Realtime Computer Graphics on GPUs

Agenda

Jan Kolomazník

Department of Software and Computer Science Education
Faculty of Mathematics and Physics
Charles University in Prague

INFO

Web: https://cgg.mff.cuni.cz/∼kolomaznik/

Email: kolomaznik@cgg.mff.cuni.cz

Put ”NPGR019” in email subject

Content and Form

- hardware support for 3D graphics (GPUs)
  - follows loosely the CG I (NPGR003) course
  - math and data structures for 3D graphics
  - GPU capabilities, advanced techniques, data handling, ..
  - 3D scene rendering methods, advanced techniques
  - GPU programming (shaders), general computing GPGPU
  - concrete API (OpenGL, GLSL, CUDA, OpenCL ..)
- 2/2 C+Ex
  - lecture and lab every week
  - practical examples, two homework tasks for the credit

Course Brief I

- GPU Architecture, History
  - simplified programmable pipeline (vertex, fragment shaders)
  - basic primitives, rasterisation, 2D rendering
  - historical background - 3D rendering - wireframe, flat, basic lighting, Gourand vs. Phong shading
  - Phong model
- Math
  - 2D linear transformation, rotation by formula, matrix, complex numbers
  - 3D transformations - affine, perspective space
  - 3D rotations - euler angles, gimbal lock, matrices
  - Normal matrices
  - Quaternions
  - lerp, slerp
  - easing/tweening
  - animation curves

Course Brief II

- Textures
  - coordinates
  - aliasing vs. filtering
  - mip-maps
  - multitexturing
  - bump mapping
  - 3D textures
- Framebuffer
  - render to texture
  - deferred shading
  - antialiasing
  - stencil buffer - shadow-map, shadow volume, mirrors
  - effects in screen space (ambient occlusion, DOF, . . .)
- Generating geometry
  - datastructures

Course Brief III

- tesselation shaders
- geometry shaders
- mesh shaders

- Speedup techniques
  - near/far clipping
  - occlusion culling
  - instancing
  - billboards, decals
  - LOD
  - triangle fan, strip

- Advanced techniques
  - bindless textures
  - megatextures
  - volume rendering
  - CAD visualization

Course Brief IV

- scientific visualization
- Other technologies
  - OGL ES
  - WebGL
  - Vulkan
  - DX11, DX12
  - Optix + raytracing
- GPGPU
  - compute shaders
  - OpenCL
  - CUDA
    - terminology
    - OGL interoperability
    - computation model
    - memory types
  - Deep learning