.
- Compute the overall energy of the rigid body, i.e. the sum of translational kinetic, rotational kinetic and potential energy.
- Apply forces to the rigid body, e.g. gravitational force.
- Implement a collision response at walls. Penalty forces are the simplest approach in this context. If a mass point of the rigid body penetrates an obstacle by vector  $\mathbf{d}$ , a corresponding penalty force, i.e. collision response force, could be  $\mathbf{f} = k\mathbf{d}$  with  $k$  being a user-defined constant. Consider friction to improve the stability. Therefore, the velocity of a penetrating mass point has to be split into normal and tangential velocity.