Study program: Information Technology

Course title: COMPUTER GRAPHICS AND SIMULATIONS

Teacher: Veljko V. Aleksić

Course status: mandatory

Number of ECTS credits: 6

Prerequisite courses: none

Course objectives

A comprehensive introduction to computer graphics and simulations with a focus on fundamental concepts and techniques and their interrelationships in diverse domains: geometry, rendering, image processing, computer animation and simulations. Training students for computer graphics programming and manipulation. Encouraging creative and critical use of appropriate digital tools and environments.

Learning outcomes

The student is expected to know and comprehend the basic concepts of interactive computer graphics and simulations, and functionally use software environments and tools for the development and manipulation of graphic objects, models, animations and simulations in various fields of application of interactive 2D and 3D graphics, including VR and AR technologies. The student knows how to implement appropriate interpolation techniques, rasterization, processing and compression of digital images; skillfully manage and calculate geometric transformations; models and animates graphic objects; simulates lighting, shading and uses textures; knows spatial hierarchy and ray tracing techniques; creates computer image, animation and interactive simulation.

Content of the course

Theoretical teaching

Color, brightness, gamma correction. Digital image. 2D transformations. Line, triangle and polygon rasterization. Triangulation. Homogeneous coordinates. Linear interpolation. Coordinate spaces and 3D geometric transformations. Vectors, matrices and uniform variables. Affine transformations. Mapping. View and perspective. Projection. Image rendering. Occlusion. Z-buffer. Transparency. Lighting, reflection and shading. Texture mapping. Aliasing. Bilinear/trilinear interpolation and anisotropic filtering. 3D surfaces representation techniques. 3D objects, scene and scene graph. Tessellation. Ray tracing. Basics of computer animation. Objects deformation. Fluids and particle systems animation. Concepts of interaction. User interface design.

Practical teaching

2D raster and vector graphics programming: geometric elements and shapes, displacement, path, color, transparency, gradients, 2D transformations. GPU Programming (3D API): Rendering Pipeline, Shaders, Translation, Rotation, Scale, Interpolation, Indexed Drawing, Projection. Software 3D modeling. Bezier and B-Spline curves, triangle meshes and NURBS surfaces. 3D polygons, surfaces and objects manipulation. UV mapping, textures and shading. Sampling. AA techniques. Motion animation, frame, key. Rendering techniques. Interactive elements programming. Simulation of processes and virtual environments, including VR and AR technologies.

Literature

[1] Marschner, S., & Shirley, P. (2015). Fundamentals of Computer Graphics (4th Edition). CRC Press. ISBN: 978-1-48222-939-4

[2] Hughes, F., Van Dam, A., McGuire, M., Sklar, F., Foley, D., Feiner, K., & Akeley, K. (2013). Computer graphics: Principles and Practice (3rd Edition). Addison-Wesley Professional. ISBN: 978-0-32139-952-6

[3] Kemeny, A., Chardonnet, J., Colombet, F. (2020). Getting Rid of Cybersickness: In Virtual Reality, Augmented Reality, and Simulators. Springer International Publishing, ISBN: 978-3-030-59341-4

Number of active teaching classes: 4	**Theoretical teaching: 2**	**Practical teaching: 2**

Teaching methods

Realization of lectures and exercises according to the interactive teaching model (popular lectures, discussions, demonstration, practical work, research, workshops). Activated forms of learning: verbal receptive learning, cooperative learning, practical learning, and learning by discovery.

Evaluation of knowledge (maximum number of points 100)

Pre-exam obligations	**Points**	**Final exam**	**Points**
Activities during teaching process	10	Final exam (written):	20
Practical teaching	30	Final exam (oral):	10
Colloquium	30		