

Advanced Computer Graphics

COMP 4004
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Dr. Hamish Carr, COMP 4004 Advanced Computer Graphics, Spring 2006

Course Description

- Advanced topics in computer graphics, which may include: GPU programming; shader languages; modelling natural phenomena; inverse kinematics; collision detection; frame-rate optimization; real-time rendering for games; scientific, medical or information visualization; geometric optimization; level-of-detail rendering; bi-directional reflectance distribution functions (BRDFs); environment mapping; bump mapping; subdivision surfaces; higher-order surface modelling. Exact topics will vary from year to year at the discretion of the lecturer, and the course may be taught in the form of seminars, in which case students will research and present recent papers on graphics techniques. The practical course will involve a significant amount of programming, which normally requires a good working knowledge of C and OpenGL.



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Topics to be Covered

- Animation
- Rendering
- Modelling
- Surface Representations
- Visualization



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Animation

- Keyframing
- Motion Blending
- Skinning
- Physics Modelling
- Collision Detection



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Rendering

- Shadows
- Multipass Textures
- Shader Languages
- Bump & Environment Maps
- Mipmaps



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Modelling

- Particle Systems
- Terrain & Weather
- Plants & Animals
- Simplification & Level of Detail
- Optimization



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Surface Representation

- Béziers & B-splines
- NURBS & Evaluators
- Subdivision Surfaces



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Organization

- 2 lectures per week
- No assigned lab time
- 1 assignment / 2 weeks
- Major project at end of term
- *after* 4th year projects complete



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Evaluation

- Two possibilities:
 - with final exam
 - without final exam



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With Exam

- 20% assignments
 - 4 assignments at 5% each
- 40% project
- 40% final



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Without Exam

- 60% assignments
 - 5 assignments, 10% each
 - 2 small assignments, 5% each (A0, A6)
 - more work involved
- 40% project
- Last 2 assignments overlap project



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Pros / Cons

- An exam means
 - more work for me setting it up
 - less work for you during term
- No exam means
 - more practice *doing* graphics
 - more work for you during term



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Lecture Schedule

- Week 1: Introduction / Files & GUIs
- Week 2: Keyframing & Pose Interpolation
- Week 3: Quaternions & ArcBalls
- Week 4: Blending & Skinning
- Week 5: Physics Modelling / Collisions
- Week 6: Textures & Shading



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Lecture Schedule

- Week 7: Particles, Fluids, Terrain, Weather
- Week 8: Plants & Animals
- Week 9: Surface Modelling (after break)
- Week 10: Simplification & Optimization
- Week 11: Visualization
- Week 12: Review / Project Day



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Assignment Schedule

- A0 available today, due Wed 25/01/06
- A1 available Mon 23/01/06, due Mon 06/02/06
- A2 available Mon 06/02/06, due Mon 20/02/06
- A3 available Mon 20/02/06, due Mon 06/03/06
- A4 available Mon 06/03/06, due Mon 10/04/06
- A5 available Wed 05/04/06, due Wed 19/04/06
- A6 available Wed 19/04/06, due Tues 02/05/06



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Project Schedule

- Assignments feed into project
- Project starts 05/04/06 after break
- Due *Tuesday*, 25/04/06, time TBD
- Project Day Wednesday 26/04/06



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Project Evaluation

- Not *quite* fixed in stone:
 - 20% required elements
 - 10% advanced (beyond assignments)
 - 5% cool
 - 5% fast (i.e. optimized)



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Required Elements

- Keyframe Interpolation
- Blended Motions
- Collision Detection
- Natural Phenomena



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Labs & Platforms

- No assigned labs
- Work when you like, where you like
- Code must not be platform-specific
 - *should* be written for lab machines
- We'll talk about GUIs, &c. on Wednesday



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Office Hours

- I will have *office hours*
 - time set aside for graphics questions
 - to be determined
- Other times, I *may* be available
 - but I am likely to be busy



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Assignment 0

- An *introductory* assignment
 - to get you back coding OpenGL
 - marks:
 - none if we have an exam
 - 5% if we don't



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Assignment 0

- Read in a character from a text file
- Render it on the screen
- Bonus: Use hierarchical transformations



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File format

- Originally .3ds files
- Converted using lib3ds (open source)
- ASCII text .m files
- A hierarchical mesh of triangles



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File header

```
#
# Created by lib3ds2m (http://lib3ds.sourceforge.net)
# As modified by H. Carr, January 2006
#
# bones=10 master=Waist01
#
```

bones = # of bones in hierarchy
master = the root of the animation hierarchy



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Bone description

Bone header
Transformation Matrix
Children
Vertices
Faces

Each bone is listed in full before the next bone



Bone header

Bone Name # of faces

Bone 0: Arm L vertices=118 faces=210 children=1
#

Bone ID # of vertices # of child bones



Transformation Matrix

Transformation matrix:
0.939693 0.342020 -0.000000 33.014305
-0.000000 0.000000 1.000000 -11.909839
0.342020 -0.939692 0.000000 25.479464
0.000000 0.000000 0.000000 1.000000

- With respect to the *world*
- i.e. *not* a hierarchical matrix



Children

Child Name
Child 0 Hand L
Child ID

- Each child is listed separately



Vertices

Vertex Coords
Vertex 0 17.675865 6.765263 22.073231
Vertex ID

- Vertices are in *global* coordinates



Faces

Vertex Coords
Face 0 2 0 1
Vertex ID

- Face list vertices in CCW order
- IDs are also *global*
- Bone 1 starts with vertex 118 (here)



Assigned Task

- Read in the vertices
- Read in the faces
- (optional) read in the bones
- (optional) convert vertices to bone coords
- (optional) find hierarchical transforms
- Render the model as wireframe or triangles

