CS 457/557 – Computer Graphics Shaders

Catalog Description: Theoretical and practical treatment of computer graphics shaders, including both RenderMan and GPU shaders. Programming in both RenderMan and OpenGL shading languages.

Credits: This course combines approximately 90 hours of instruction, and approximately 30 hours of programming work for 4 credits.

Terms Offered: Winter

Prerequisites: Previous graphics pipeline programming experience

At OSU, any of our CS computer graphics courses are acceptable.

Courses that require this as a prerequisite: None

Structure: Three 50-minute lectures per week
Note: Due to extensive programming assignments, this course has an implied, non-scheduled lab. The lab takes place on the students’ own times, and is not part of the official course schedule.

Instructor: Mike Bailey

Measurable Student Learning Outcomes for both CS 457 and CS 557 students:
On completion of the course, students will have demonstrated the ability to:

1. Explain the difference between Model Coordinates, World Coordinates, Eye Coordinates, Clip Coordinates, Normalized Device Coordinates, and Screen Coordinates (ABET Outcomes a, j)
2. Explain the ModelView and Projection matrices, and what operations belong in each, and why (ABET Outcomes a, j)
3. Describe where surface, displacement, vertex, fragment, geometry, tessellation, and compute shaders fit into the graphics pipeline (ABET Outcomes a, i)
4. Explain the difference between uniform, varying, and attribute variables (ABET Outcomes a, i)
5. Demonstrate the application of octave noise to shader effects (ABET Outcomes a, j)
6. Demonstrate how shaders can be used to simulate various optics effects (ABET Outcomes a, j)
7. Demonstrate the difference between bump-mapping and displacement-mapping (ABET Outcomes a, j)
8. Demonstrate how to use cube mapping to achieve a good approximation to reflection and refraction. Explain what is different about reflection and refraction done this way and real reflection and refraction (ABET Outcomes a, j)
9. Apply shaders to visualization problems (ABET Outcomes a, b, c, j, k)
10. Demonstrate how to use textures in shaders (ABET Outcomes a, j)
11. Demonstrate the use of a smooth step to avoid the aliasing effects of sharp transitions (ABET Outcomes a, j)

**Additional Measurable Student Learning Outcome for CS 557 Students:**

12. Read a current research paper on the use of shaders and write a 5-page paper Analyzing it. (ABET Outcomes a, b, c, f, g, l, j)

**Learning Resources:**

**Course Content:**
- A more advanced look at the graphics pipeline
- RenderMan
- The RenderMan Interface Bytestream
- RenderMan Surface and Displacement shaders
- Light interaction
- Color interaction
- Opacity interaction
- Step boundaries
- Smooth step boundaries
- Positional and gradient noise
- Fractional Brownian Motion (FBM, 1/f, octave) noise
- The OpenGL Shading Language (GLSL)
- GLSL Vertex shaders
- GLSL Fragment shaders
- GLSL Geometry shaders
- GLSL Tessellation shaders
- GLSL Compute shaders
- Hiding data in textures for visualization

**Evaluation of Student Performance:**
Projects: 800 points
Tests (2) 200 points total (i.e., 100 points each)
TOTAL 1000 points

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<th>Points</th>
<th>Grade</th>
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<tr>
<td>950</td>
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Students with Disabilities:
Accommodations are collaborative efforts between students, faculty and Disability Access Services (DAS). Students with accommodations approved through DAS are responsible for contacting the faculty member in charge of the course prior to or during the first week of the term to discuss accommodations. Students who believe they are eligible for accommodations but who have not yet obtained approval through DAS should contact DAS immediately at 737-4098.

Link to Statement of Expectations for Student Conduct, i.e., cheating policies http://oregonstate.edu/studentconduct/http:/%252Foregonstate.edu/studentconduct/code/index.php

Wordle from the Course Notes: