**Nazwa przedmiotu:**

Computer Graphics

**Koordynator przedmiotu:**

Janusz Rzeszut

**Status przedmiotu:**

Obowiązkowy

**Poziom kształcenia:**

Studia I stopnia

**Program:**

Computer Science

**Grupa przedmiotów:**

Technical Courses

**Kod przedmiotu:**

ECOGR

**Semestr nominalny:**

7 / rok ak. 2015/2016

**Liczba punktów ECTS:**

6

**Liczba godzin pracy studenta związanych z osiągnięciem efektów uczenia się:**

120h
lecture 30h, tutorial 30 h, total 60h
It is assumed that student's own work should be at least equal to the total number of hours.

**Liczba punktów ECTS na zajęciach wymagających bezpośredniego udziału nauczycieli akademickich:**

3 ECTS
60h lectures and tutorials

**Język prowadzenia zajęć:**

angielski

**Liczba punktów ECTS, którą student uzyskuje w ramach zajęć o charakterze praktycznym:**

1 ECTS
30h of tutorials

**Formy zajęć i ich wymiar w semestrze:**

|  |  |
| --- | --- |
| Wykład:  | 30h |
| Ćwiczenia:  | 30h |
| Laboratorium:  | 0h |
| Projekt:  | 0h |
| Lekcje komputerowe:  | 0h |

**Wymagania wstępne:**

basic knowledge of linear algebra, vectors, matrices
basic knowledge of physics, optics
basic knowledge of computer architecture

**Limit liczby studentów:**

32

**Cel przedmiotu:**

Students should become familiar with methods of image generation and computer graphics hardware. The course consists of two parts: lecture and tutorials. The lecture covers main problems concerning computer graphics hardware and methods of image rendering. Tutorials are devoted mainly to mathematics and algorithms

**Treści kształcenia:**

L1. General information, organization of lecture, references, questionnairy- knowledge level,
Basic notions, image, computer graphics, image processing, image analysis, image as matrix, computer graphics hardware- output devices, input devices.
L2. Comuter graphics survey, areas of application, display devices, CRT tube, magnetic deflection, random scan devices, raster scan devices, interlaced vs noninterlaced, luminescence, persistence, refresh rate
L3. CRT colour tubes, delta, PIL, Trinitron, guns arrangement, triads of phosphors, LCD displays, plasma, OLED, screen resolution, aspect ratio, square pixels, estimation of timing requirements, video signal, composite signal, video dac, raster generator, structures of display controllers Look Up Table, number of bits per pixel
L4. Antialiasing, straightforward supersampling, finite width of line, weighted area sampling, filtering, midpoint algorithm, Piteway-Watkinson algorithm,
L5. Polygon filling, scan-line fill, inside-outside test, even-odd rule, winding number, directional edge crossing,
L6. Scan line fill of curved boundary areas, boundary fill algorithm, 4- and 8-neighbourhood, flood fill algorithm, area fill attributes, mapping patterns into area,
L7. Depth perception, stereovision,
L8. Polygon rendering methods, constant intensity flat shading, Mach bands, Gouraud shading, linear interpolation, bilinear interpolation, Phong shading – normal vector interpolation,
L9. Illumination, basic notions, photometry units, perfect diffuser – Lambertian surface, basic illumination models, ambient light, perfect diffuse reflection, specular reflection, transparency, refraction, attenuation with distance, aerial perspective, modelling real light sources,
L10. Ray-tracing, basic concept, primary and secondary rays, shadows, soft shadows, ray-surface intersection, bounding volumes, visible surface detection, Z-buffer, object representation, analytical, parametric equations, triangular mesh, sweep representation, Constructive Solid Geometry, octree, volume representation- voxels,
L11. Input devices, logical vs physical devices, input modes keyboards, mouse, trackball, bat, digitizers, light pen, 3D scanners, mechanical, optical, interactive drawing techniques,
L12. Colour in Computer Graphics, properties of human visual system, receptors, receptor response, colorimetry , visual colorimeter, colour space CIE XYZ, RGB, tristimuli, matching functions, chromaticity coordinates, chromaticity diagram,
L13. Transformation between colorimetry systems, RGB EBU, RGB FCC, Colour monitors, number of colours displayed, HSV model, HLS model,
L14. Hardcopy devices, monochromatic printers, bilevel printing, grey scale, colour printers, inkjet, thermosublimation, film recorders
L15. Animation, basic problems, physically based movements control,motion capture, morphing techniques

Tutorials
Ex.1. 2D coordinate systems, point, line, plane Euclidean distance, Cartesian coordinate system, polar coordinates, transformation between polar and Cartesian systems, orientation of coordinate system,
Ex.2. 3D coordinate system, right hand, left hand orientation, rule of thumb, spherical coordinates, transformation between polar and Cartesian coordinates, cylindrical coordinates, measures of angle, solid angle,
Ex.3. Points and vectors, method of defining vectors, equivalency of points and vectors, vector addition, vectors in 3D space, vector operations, summing, scalar product, vector product,
Ex.4. Vectors and matrices, row vector, column vector, transposition, multiplication, unitary matrix, determinant, matrix inversion,
Ex.5. Test1
Ex.6. Nonlinearities in display channel, gamma correction, equations for rough and precise correction, use of LUTs for correction, saturation, low level signals, method of estimation average gamma value
Ex.7. 2D geometric transformations, sreen coordinates, matrix notation, placement of the origin of coordinate system, detailed disscussion of transformations, translation, rotation, rotation about arbitrary pivot point, scaling, scaling relative to fixed point,
Ex.8. Homogenous coordinates, translation, rotation, scaling, composite transforrmation, concatenation of transformations, translations, rotations, scalings, reflections, shear,
Concatenation properties, computational efficiency of composite transformations,
Ex.9. Transformations between coordinate systems –2D, change of position, change of orientation, versors of new system,, mirroring about arbitrary line,
Ex.10. Basic raster algorithms, line, circle, ellipse, line equations, slope-intercept, axis crosspoint, implicit form,DDA algorithm, Bresenham line algorithm, Bresenham circle algorithm,
Ex.11. Twodimensional viewing, world coordinates, window, viewport, window to viewport transformations, clipping, line clipping, Cohen-Sutherland algorithm, Lian-Barsky algorithm,
Polygon clipping, Sutherland-Hodgeman algorithm, Weiler\_Atherton algorithm
Ex.12. Slide session, images from SIGGGRAPH conference
Ex.13. Three dimensional concepts, 3d transformations, homogenous coordinates, object movements vs coordinate system movements, rotation, directional cosines, Euler angles, aeroplane view, roll, pitch, yaw, carousel, cinecamera crane,
Ex.14. Projections, classification, parallel, orthographic, axonometric, isometric, oblique projections cavalier, cabinet, perspective projections, one, two and three vanishing points,
Equivalence of perspective projections and camera obscura view,
Ex.15. Test2

**Metody oceny:**

The maximum score for two mid-term tests is 100 points.
The final result is based on the following pattern:
• 5.0: 91-110 points
• 4.5: 81-90 points
• 4.0: 71-80 points
• 3.5: 61-70 points
• 3.0: 51-60 points
• 2.0: 0 -50 points

**Egzamin:**

nie

**Literatura:**

E.Angel “Interactive Computer Graphics” 3rd ed. Addison-Wesley 2003
D.Hearn, P.Baker „Computer Graphics”, Prentice Hall1994
J.D.Foley, A.vanDam,S.Feiner,J.Hughes “Computer Graphics.Principles and practice”2nd ed in C. Addison-Wesley 1997
J.D.Foley, A.vanDam “Fundamentals of interactive Computer Graphics” Addison-Wesley 1982
W.Newman, R.Sproul “Principles of interactive Computer Graphics”, McGraw Hill 1979
D.F.Rogers “Procedural elemets for Computer Graphics” McGraw Hill1980

**Witryna www przedmiotu:**

https://studia.elka.pw.edu.pl

**Uwagi:**

## Efekty przedmiotowe

### Profil ogólnoakademicki - wiedza

**Efekt ECOGR\_W01:**

knows graphical hardware, displays, input devices, principle of working,

Weryfikacja:

test1

**Powiązane efekty kierunkowe:** K\_W01, K\_W02

**Powiązane efekty obszarowe:** T1A\_W01, T1A\_W02, T1A\_W03, T1A\_W07, T1A\_W01, T1A\_W02, T1A\_W03, T1A\_W07

**Efekt ECOGR\_W02:**

knows problems of raster image creation

Weryfikacja:

test1

**Powiązane efekty kierunkowe:** K\_W01, K\_W02

**Powiązane efekty obszarowe:** T1A\_W01, T1A\_W02, T1A\_W03, T1A\_W07, T1A\_W01, T1A\_W02, T1A\_W03, T1A\_W07

**Efekt ECOGR\_W03:**

knows basic algorithms of raster graphics

Weryfikacja:

test

**Powiązane efekty kierunkowe:** K\_W01, K\_W09, K\_W10

**Powiązane efekty obszarowe:** T1A\_W01, T1A\_W02, T1A\_W03, T1A\_W07, T1A\_W03, T1A\_W04, T1A\_W07, T1A\_W03, T1A\_W04, T1A\_W07

### Profil ogólnoakademicki - umiejętności

**Efekt ECOGR\_U01:**

is able to calculate timing parameters of raster displays

Weryfikacja:

test

**Powiązane efekty kierunkowe:** K\_U01, K\_U08

**Powiązane efekty obszarowe:** T1A\_U01, T1A\_U08, T1A\_U09

**Efekt ECOGR\_U02:**

is able to implement computer graphics algorithms

Weryfikacja:

test

**Powiązane efekty kierunkowe:** K\_U02, K\_U08

**Powiązane efekty obszarowe:** T1A\_U02, T1A\_U08, T1A\_U09

### Profil ogólnoakademicki - kompetencje społeczne

**Efekt ECOGR\_K01:**

knows the needs to rise his/her competention

Weryfikacja:

test, discussion

**Powiązane efekty kierunkowe:** K\_K01

**Powiązane efekty obszarowe:** T1A\_K01