PyFX

A Framework for Real-Time Graphics Effects

Lennart Ohlsson

Lund University

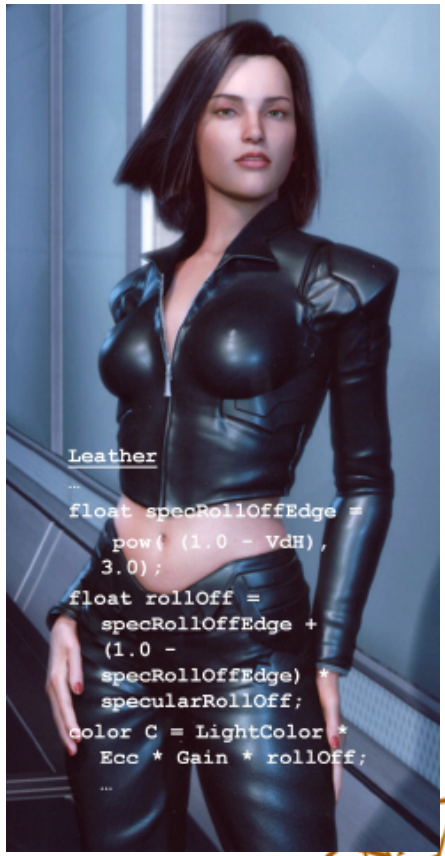
`http://graphics.cs.lth.se/pyfx`

Outline

- Programmable GPUs
- Effect frameworks
- Real-time effects in Python
- Features and benefits
- General purpose number crunching on the GPU

Shaders

- Surface details as algorithms, not images
- Established technique in animated movies
- Renderman Shading Language
- Cinematic graphics may take time



Programmable GPUs

- Real-time graphics requires GPUs
- Modern GPUs more complex than CPUs
- Specialized and very high performance
- Programmatic control
- Real-time shaders
- Programmed in high-level languages, for example Cg

Integrating shaders into application

- To be done by application on the CPU
  - Compiling and loading shaders
  - Providing shader parameters
  - Setting up rendering pipeline
  - Associating textures to shaders
  - Running multiple rendering passes
  - Using intermediate render targets
- Rather low level APIs
- Creates unnecessary dependencies

Effect frameworks

- “Effects”- units of encapsulation
- Existing effect frameworks
  - CgFX, DirectX Effects
  - Effects specified in declarative mini-languages
- Still insufficient
  - Encapsulation incomplete
  - Lack important features
  - Not extensible

PyFX

- A Python based effect framework
- Effects are specified in Python
- Framework implemented in Python
- Designed to be independent of graphics platform and shader runtime system
- Current implementation on PyOpenGL and Cg runtime (via SWIG)

A simple effect – Refraction

```
from FX import *

environmentTexture = Texture(...)
environmentMap = Sampler(environmentTexture, ...)

theta = 1.1    # index of refraction

refract = Cg( """ ... Cg code ... """)

passes =
   [Render(
      VertexShader = refract.vertex(target=arbvp1),
      FragmentShader = refract.fragment(target=arbfp1)
    )]
```

- almost like CgFX so far ...

Generic application interface

```
e = Effect(”refract”, theta=1.2)
...

while e.hasMorePasses():
    render(geometry)
```

- shader parameters bound by name matching
  - instance or class variables on effect
  - standard variables from the graphics API
  - vertex attribtues on geometry
- complete encapsulation of effects

Another effect - Glow

```
passes =
   [Render(Target=blurBuffer, Color=GlowColor)] +
   gaussian2DBlur +
   [ImageProcessing(Source=blurTexture,
                    AlphaBlendEnable=True,
                    SrcBlend=SRCALPHA,
                    DestBlend=ONE)]
```

- Multiple passes
- Needs features not in CgFX
  - render to texture
  - passes without geometry
- were easily added to framework

Glow continued

```
from convolution import *

gaussian2DBlur =
   3*[gaussian1DBlur(1,0),
      gaussian1DBlur(0,1)]

def gaussian1DBlur(x,y):
   vs = convolve4x1D.vs(...)
   fs = convolve4x1D.fs(...)
   return ImageProcessing(
      Target=blurBuffer,
      VertexShader=vs,
      FragmentShader=fs)
```

- **Using ordinary programming language features make effects easier to write**

GPGPU

- Using GPU as general purpose number cruncher
- Typical user scenario is interactive calculator
- Perfect match for a script language
- Example: Image processing