Advanced lighting in 2D graphics

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Intro

- Attempting to create 2D lighing that "looks 3D"
- Utilizing modern graphics hardware
- Making it reusable for other projects
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2D is not (completely) dead

- Integrated, mobile GPUs
- Easy programming
- Art not limited by tech
- Artists can “cheat”
- Don’t always need 3D (RTS, Infinity-style RPG)

Pre-rendered graphics

- 3D -> tool -> 2D -> postprocessing -> game
- Can look photorealistic
- Low HW requirements
- Lighting usually pre-rendered, static

2D dynamic lighting in games

- Homogenous lighting in a circle around the source
- Shadowing in special cases (e.g. interior with vertical walls)
- Can't light a complex object (no idea where "front" is)

We can do better

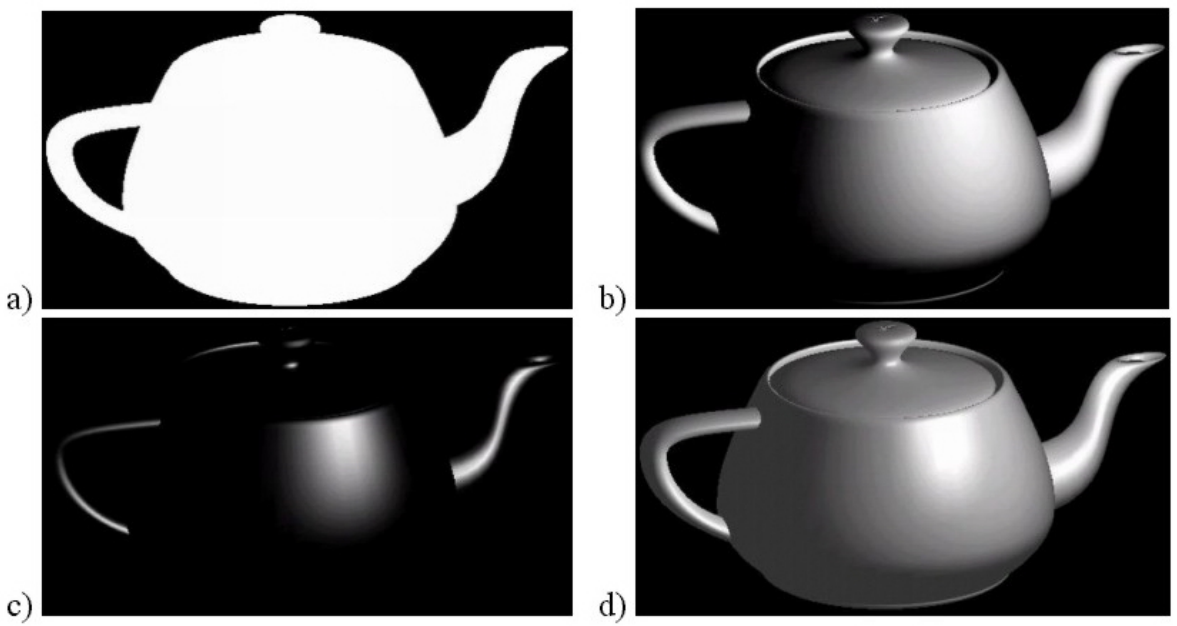
- Not much progress since 2000
- Generic Android phone has a better GPU than a GeForce 2
- Fixed function GPUs are dead
- We can build our software renderer in shaders

Goals

- Move forward from 2000
- Achieve “real” dynamic lighting in 2D
- Make it easy to implement in any engine
  - Tools
  - Documentation

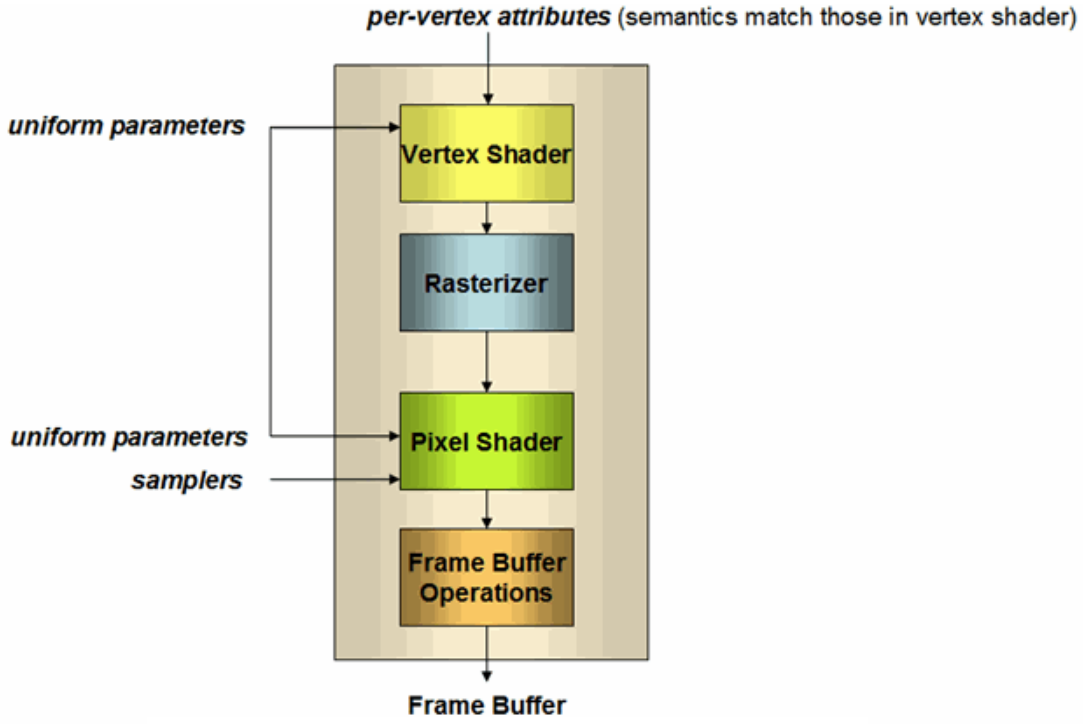
Phong reflection model

- Not Phong *shading* model
- Common in real-time 3D (fast & good image)
- Ambient, diffuse, specular



Graphics pipeline

- Vertex shader (3D primitives)
  - Vertex attributes (position, color, etc.)
- Fragment shader (pixels or subpixels)
  - Textures
  - Data calculated by vertex shader



Current approach

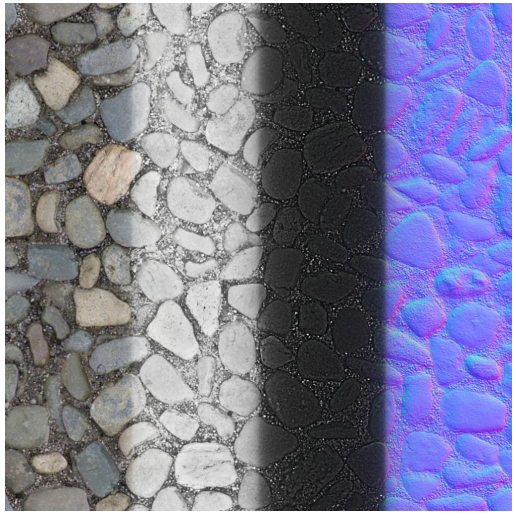
- Phong reflection model “in 2D”
- Can be built upon later
  - Self-shadowed radiosity normal mapping... in 2D
  - Environment mapping (sky reflection on shiny surfaces)
  - ...
- Game simulation still needs to be 3D, but not graphics

Phong 2D

- We only have 2D data (textures)
- Need all data for Phong model
  - From 3D simulation: Light/s, viewer positions
  - From textures (per pixel):
    - Relative position
    - Normal
    - Color (diffuse, specular)

Texture data

- Normals (RGB8, RG8, palette)
- Specular? (RGB8, G8)
- Diffuse (RGBA8)
- Position (RGB8, heightmap)
- Memory/compute tradeoff
- Anywhere between 40bpp and 104bpp is possible
  - 2000: 8bpp or 32bpp
  - We have more VRAM now (but mobile. . .)



Texture (sprite) authoring

- Manual
  - Hard
  - Seriously? Paint positions in Photoshop?
- Pre-rendered
  - No need to optimize models for a game
  - Million triangles is not a problem
  - Procedural textures

Pre-rendering

- Render-to-texture
- Performance doesn't matter
- Phong model (without the "Phong" part)
- Render per-pixel data Phong model would use
- For diffuse, a raytracer with AA is better
- AA and vectors don't mix (2x resolution?)

Current status

- Demo app not yet started
- Working on pre-rendering
  - Only loading models works (DerelictAssimp)
- Portable "graphics engine" complete
  - Vertex/Index Buffers
  - Textures
  - **Modular shaders**
  - VFS, YAML, etc. (reused)

Modular shaders

- Can exchange shader program modules at run-time
- Primitive polymorphism
- Completely irrelevant to the work
- Makes implementation much easier

Roadmap

- Finish pre-rendering tool
- Implement demo & start working on the thesis
- Time-based:
  - GUI for the pre-rendering tool
  - Improve the lighting model (esp. self-shadowing)
- Integrate into engine

Sources

- Inspiration: Normal/Parallax/Relief mapping in 3D
- Literature:
  - B. T. Phong, Illumination for computer generated pictures, Communications of ACM 18 (1975), no. 6, 311–317.
  - Blinn, J. F. 1978. Simulation of wrinkled surfaces. SIGGRAPH 1978.
- Cool stuff I want to use (time):
  - Mitchell, J., McTaggart, G., and Green, C. 2006. Shading in Valve's source engine. SIGGRAPH 2006.
  - Green, C. 2007. Efficient Self-Shadowed Radiosity Normal Mapping. SIGGRAPH 2007.

More info

- http://kiithcoding.nfshost.com
- https://github.com/kiith-sa/awesome2D
- D
- OpenGL2/GLSL
- Assimp
- SDL2

Thank you for your attention!