CM3045 3D Graphics and Animation

Module description

Target Audience

Level 6 BSc CS students interested in

Module goals and objectives

Upon successful completion of this module, you will be able to:

- Explain the mathematical and theoretical principles of computer graphics and apply then to practical computer graphics problems.
- Explain many computer graphics and animation techniques used in contemporary graphical software and use them to create computer graphics and animation sequences
- Develop basic but complete graphics software systems
- Analyse and evaluate the use of computer graphics methods in practical applications.
- Apply computer graphics and animation techniques to creating aesthetic effects

Textbook and Readings

Specific essential readings for each week from the following list are included in the Readings page for each week:

- Computer Graphics: From Pixels to Programmable Graphics Hardware By Alexey Boreskov, Evgeniy Shikin
    - ***Topic 1:*** Chapter 1
    - ***Topic 2:*** Chapter 2, sections 4.1-4.8
    - ***Topic 4:*** Chapters 11 and 12 (optional)
    - ***Topic 6:*** Sections 4.9, 4.10
    - ***Topic 8:*** Chapter 13
- Computer Graphics by Somnath Sinha and Aditi Paul
    - ***Topic 6:*** Chapter 5, 7

Module outline

The module consists of ten topics that focus on key areas of the fundamentals of computer science.

Topic 1. 3D Graphics Overview

Key concepts:

3D graphics basic
Unity Game Engine
3D Models

Learning outcomes:

1. Explain the basic idea of 3D graphics
2. Evaluate and select 3D graphics engines for use in a project.
3. Create simple scenes from basic primitives or imported assets

Topic 2. 3D Models and Transforms

Key concepts:

Transforms
Mathematics of Transforms
Unity Basics

Learning outcomes:

1. Explain the basic mathematical and theoretical principles of 3D models and transforms
2. Use transforms and objects to create 3D graphics scenes
3. Create simple scenes from basic primitives or imported assets

Topic 3. Physics Simulation

Key concepts:

Physics Simulation
Physics Objects
Forces

Learning outcomes:

1. Explain the mathematical and theoretical principles of physics simulation and apply them to interactive graphics
2. Explain the use of physics engines in practical graphics and animation
3. Develop basic but complete physics based graphics environments

Topic 4. Keyframe Animation

Key concepts:

Keyframe animation
State Machines
Unity Event System

Learning outcomes:

1. Explain the basic mathematical and theoretical principles of keyframe animation
2. Use keyframe animation to produce particular movement effects
3. Create simple keyframe animation sequence

Topic 5. Character Animation

Key concepts:

Body Animation
Facial Animation
Gaze Animation

Learning outcomes:

1. Explain the basic mathematical and theoretical principles of character animation
2. Analyse and evaluate the use of different character animation methods for practical applications
3. Create simple interactive animated characters
4. Use character animation to give a sense of personality or expression with characters

Topic 6. Rendering and the Graphics Pipeline

Key concepts:

Cameras
Rasterization
Hidden Surface Removal

Learning outcomes:

1. Explain the 3D graphics pipe and how it is implemented on modern graphics hardware
2. Use interactive and animated cameras in a graphics experience
3. Evaluate the benefits of GPU shader versus CPU based graphics techniques

Topic 7. GPU Programming

Key concepts:

GPU Shaders
Vertex Shaders
Fragment Shaders

Learning outcomes:

1. Explain the function and behavior of GPUs and shader programs
2. Develop basic but complete graphics shader pipelines
3. Evaluate the benefits of GPU shader versus CPU based graphics techniques

Topic 8. Lighting and Materials

Key concepts:

Lighting
Materials
GPU Lighting

Learning outcomes:

1. Explain the basic mathematical and theoretical principles of lighting and materials
2. Explain how lighting and materials are used in contemporary graphical software and used them to create 3D graphics scenes
3. Apply lighting and materials to creating aesthetic effects

Topic 9. Textures

Key concepts:

Texturing
Normal Mapping
Advanced Texturing Techniques

Learning outcomes:

1. Explain the basic mathematical and theoretical principles of texturing
2. Explain how texturing is used in contemporary graphical software and used them to create 3D graphics scenes
3. Apply texturing to creating aesthetic effects

Topic 10. Advanced Techniques

Key concepts:

Global Illumination
Particle Systems
Careers in 3D Graphics and Animation

Learning outcomes:

1. Explain the mathematical and theoretical principles of advanced computer graphics topics and apply then to practical computer graphics problems.
2. Explain and use the implementations of advanced techniques in graphics engines
3. Apply several advanced graphics and animation techniques to creating aesthetic effects

Activities of this module

The module is comprised of the following elements *(please explain in detail the activities included in the module, for example:*

- *Lecture videos.*
- *Practice Quizzes.*
- *Peer Reviewed programming/development Assignments.*
- *Graded Assignments.*
- *Discussion Prompt.*
- *Readings.*

How to pass this module

The module has two major assessments each worth 50% of your grade:

- Coursework [50%]: The coursework consists of several activities. This is a detailed breakdown of all of the marks. The mark shown on the Coursera platform is your coursework mark.
- Final Examination [50%]

Activity	Required?	Deadline week	Estimated time per module	% of final grade
End of topic quizzes for topics 1-5	Yes	1-10	1-2 hours	5%
Mid-Term Quiz	Yes	11	1 hour	10%
Programming exercises and report, staff graded coursework	Yes	11	Approximately 20 hours	35%
Written examination	Yes	22	2 hours 15 minutes	50%