STUDY MODULE DESCRIPTION FORM

Name of the module/subject	Code
Vision based Control	**1010532131010559200**

Field of study	Profile of study (general academic, practical)	Year /Semester
Automatic Control and Robotics	**general academic**	**2 / 3**
Elective path/specialty	Subject offered in:	Course (compulsory, elective)
Smart Aerospace and Autonomous Systems	**Polish**	**elective**

Cycle of study:	Form of study (full-time,part-time)
Second-cycle studies	**full-time**

No. of hours					No. of credits
Lecture: **30**	Classes: **-**	Laboratory: **-**	Project/seminars: **45**		**4**

Status of the course in the study program (Basic, major, other)	(university-wide, from another field)
major	**from field**

Education areas and fields of science and art	ECTS distribution (number and %)

Responsible for subject / lecturer:

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Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	The student starting this module should have basic knowledge of linear algebra and digital signal processing.
2	**Skills**	He/she should have skills to solve basic problems related to using of sensory information in control and the ability to acquire information from given sources. The student should understand the necessity of extending his/her competences.
3	**Social competencies**	In addition, in respect to the social skills the student should represent such features as honesty, responsibility, perseverance, curiosity, creativity, manners, and respect for other people.

Assumptions and objectives of the course:

1. Provide students with knowledge of image processing and analysis techniques in the field of image pre-processing, segmentation, recognition and interpretation of visual information for use in control.
2. Provide students with knowledge of elements of machine vision systems, their structure and possible applications in robotics and automation.
3. Develop students' skills to select the appropriate image processing methods, depending on the given tasks and the ability to use visual feedback in the control.

Study outcomes and reference to the educational results for a field of study

Knowledge:

1. have knowledge on construction and use of machine vision systems, - [K_W6]
2. have wide and in-depth knowledge on vision measurement and control systems, - [K_W11]
3. have knowledge of the development trends and most crucial new achievements in the field of automatics and robotics and related disciplines, - [K_W12]
4. know and understand the methods of image processing and analysis techniques in the field of image pre-processing, segmentation, recognition and interpretation of visual information. - [-]

Skills:

1. is able to employ advanced methods of processing and analyzing images acquired from visual signals, and extract information from analyzed signals, - [K_U11]
2. is able to assess usefulness and possibility of employing new developments in the field of automatics and robotics (methods and tools), - [K_U16]
3. is able to evaluate usefulness of methods and tools for solving a robotics and automatics problem using knowledge on vision systems; is able to shape the properties of vision measurement systems. - [K_U22]

Social competencies:

1. is responsible for his/her own work, is able to collaborate and cooperate in a team, and take responsibility for the jointly performed tasks, - [K_K3]

2. is aware of the necessity to approach technical aspects professionally, to acquaint themselves in detail with documentation and environmental conditions in which devices and elements will operate, - [K_K4]

3. is aware of the complexity of the methods and algorithms of image processing and the necessity for an individual approach in solving the tasks and problems, particularly during the implementation of visual feedback. - [-]

Assessment methods of study outcomes

Formative assessment:

a) project:

on the basis of an assessment of the current progress of the project

evaluation of doing correctly assigned tasks (following provided lab. instructions),

Total assessment:

a) verification of assumed learning objectives related to lectures:

i. evaluation of acquired knowledge on the basis of the written exam in the test form,

ii. individual discussion on results of the exam,

b) verification of assumed learning objectives related to project:

i. evaluation of student?s knowledge and skills related to implementation of the project task,

ii. evaluation of report connected with presentation of the project.

Additional elements cover:

i. discussing additional aspects of the subject,

ii. the effectiveness of the application of the knowledge gained during solving the given problem,

iii. ability to work within a team,

iv. showing perceptual difficulty which allows current improvement of the teaching process.

Course description

The lecture should cover the following topics:

Applications of vision feedback in robotics and control tasks. The control based on the error in the task space and the image features space. The concept of a digital image, image representations, models of color spaces, transformations between models. Pre-processing and image correction techniques: point operations, histogram, brightness and contrast correction, image thresholding, LUTs for point operations. Context processing, image correlation, image filtering in spatial domain, nonlinear filtering, statistical filters. Morphological operations in image processing: erosion and dilation, complex operations and morphological image filters. Image processing using frequency methods, image filtering in the frequency domain, cosine transform in image compression. Some techniques for image segmentation. Basic methods of representation and analysis of shapes in images. Complex image recognition techniques, the SIFT algorithm. Camera model and camera calibration procedure. Characteristics of machine vision components and design of visual feedback. Industrial vision systems and smart cameras. Image acquisition techniques, tools for data acquisition and image processing.

Project lectures are carried out in the form of fifteen 3-hour meeting, which took place in the laboratory. Exercises are performed by two-person teams of students. During the course teams perform the selected project task. Project tasks include the following: calibration of cameras and video measuring system. Image acquisition, identification tags, a mobile robot localization. The use of visual information in the control of mobile robot and manipulator. The use of industrial vision system for the implementation of selected tasks in industrial process control.

Learning methods:

1. Lectures: multimedia presentation illustrated with examples using Matlab and other demonstration showing specific image processing methods and application of vision systems.

2. Project: teamwork solving project tasks.

Basic bibliography:

1. Gonzalez R.C., Woods R.E., Digital Image Processing, Prentice Hall, SE, 2002

2. B. Siciliano, O. Khatib (Eds.) Springer Handbook of Robotics, Springer-Verlag 2008

Additional bibliography:

1. Fu K.S., Gonzalez R.C., Lee C.S.G., ROBOTICS, Control, Sensing, Vision, and Intelligence, McGraw-Hill 1987

Result of average student's workload

Activity	Time (working hours)
1. participating in lectures	30
2. participating in project classes	45
3. preparing project final report	5
4. consulting issues related to the subject of the course	2
5. studying literature / learning aids	16
6. participating in exam	2

Student's workload		
Source of workload	**hours**	**ECTS**
Total workload	100	4
Contact hours	79	3
Practical activities	50	2