Year : 2018/19

24309 - Computer Graphics

Syllabus Information

Academic Course: 2018/19
Academic Center: 337 - Polytechnic School
Study: 3377 - Bachelor's Degree in Computer Engineering
Subject: 24309 - Computer Graphics
Credits: 5.0
Course: 3
Teaching languages: Theory: Grupo 1: Pending
Grupo 2: Pending
Practice: Grupo 101: Pending
Grupo 102: Pending
Grupo 201: Pending
Grupo 202: Pending
Seminar: Grupo 101: Pending
Grupo 102: Pending
Grupo 103: Pending
Grupo 104: Pending
Grupo 201: Pending
Grupo 202: Pending
Grupo 203: Pending
Grupo 204: Pending
Teachers: Jose Angel Blat Gimeno, Ricardo Jorge Rodrigues S. Marques , Antonio Agudo Martinez
Teaching Period: Segundo trimestre

Presentation

This course aims at providing and consolidating both the theoretical and practical foundations of Computer Graphics. Moreover, by taking this course, the student will also have a first exposure to advanced techniques in visualization, image synthesis and image processing.

Associated skills

1 - Capacity for independent learning in the future, gaining more profound knowledge of previous areas or learning new topics.

2 - Capacity for oral and written communication in Catalan, Spanish and English, which enables synthesis and oral and written presentation of the work carried out.

3 - Organize the work in terms of good time management, organisation and planning.

4 - Demonstrate initiative and work individually when the situation requires it.

5 - Capacity for adapting to changing environments

6 - Identify the major computer graphics challenges and contributions made to society.

Learning outcomes

1 - Detailed understanding of the goals of computer graphics

2 - Detailed understanding of the basic mathematical tools for computer graphics

3 - Detailed understanding of the graphics processing unit (GPU) rendering pipeline

4 - Ability to efficiently use the OpenGL graphics library for graphic representation and display of 3D scenes

5 - Understanding the pros and cons of the two main alternative paradigms for image synthesis: razterization VS ray tracing
6 - Development and consolidation of algorithm design and programming skills
7 - Overall understanding of the advanced computer graphics algorithms and tools
8 - Ability to globally assimilate, reorganize, summarize and present advanced computer graphics content
9 - Ability to work in team
10 - Ability to analyze a problem and develop adequate solutions/algorithms

Prerequisites

Linear Algebra, Calculus and Physics. Algorithmics and Structured Programming.

Contents

Class #1: Introduction
Why study computer graphics?
Applications: movies, games, science
Visualization and digital media technologies
Digital Drawing, frame buffer
Introduction to rasterization

Class #2: Signal and image processing
Sampling and artifacts
Antialiasing by filtering and supersampling
Convolution
JPEG compression and DCT
Basic image processing: edges, filters,

Class #3: Geometric transforms and camera models
Linear transformations
2D and 3D transformations
Homogeneous coordinates
Coordinate systems
Perspective and Orthographic cameras

Class #4: Texture mapping
Texture coordinates
Texture sampling
Texture antialiasing
Filtering

Class #5: Rasterization
Visibility. Z-buffer
Shading, Phong, Lambertian models
Shading Meshes
GPUs

Class #6: Splines and Bezier curves
Camera paths
Splines. Interpolation. Basis functions
Bezier curves
Piecewise curves

Class #7: Geometry
Implicit and explicit representations

Level sets and fractals
NURBS and Bezier surfaces
Point Clouds

Class #8: Meshes and geometry processing
Meshes: points and elements
Subdivision, simplification, regularization
Connectivity
Local operations

Class #9: Ray tracing
Ray-surface intersection
Modeling and computation
Acceleration: uniform and non-uniform grids
Trees
Bounding volume

Class #10: Global illumination
Reflection equation
Rendering equation
Materials
Light transport. Bounces
Montecarlo integration
Class #11: Animation and simulation
Principles
Key-frame animation
Physics-based animation
Fluids
Interaction

Class #12: Motion capture and new technologies
Motion capture systems
Vision-based modeling from images and video: rigid and non-rigid
Image-based rendering
Virtual reality
Augmented reality

Teaching Methods

Methodology for Theory classes:
Theory classes with practical examples.

Methodology for Practical classes:

Implementation of computer graphics' algorithms. All used software is open source. The practical exercises are implemented in C++.

Methodology for the Seminar classes:

Presentation of a scientific article, informative article, tutorial or practical case.

Evaluation

The evaluation of this course is performed in three separate blocks:

1. **Theory** block: **50%** of the final grade, **recoverable**

2. **Practical** block: **30%** of the final grade, **NOT recoverable**
3. **Seminar** block: **20%** of the final grade, **NOT recoverable**

The minimum grade required to pass the course is 5.0 points out of 10. The minimum grade for every block is 4.0 points, considering just one block under 5.0 points.

Each block is evaluated as follows:

1. **Theory** block: evaluated through a **written exam** at the end of the course.
2. **Practical** block: evaluated through a set of **deliverables and reports**, and through an **oral defense**. The practical work will be done in groups of 3 persons.
3. **Seminar** block: evaluated through **presentations in groups of 4 or 5 people**, the content of which aims at consolidating the theoretical-practical basis acquired in the theory and seminar blocks.

Bibliography and information resources

1 - Fundamentals of Computer Graphics by P. Shirley, S. Marschner, et al.

2 - Computer Graphics: Principles and Practice (3rd Edition) by Hughes, van Dam, et al.

3 - Physically Based Rendering, Third Edition: From Theory to Implementation by Pharr, Jakob and Humphreys.

4 - 3D Computer Graphics by A. Watt.

5 - 3D Computer Graphics: A Mathematical Introduction with OpenGL by S. Buss.

6 - Computer Graphics: Principles and Practice by J. Foley.