COURSE DESCRIPTION CARD - SYLLABUS

Course name

3D Computer Graphics

Course

Field of study

Bioinformatics

Year/Semester

3/6

Area of study (specialization)

Profile of study

general academic

Level of study

First-cycle studies

Course offered in

polish

Form of study

full-time

Requirements

elective

Number of hours

Lecture

30

Laboratory classes

30

Other (e.g. online)

Tutorials

Projects/seminars

Number of credit points

4

Lecturers

Responsible for the course/lecturer:

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Instytut Informatyki

60-965 Poznan, ul. Piotrowo 2

Responsible for the course/lecturer:

Prerequisites

Knowledge:

Student starting this module should have basic knowledge regarding programming languages, geometry and computer system architectures.

Skills

The student should have the skills to solve simple algorithmic problems, program in C/C++ and to acquire knowledge from the designated sources of information.

Social competences:

The student should also understand the need to extend his/her competences and be ready to work in a team. Moreover, the student should show such attitudes as honesty, responsibility, perseverance, curiosity, creativity, manners, and respect for other people.

Course objective

1. Teach students the basic concepts and definitions related to computer graphics.

2. Teach students the mathematical basics of 3D graphics.
3. Teach students the methods of 3D object animation.
4. Teach students the shading models and hidden surface removal methods.
5. Teach students different types of 3d model representations.
6. Teach students basics of raster algorithms and halftone approximation
7. Teach students basic polygon clipping algorithms.
8. Develop students' computer graphics application programming skills by introducing popular computer graphics libraries.

Course-related learning outcomes

Knowledge

1. Knows the basic concepts and issues related to computer graphics and visualization of 3D models. [K_W09]
2. Knows the mathematical and physical basis of computer graphics. [K_W02, K_W03]
3. Knows the visualization algorithms of 3D models and the data structures used in them [K_W08]

Skills

1. Can design and implement a program that visualizes and animates a set of three-dimensional models [K_U07]
2. Can select the appropriate algorithm for the given problem visualization of three-dimensional objects and the corresponding data structure [K_U06]
3. Able to perform simple analysis based data visualization techniques [K_U03]
4. Able to acquire supplementary knowledge and raise qualifications [K_U14]

Social competences

1. Understands the need to learn throughout whole life and to broaden his competences. - [K_K01+]
2. Is able to collaborate and cooperate in a team fulfilling different roles. - [K_K02++]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Formative assessment:

a) lectures:

- based on answers to questions related to subjects covered during previous lectures,

b) laboratory classes:

- evaluation of correctness of implementation of assigned tasks (following provided lab. instructions),

Total assessment:

a) verification of assumed learning objectives related to lectures:

- evaluation of acquired knowledge on the basis of the written exam (a test, 50 questions, total points achievable 50, 25 points needed to pass).

b) verification of assumed learning objectives related to laboratory classes:

- based on the project implemented by a team of students, each students' grade is evaluated based on the quality of his/hers part as well as answering to several project related questions.

Programme content

Lectures cover the following topics

Subject 1: Basic concepts and definitions in the field of computer graphics. Introduction of: image buffering, hidden surface removal, basic texturing algorithms, basic texture types, several classes of special effects.

Subject 2: Mathematical basics of 3D graphics. Short repetition of computational geometry. Introcution of homogenous coordinate system, geometrical transformations and their matrix representation, quaternions and their relation to 3D rotation, typical vertex processing pipeline in 3D application, view and projection matrices (perspective and orthogonal projection), geometrical transformations of normal vectors.

Subject 3: Animation techniques. Vector graphics animation (per vertex animation, skeletal animation, inverse kinematics).

Subject 4: Introduction of light abstraction types (point, directional, cone and surface lights).

Subject 5: Shading models. Introduction of basic radiometry terms. Description of BRDF nad Schlicks BSF functions. Derivation of basic shading models: Lambertian diffuse model, Phong and Phong-Blinn model. Introduction of complex shading models such as: Cook-Torrance model.

Subject 6: Introduction of raytracing rendering algorithm. Algorithms for detecting intersection of ray with a sphere, AABB bounding box and a triangle. Algorithms for generating main ray, shadow ray, reflected ray and transmitted ray. Whitted's raytracing algorithm and its generalizations. Data structures for acceleration of ray-scene intersection. Antialiasing methods in raytracing.

Subject 7: Monte Carlo Rendering. Mathematical basics and algorithms.

Subject 8: Polygon clipping algorithms: Cohen-Sutherland, Cyrus-Beck, Sutherland-Hodgeman and Greiner-Hodgeman. Polygon clipping in homogenous space.

Subject 9: Description of 3d object representation methods including trimeshes, voxels, mathematically defined surfaces and particlesystems. Visualization techniques for such objects are provided as well.

Subject 10: Raster algorithms. Description of methods for rendering geometrical figures on raster displays including Bresenham's algorithms and filling algorithms. Halftone approximation including threshold, Floys-Steinberg and cell-based methods. Image filtering methods. Affine and perspective correct texture mapping.

Subject 11: Data visualization. Introduction to data visualization process. Discussion of exemplary visualization methods for various data types.

During laboratories the students learn basic of computer graphics and implement simple exercises:

Laboratory 1: Introduction to OpenGL API. Discussion about the basic program structure. Introduction to several basic topics related to drawing and animating of 3D models.

Laboratory 2-4: OpenGL exercises related to moving, rotating and animation of 3D objects on a scene. Students gain the skills to correctly construct geometrical transformation matrices.

Laboratory 5: Methods allowing to draw arbitrary trimeshes.

Laboratory 6: Texturing and shading of objects in OpenGL via ready made shader programs. Introduction of several texturing algorithms including bi- and trilinear filtering as well as mip mapping.

Laboratory 7: Introduction to HLSL language. Simple exercises based on implementation of simple geometry transforming shaders and simple shading models.

Laboratory 8: Implementation of per-vertex shading models in GLSL, including Lambert and Phong models.

Laboratory 9: Implementation of per-fragment shading models in GLSL including Phong and cell shading.

Laboratory 10: Texturing in GLSL. Multitexturing, Simple environment mapping.

Laboratory 11: Fur effect in GLSL as an illutration of instancing. Geometry shaders.

Laboratory 12-13: Normal mapping and Parallax mapping + optimizations.

Laboratory 14-15. Preparation of final project

Teaching methods

1. Lectures: multimedia presentation, presentation illustrated with examples presented on black board, solving tasks, multimedia showcase.

2. Labs: solving tasks, practical exercises, discussion, teamwork, multimedia showcase.

Bibliography

Basic

1. G. Banaszak, W. Gajda: „Elementy algebry liniowej” część I i II, WNT, Warszawa, 2002

2. B. Kaczmarek: „Elementy algebry i analizy macierzy”, Wydawnictwo PP, 1689, Poznań, 1992

3. J. Ganczarski: OpenGL w praktyce, Helion 2008

4. R. S. Wright: OpenGL: księga eksperta, Helion 2011

5. C.D. Hansen, C.R. Johnson (eds.): The Visualization Handbook, Elsevier, 2005

Additional

1 A.N. DcGorban, , B. Kégl, D.C. Wunsch, A. Zinovyev, (Eds.) Principal Manifolds for Data Visualization and Dimen-sion Reduction

2. F.H. Post, G.M. Nielson, G.-P. Bonneau, Data Visualization: The State of the Art, Proceedings of the 4th Dagstuhl Seminar on Scientific Visualizationn

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,0
Classes requiring direct contact with the teacher	60	2,5
Student's own work (literature studies, preparation for laboratory classes, preparation for tests, project preparation) [1]	40	1,5

[1] delete or add other activities as appropriate