Innovative Lifelong e-Learning for Professional Engineers

(e-ProfEng)

586391-EPP-1-2017-1-SE-EPPKA2-CBHE-JP

Training in Electrical Engineering Discipline

Modelling and Simulation in Electrical Engineering

Data visualization in data analysis

Data visualization at FERIT Osijek

Josip Job

FERIT Osijek 2.4.2019.

Data visualization at FERIT Osijek

Graduate study programme

Data visualization

- Goals:
  - Introduce students to theoretical and practical knowledge in the field of data visualization. Teach them how to use and to work with data visualization tools and libraries. Train them to work individually and within team on data visualization projects, and enable critical thinking and evaluation of data visualization.
- Course description
  - Introduction to data visualization, importance of data visualization: storage of information, decision support, information transfer. Data types. Nominal, ordinal and quantitative data. Dimensions and measures. Visual encoding variables. Data visualization reference model. Data visualisation design. Data analysis. Visualization of multidimensional data. Perception, human visual system, Gestalt psychology. Interaction. Animation. Cartography. Graphs and trees. Colours. Narrative visualization. Text visualization. Evaluation of data visualization. Data visualization tools.

Data visualization

- Graduate University Study Programme in Computer Engineering
    - Elective module Software Engineering
    - Elective module Information and Data Science
- Lectures: 30 h
- Labs: 15 h (D3.js + HTML/CSS/JavaScript)
- Practical work in lab: 15 h (D3.js + HTML/CSS/JavaScript)
- Course lecturers

    Josip Job, Lecturer

    Časlav Livada, Lecturer

Data visualization

- Learning outcomes
  - Upon successful completion of the course, students will be able to:
    1. indicate and describe the basic elements of visualization
    2. design and create one's own data visualisation using appropriate tools and software libraries
    3. propose design of data visualisation in line with good practice and in accordance with the theoretical basis
    4. interpret and analyse data visualization design

3D Computer Graphics

- Goals
  - Show students the principles of geometric modelling, 3D graphics and computer animation. Introduce matrix representation of geometric transformations and projections into 3D, and application of OpenGL and BMRT (virtual scene, coordinate systems, camera model, z-mail, charting, shading) programme interfaces.
- Course description
  - Students will be introduced to the theoretical and practical fundamentals of applying the principles of geometric modelling, 3D graphics and computer animation. The concepts and techniques of representing three-dimensional objects and realising their realistic presentation are elaborated. Understand the basic principles of interpolation and hierarchical structures needed to apply the visualisation process. Practical computer programming skills.

3D Computer Graphics

- Graduate University Study Programme in Computer Engineering
  - Elective course for all modules
- Lectures: 30 h
- Labs: 30 h

- Course lecturers

BAUMGARTNER ALFONZO, Lecturer

GALIĆ IRENA, Lecturer

LEVENTIĆ HRVOJE, Associate

3D Computer Graphics

- Learning outcomes
  - Upon successful completion of the course, students will be able to:
    1. interpret the methods of modelling 3D objects and making their realistic view
    2. describe lightning, transparency, texture and shading models
    3. interpret the basic principles of interpolation, hierarchical structures needed to apply the virtual display process
    4. apply mathematical and physical knowledge to computer graphic problems and evaluate results
    5. define and describe the concepts of geometric modeling, 3D graphics and computer animation
    6. connect the acquired knowledge to create a computer graphics algorithm and interpret the result

Computational Geometry and Robot Vision

- Goals
  - Get acquainted with the presentation of basic geometric structures and spatial relationships with corresponding data structures. Master the basic methods for effective analysis of image geometry and 3D space. Learn to use image processing tools and images obtained by 3D sensors. Learn to implement software solutions for image analysis and 3D space information for applications in robotics and intelligent autonomous systems.
- Course description
  - Basic concepts: coordinate system, point, direction, length, vector, plane, surface, polygon, polyhedron, normal. Description of the position and orientation of the rigid body. Transformations between coordinate systems. Partition of plane and space. Triangulation. Delaunay triangulation. Finding your nearest neighbor. kD-tree. Convex shell. Voronoi diagram. Maps of space. Registration of points collections. Hough's transformation. Random sampling method (RANSAC). Application of computer vision in robotics. Perception sensors: camera, 3D camera, stereo vision, LIDAR. Filtering the image. Edge detection. Detection point of interest. Segmentation of 3D image and cloud. Optical current. Calibrate the camera. Determine the position of the camera in relation to the robot's working environment. Three-dimensional reconstruction of objects and scenes based on two or more images taken from different positions. Building a map of the robot's working environment based on data obtained through computer vision. Identifying places. Identifying objects. Obstruction detection.

Computational Geometry and Robot Vision

- Graduate University Study Programme in Computer Engineering
    - Elective block Robotics and artificial intelligence
- Lectures: 30 h
- Labs: 30 h

- Course lecturers

    GALIĆ IRENA, Lecturer

    HABIJAN MARIJA, Associate

    LEVENTIĆ HRVOJE, Associate

Computational Geometry and Robot Vision

- Learning outcomes
  - Upon successful completion of the course, students will be able to:
    1. understand the basic principles of commonly used methods and tools for image processing and data obtained by 3D sensors.
    2. select the appropriate methods for resolving problems in the image processing area and the images obtained by 3D sensors.
    3. select appropriate data structures for displaying two-dimensional and three-dimensional geometric structures as well as their interrelationships.
    4. create a computer program for image processing using the available software tools.
    5. create a computer program for data processing obtained by 3D sensors using the available software tools.
    6. create a software solution for identifying objects on images obtained by 3D kemer and determining the position of an object relative to the camera.

Image Processing and Computer Vision

- Goals
  - Introduce students to basic methods used in image processing and computer vision, from basic image transformation, image enhancement, feature extraction to basic computer vision algorithms. Through programme tasks, students are introduced to the ways in which image processing algorithms and computer vision work.
- Course description
  - Definitions, image types, discretisation, degradations in digital images. Image transformations: continuous Fourier transform, discrete Fourier transform, image pyramids, discrete wavelet transform. Colour perception and colour spaces. Image compression. Image interpolation. Image enhancement: point operations, linear filters, wavelet shrinkage, median filters, m-smoothers, morphological filters, nonlinear diffusion filtering, Discrete Variational Methods, Continuous Variational Methods, Fourier methods and deconvolution. Feature extraction: edges, edges in multichannel images and corners, contour representations and Hough transform. Texture analysis. Segmentation: classical methods, optimisation methods. Image sequence analysis: local methods, variational methods. 3-D reconstruction: camera geometry, stereo, shape-from-shading. Object recognition: invariants, eigenspace methods.

Image Processing and Computer Vision

- Graduate University Study Programme in Computer Engineering
    - Elective course for all modules
- Lectures: 45 h
- Labs: 30 h

- Course lecturers

  GALIĆ IRENA, Lecturer

  HABIJAN MARIJA, Associate

  LEVENTIĆ HRVOJE, Associate

Image Processing and Computer Vision

- Learning outcomes
  - Upon successful completion of the course, students will be able to:
    1. define and describe the concepts of image processing and computer vision
    2. describe the methods of image processing and computer vision
    3. apply the basics of image processing and computer vision and evaluate results
    4. analyse a practical problem of digital image processing
    5. use and customise the basic image processing and computer vision algorithms and interpret results
    6. interconnect acquired knowledge and apply methods for processing image and computer vision in open source applications and interpret results

Robot Vision

- Goals
  - Gain basic knowledge from the field of computer vision. Provide an insight into possibilities of application of computer vision for object recognition, robot manipulation and localisation of autonomous mobile systems. Make students understand the basic principles of modern computer vision methods, and teach them to apply these methods for solving technical problems, which require object recognition, robot manipulation and localisation of autonomous mobile systems. Learn how to develop computer programmes based on computer vision.
- Course description
  - Introduction to robot vision: basic terms, application of computer vision in robotics, examples. Image filtering. Edge and corner detection. Hough transform. Recognition of two- and three-dimensional objects. Camera model. Camera calibration. Stereo vision. Optical flow. Estimating camera pose relative to the operating environment of a robot. Multiple view of a three-dimensional object and scene reconstruction. Fusion of measurement data obtained by sensors of different types. Environment map building using data obtained by a vision system. Uncertainty of vision-based measurement. Application of computer vision methods for manipulation with objects in robotised production systems and navigation of mobile robots in their operating environments. 3D cameras. Segmentation of range images and 3D point clouds. Object recognition and pose estimation using a 3D camera.

Robot Vision

- Graduate University Study Programme in Computer Engineering
  - Elective course for all modules
- Lectures: 30 h
- Labs: 30 h

- Course lecturers

  CUPEC ROBERT, Lecturer

  NYARKO EMMANUEL-KARLO, Associate

Robot Vision

- Learning outcomes
  - Upon successful completion of the course, students will be able to:
    1. create a computer programme which uses the Hough transformation and RANSAC algorithm for solving computer vision problems
    2. create a computer programme for recognition of 2D and 3D objects in an image acquired by a standard and 3D camera
    3. to perform the calibration of a camera and a stereo camera system
    4. combine programme components for creating 3D models of objects and scenes from two or multiple images acquired by a standard and 3D camera into a computer application
    5. to explain how a mobile robot can localize itself in an operating environment using computer vision
    6. create a computer program which implements basic computer vision methods using appropriate program libraries for computer vision

Sonar computing

- Goals
  - Introduce students to the basics of sonar system design and skills to reconstruct the surface and image of underwater objects using the sonar signal. Introduce procedures for displaying signal spectrum, digital filtering of 1D and 2D sonar signals, creating 2D and 3D submarine images, designing an antenna or transceiver field, displaying antenna radiation, emitting and wave simulation, sonar image processing, and submarine mining in sonar images.
- Course description

  Mathematical models of underwater media for wave transmission. Diffusion simulation of wave transmission and sampling. Transformation of coordinates between coordinates of the environment, sonar and diver. Application of 3D computer models for simulation of underwater reconstruction. Computer models of hulls and naval ports. Simulation of hull reconstruction. Algorithms for creating 2D and 3D underwater images by changing the sonar system. Calculating linear field radiation graphs of underwater transmitters. Digital FIR filters for bandwidth limited signal. Filtering methods 1D and 2D sonar signals. Quadrature demodulation procedures. Methods of forming antenna air in the time and frequency domain. Calculate distance of objects in close and far field. View the environment using point clouds. The colouring of point clouds by intensity and distance. Orthographic projection of 3D clouds of points on a 2D image. Sonar for detecting underwater mines. Segmentation of objects in sonar images. Segmentation of underwater mine in sonar images.

Sonar computing

- Graduate University Study Programme in Computer Engineering
  - Elective course for all modules
- Lectures: 30 h
- Labs: 30 h

- Course lecturers

  ALEKSI IVAN, Lecturer

Sonar computing

- Learning outcomes
  - Upon successful completion of the course, students will be able to:
    1. define and explain the characteristics of the sonar and its environment
    2. describe methods of digital signal processing sonar
    3. create a software solution for creating images using sonar
    4. validate and compare different methods and sonar models
    5. develop and apply different methods and models of sonar in the MATLAB and C ++ programming environment