COURSE DESCRIPTION CARD - SYLLABUS

Course name
Intelligent Vision Systems

Course

Field of study
Automatic Control and Robotics

Year/Semester
1/1

Area of study (specialization)
Vision systems

Profile of study
general academic

Level of study
Second-cycle studies

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
15

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points

4

Lecturers

Responsible for the course/lecturer:
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Faculty of Control, Robotics and Electrical Engineering

Piotrowo 3A, 60-965 Poznan, Poland

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Faculty of Control, Robotics and Electrical Engineering

Piotrowo 3A, 60-965 Poznan, Poland

Prerequisites

Knowledge: A student starting this course should have knowledge of the basics of signal theory, signal processing and information.

Skills: He or she should have the ability to use basic methods of signal processing and analysis in the time and frequency domain, coding digital signals (compression, encryption and redundant coding), as well as the ability to obtain information from the indicated sources. He or she should also understand the need to expand their competences and be ready to work in a team.

Social Competences: In addition, a student should show such qualities as honesty, responsibility, perseverance, cognitive curiosity, creativity, personal culture, respect for other people.

Course objective

1. Provide students with knowledge about vision systems, their construction, design, applications and modernization.

2. Developing students' problem-solving skills related to the selection of appropriate signal processing techniques for specific vision systems.

Course-related learning outcomes

Knowledge

A student has:

1. specialist knowledge of remote and distributed systems, real-time systems and network techniques - [K2_W3]

2. detailed knowledge of the construction and use of advanced sensory systems - [K2_W6]

3. knowledge about development trends and the most important new achievements in the field of automation and robotics and related scientific disciplines - [K2_W12]

4. basic knowledge about the life cycle of automation and robotics systems as well as control and measurement systems - [K2_W13]

Skills

A student:

1. can analyze and interpret technical design documentation and use the scientific literature related to a given problem - [K2_U2]

2. can use advanced methods of signal processing and analysis, including video signal, and can extract information from the analyzed signals - [K2_U11]

3. is able to select and integrate the elements of a specialized measurement and control system, including: a control unit, an executive system, a measuring system and peripheral and communication modules - [K2_U13]

4. is able to evaluate the usefulness and the possibility of using new achievements (including techniques and technologies) in the field of automation and robotics - [K2_U16]

Social competences

He or she is is aware of the need for a professional approach to technical issues, scrupulous reading of the documentation and environmental conditions in which the devices and their components can function - [K2_K4]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Formative assessment:

a) in the field of lectures: based on answers to questions about the material discussed in previous lectures

b) in the field of laboratory classes: on the basis of the assessment of the current progress in the implementation of tasks.

Summative assessment:

a) in the field of lectures, verification of the assumed learning outcomes is carried out by:

i.assessment of the knowledge and skills demonstrated in the prepared presentation on a given topic and in the form of an oral test consisting in delivering and defending this presentation

ii. oral answers to specific, problem and cross-sectional questions asked,

b) in the field of laboratory classes, verification of the assumed learning outcomes is carried out by:

i. assessment of the student's preparation for individual laboratory classes and assessment of skills related to the implementation of laboratory exercises,

ii. evaluation of reports from performed laboratory exercises,

iii. grading scale: 0 ... 49% of possible points - unsatisfactory, 50 ... 59% - satisfactory, 60 ... 69% - satisfactory plus, 70 ... 79% - good, 80 ... 89% - good plus, 90 ... 100% - very good.

Obtaining additional points for activity during classes, in particular for:

i. discuss additional aspects of the issue,

ii. the effectiveness of applying the acquired knowledge while solving a given problem,

iii. the ability to cooperate as part of a team practically carrying out a detailed task in the laboratory,

iv. comments related to the improvement of teaching materials,

v. identifying students' perceptual difficulties, enabling the ongoing improvement of the teaching process.

Programme content

The lecture program includes the following topics:

1. Introduction to vision systems - definition of a vision system, construction of a vision system, data processing sequence, digital image representation, image processing, basic image correction algorithms, object detection and tracking.

2. Standards of industrial cameras - types of image sensors (CCD, CMOS, black and white, color, area, line); camera interfaces (Camera Link, FireWire, GigE, USB); special applications - high-speed cameras; selection of cameras, EMVA-1288 standard, objective comparison of cameras.

3. Vision systems in control - CCTV, characteristics, requirements; Vision Builder for Automated Inspection (National Instruments) as an example of an industrial vision system; intelligent cameras as autonomous systems - construction, selection, software, performance.

4. CCTV systems - definition of video monitoring, PN-EN 50132 standard, types and construction of CCTV systems, camera and image resolution, types of cameras, video recorders, transmission media, implementation of the environment model (panorama) from a video sequence from a PTZ motorized camera, automatic image analysis systems, hemispherical cameras.

5. Vision systems in technology and medicine - thermovision, theoretical foundations, possibilities and limitations, practical solutions; ultrasonic vision systems, theoretical basis, possibilities and limitations, sources of errors; ultrasound systems (ultrasound); OCT imaging systems (optical coherence tomography), theoretical foundations, possibilities and limitations, practical solutions.

6. Architectures of multimedia data transmission systems - analogue radio, digital radio, SDR (software defined radio); analog TV (terrestrial, satellite, cable), digital TV; analog telephony, analog modems, DSL (digital subscriber line) technology, cable modems, cable TV system architecture, digital telephony, ISDN, Video over IP, P2P.

7. DVB digital television systems - television system architecture, operation scheme in the transmitting and receiving system, transmitting stations, signal preparation, FEC (forward error correction), transport stream, multiplex, data compression, MPEG standard, H.264, scaling hierarchical, network (terrestrial, cable, satellite - DVBT, DVBS, DVBC, DVBH), transmitters, STB receivers (set-top-box), DSP graphics processors.

8. Multimedia transmission in mobile systems - mobile telephony, unicast 3G protocols, 4G LTE standard (long term evolution), MIMO systems, mobile video.

9. History of television

10. Digital TV services - interactive TV, stereovision.

11. Digital TV standards - SD, HD, DVB, ATSC; digital modulations - OFDM, SFN, MFN architecture.

12. Vision systems in medicine - USG, OCT, NMR, X-ray.

13. Review of audio compression methods - standards of coding and voice transmission in television systems, audio signal compression standards, lossless coding, lossy coding.

14. Video codecs - M-JPEG, MPEG-2, AVC / MPEG-4, H.264 / MPEG-4 part 10.

15. Summary, development trends in intelligent vision systems.

Laboratory classes are conducted in the form of 2-hour exercises. Exercises are carried out by 2-person teams. At the end of the class, each team submits a written report, which is assessed with a maximum of 10 points. On the basis of the sum of the points obtained from the reports, the student obtains a final grade: 3.0 - when he obtained at least 50% of the points possible, 3.5 - when he obtained at least 60% of the points, 4.0 - when he obtained at least 70% of the points 4.5 - when he obtained at least 80% of the points, 5.0 - when he obtained at least 90% of the points.

The program of laboratory classes includes the following issues:

1. Video sequence coding and decoding in MPEG-2 standard, which is widely used for recording compressed video signal. The exercise concerns: the principles of the encoder operation, types of frames in the video sequence, analysis of the selection of encoder parameters, the use of the VcDemo program.

2. Thermal imaging systems - blackbody thermal radiation, analysis of infrared images with the use of ThermaCAM Explorer computer program, thermal losses and overheating of elements.

3. Ultrasonic vision systems - calculation of the speed of sound in various media, ultrasonography - principle of operation, types of ultrasound probes, analysis of ultrasound images, operating modes of ultrasound devices, suppression of ultrasound waves in various centers, influence of wavelength, partial reflection of the wave.

4. Coding and decoding of video sequences, H.264 standard - the principle of operation of the H.264 encoder, frame types, relation between SNR and PSNR with the quality of the encoded image and the size of the data stream, subjective assessment of the quality of the coded sequences, the use of the VcDemo program.

5. Testing digital cameras - analysis of image quality obtained from various types of digital cameras. Basic parameters determining image quality from cameras. Use of the test board to test cameras.

6. Smart Camera, examples of applications - Smart Camera NI 1742 and Vision Builder software (National Instruments), creating programs to detect specific elements, simulation of industrial quality control systems.

7. Calibration and testing of the quality of the LCD monitor, use of the professional ColorMunki color calibrator, analysis of the obtained calibration results, color palettes displayed by the monitors.

Teaching methods

1. Lecture: multimedia presentation, presentation illustrated with examples given on the board, demonstration.

2. Laboratory classes: conducting experiments, practical exercises, discussion, team work.

Bibliography

Basic

1. Teaching materials on the website www.dsp.put.poznan.pl

2. R. Szeliski, Computer vision: algorithms and applications, Springer-Verlag, 2011.

2. M. Wysocki, T. Kapuściński, Systemy wizyjne, Uniwersytet Rzeszowski, 2013.

Additional

1. Forsyth, Ponce,Computer Vision: A Modern Approach, Prentice-Hall 2002

2. Gonzalez, Woods, Digital Image Processing, Addison-Wesley 2002

3. Domański M., Zaawansowane techniki kompresji obrazów i sekwencji wizyjnych, WPP, Poznań 2000

4. Minoli D., IP multicast with applications to IPTV and mobile DVB-H, John Wiley & Sons 2008

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,0
Classes requiring direct contact with the teacher	51	2,0
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	49	2,0

[1] delete or add other activities as appropriate