COS 426 : Precept 11
Particle Systems
Agenda

• What you need to do

• Framework introduction
  • Updaters
  • Initializers

• System Settings
Assignment details

• Easier, worth bit less points
• More freedom / burden on you
• Required features
  • Euler Integration
  • Sphere Initialization
  • Mesh Initialization
  • Simple collisions
  • Sinks
  • Cloth
  • Damping
Wait, slow down...

- Particle systems
  - Each particle has number of attributes
    - Positions
    - Velocities
    - Colors
    - Sizes
    - Lifetimes
    - Etc...
  - Initialize certain number of particles at each time-step
  - Update each particle at each time-step
  - Different Initialization / update -> Different effects
Yay!
Framework

Particle Engine

Emitter

Initializer

Updater

Settings
Initializer

- Function that specifies how new particles are generated
  - What is the position
  - What is initial velocity
  - Etc.
- Takes in a set of options
  - Can be anything that you need
  - Stored in this._opts variable
- Must implement initialize function!
  - Framework calls MyInitializer.initialize();
Initializer

- Example
  - `new MyInitializer( {position: new THREE.Vector3() } );`
  - Position can be accessed as
    - `this._opts.position`
  - `initialize ( particleAttributes, toSpawn )`
    - `particleAttributes` - arrays of positions, velocities, etc.
    - `toSpawn` - array of indices into these arrays
  - Particle Engine manages when to remove the particles
    - Just use `toSpawn` array!
Arrays side note

- Fixed size buffer
  - Buffer stores max. 1000 particles
  - Generate 100 particles per second
  - Each particle lives 11 seconds
- Need to be able to know when particle is dead to free up space in array
  - Lifetime $< 0 \rightarrow$ kill particle (utils.js)
- This is managed for you!
Updater

- Function that specifies how new particles are updated
  - Apply forces to particles
  - Do collision detection
  - Change velocities/colors etc.
- Wide range of possible effects!
- Takes in set of options
  - Can be anything that you need
  - Stored in this._opts variable
- Must implement update function!
  - Framework calls MyUpdater.update();
Updater

- new MyUpdater( {gravity: new THREE.Vector3(0, -10, 0) } );
- Can be accessed as
  - this._opts.gravity
- Similarly you can pass other useful things:
  - Collidable objects
  - Sinks
- update ( particleAttributes, alive, delta_t )
  - particleAttributes - arrays of positions, velocities, etc.
  - initialized - array of specifying whether particle is initialized ( active )
    - Only update active particles
  - delta_t - global time, used for your integration
Settings

- Particle Engine can be specified with set of settings
  - systemSettings.js

- Need to specify
  - Updater + Updater options
  - Initializer + Initializer options
  - Material
  - Max Particle Count (Buffer Size)
  - Particle Frequency
Settings

```
SystemSettings.mySystem = {

  // Particle Material
  particleMaterial: SystemSettings.standardMaterial,

  // Initializer
  initializerFunction: VoidInitializer,
  initializerSettings: {},

  // Updater
  updaterFunction: VoidUpdater,
  updaterSettings: {},

  // Scene
  maxParticles: 1000,
  particlesFreq: 1000,
  createScene: function () {},
};
```
Settings - Optional

- Scene
  - Just write a function that creates THREE.js objects
  - Add them to the scene

```javascript
createScene : function () {
  var sphere_geo = new THREE.SphereGeometry( 1.0, 32, 32 );
  var phong = new THREE.MeshPhongMaterial( {color: 0x444444,
                                           emissive:0x442222,
                                           side: THREE.DoubleSide } );
  var sphere = new THREE.Mesh( sphere_geo, phong )
  sphere.position.set (30.0, 30.0, 30.0);
  Scene.addObject( sphere );
}
```
Settings - Optional

- Cloth
  - Rendered differently
  - Need to define grid structure

```
// Cloth specific settings
cloth : true,
width : 20,
height : 20,
```

- max. particle count and particle frequency ignored.
Utils.js

- particleAttributes arrays access
  - Huge array of numbers
    - particleAttributes.position[0] returns number, not THREE.Vector3!
  - Provided functions
    - getElement(i, attribute)
    - setElement(i, attribute, val)
    - getGridElement(i, j, width, attribute)
    - setGridElement(i, j, width, attribute, val)
  - Also have function to kill particles
    - Useful for sinks!