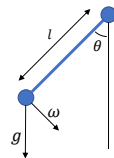# 上机作业

Game Physics

DALab

作业内容

- 单摆模拟
  - 3 method (Explicit Euler, Mid point, Trapezoid method)
  - Result analysis
- 头发模拟
  - Verlet method
  - Interaction requirement

单摆模拟

- Equation of motion
  - $\theta^{n+1} = \theta^n + \omega^n \Delta t$
  - $\omega^{n+1} = \omega^n - \frac{g}{l}\sin\theta \Delta t$

单摆模拟

- Explicit Euler
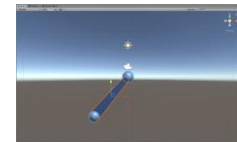 - $x(t_0 + h) = x_0 + hf(x_0)$
- Midpoint
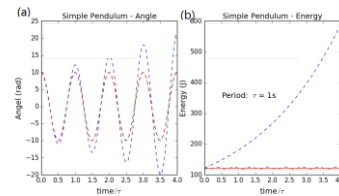 - $x(t_0 + h) = x_0 + hf\left(x_0 + \frac{h}{2}f(x_0)\right)$
- Trapezoid
  - $x(t_0 + h) = x_0 + h\frac{f(x_0)+f(x_0+hf(x_0))}{2}$

单摆模拟

- Result analysis
  - Compare the results with analytical solution
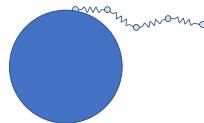   - Angle
    - Energy
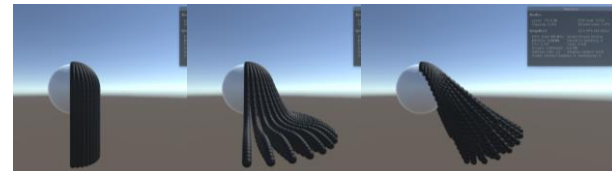 - Use figures / tables

头发模拟

- Model
  - Mass-spring system

头发模拟

- Verlet integration with damping
  - $x(t + \Delta t) = x(t) + d \cdot \left(x(t) - x(t - \Delta t)\right) + a(t)\Delta t^2$
- Spring constraint
  - $x_1' = x_1 + (x_2 - x_1) \cdot \frac{\|x_2 - x_1\| - l_r}{2\|x_2 - x_1\|}$
- Collision constraint
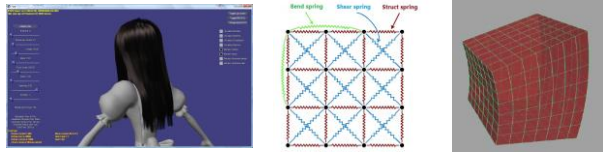 - Collision with sphere
- Relaxation method

头发模拟

- Interaction requirement
  - Adjust the mass / rest length / the number of hairs with UI
  - Move / rotate head with mouse / keyboard
  - Show frame rate on screen

头发模拟

- Bonus
  - Implicit solver
  - Hair Rendering
  - Cloth / Jelly Cube simulation

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