Machine vision in robotics and automation - course description

General information

Course name	Machine vision in robotics and automation
Course ID	11.9--AutD-MViRaA-Er
Faculty	Faculty of Computer Science, Electrical Engineering and Automatics
Field of study	Automatic Control and Robotics / Computer Control Systems
Education profile	academic
Level of studies	Second-cycle Erasmus programme
Beginning semester	winter term 2022/2023

Course information

Semester	2
ECTS credits to win	4
Course type	optional
Teaching language	english
Author of syllabus	• dr hab. inż. Bartłomiej Sulikowski, prof. UZ

Classes forms

The class form	Hours per semester (full-time)	Hours per week (full-time)	Hours per semester (part-time)	Hours per week (part-time)	Form of assignment
Laboratory	30	2	-	-	Credit with grade
Lecture	15	1	-	-	Credit with grade

Aim of the course

· Familiarize students with the successive stages of the vision system (from the acquisition process to the result of the classification algorithm)
· Develop the ability to use the vision system, configure its basic parameters and use information from the system in the robot control.

Prerequisites

Basics of Robotics, Digital Signal Processing, Decision Supporting Systems

Scope

Characteristics and architecture of the video system. Camera Configurations: "Eye in the hand" and "Eye off the hand". Basic parameters of the vision system. Potential applications. Challenges and problems. Integration of the vision system with executive devices (robots). Standard tasks (pick and place, quality control, etc).

Optics: lens construction, lens parameters: focal length, brightness, abberations, distortion, vignetting. Focusing methods. Depth of field.

Acquisition of images. Range of visible light, infrared and ultraviolet bands. Photosensitivity. Parameters of sensors (resolution, dimensions and proportions). CMOS, CCD and others sensors. RGGB filters (Beyer mesh). ISO sensitivity. Exposition.

Backlighting systems: "backlight", "light-field", "diffuse-light" (axial diffuse-light). Operating modes: continuous and triggered.

Image transmition standards and protocols.

Digital representation of the image. Image file formats: RAW, TIF and JPEG. Lossy and lossless representation. Color models: RGB, CMYK, HSV, xyz and others. Conversions between color models.

Image processing. Histogram operations (normalization, alignment, stretching). Noncontext operations: arithmetic, non-linear (gamma correction). Contextual operations (filtration): lowpass filters (averaging, smoothing), high pass (sharpening, directional, detecting edges), median filter. Application 2D Fourier transform in image processing.

Morphological operations. Erosion and dilation. Closing and opening. Hit Or Miss, Top-Hat, Bottom-Hat operations. Edge extraction. Skeletonization. Morphological operations for images in shades of gray.

Methods of object segmentation. Recall. Otsu algorithm.

Basics of extraction and selection of features of objects. Basic pattern recognition methods. Template matching method.

Calibration of the camera. Location and orientation of the camera in the robot base layout.

Control of the industrial manipulator using information from the video system.

Teaching methods

Lecture: conventional lecture, discussion

Laboratory: laboratory exercises

Learning outcomes and methods of theirs verification

Outcome description	Outcome symbols	Methods of verification	The class form
Student can perform basic operations related to image processing (from pre-processing to simple pattern recognition algorithm)		• activity during the classes • an evaluation test	• Lecture • Laboratory
Student is able to describe the impact of information coming out of the vision system on robot control		• an evaluation test	• Lecture
Student can configure and safely use a simple vision system		• an evaluation test • an observation and evaluation of activities during the classes	• Lecture • Laboratory
Student can characterize the vision system parameters		• an evaluation test	• Lecture • Laboratory
Student knows and understands the impact of camera settings on the acquisition process		• an evaluation test	• Lecture • Laboratory
Student can name and briefly characterize the successive stages of image processing		• an evaluation test	• Lecture

Assignment conditions

Lecture – the main condition to get a pass is a sufficient number of positive evaluations of written or oral tests conducted at least once per semester.

Laboratory - the condition for passing is at least 80% from all laboratory exercises and obtaining positive grades from tests verifying the knowledge and skills acquired during the exercises .

Calculation of the final grade: lecture 50% + project 50%

Recommended reading

1. P. I. Corke, Robotics, Vision and Control Fundamental Algorithms in MATLAB, Springer, 2019, www.petercorke.com (available online)

2. P. I. Corke, VISUAL CONTROL OF ROBOTS: High-Performance Visual Servoing,

3. B. K. P. Horn, Robot Vision, MIT Press, McGraw–Hill, 1986

4. R. C. Gonzales, P. Wintz, Digital Image Processing, Addison–Wesley, London, 1977.

Further reading

1. E.R. Davies, Machine Vision, Elsevier, 2005

2. D. H. Ballard, C. M. Brown, Computer Vision, Prentice–Hall, New York, 1982.

Notes

Modified by dr hab. inż. Wojciech Paszke, prof. UZ (last modification: 11-04-2022 09:05)