(*faculty stamp*)

COURSE DESCRIPTION

1. Course title: ROBOT VISION	**2. Course code**
3. Validity of course description: 2016/2017	
4. Level of studies: BSc programme	
5. Mode of studies: intramural studies	
6. Field of study: MACROCOURSE	(FACULTY SYMBOL)
7. Profile of studies: general	
8. Programme:	
9. Semester: 7	
10. Faculty teaching the course: Institute of Automatic Control, Rau1	
11. Course instructor: dr hab. inż. Henryk Palus, prof. Pol. Śl.	
12. Course classification: programme courses	
13. Course status: elective	
14. Language of instruction: English	
15. Pre-requisite qualifications: The subject complements a basic knowledge of image processing acquired by students in the subject of Computer Graphics and Vision, and directs it to problems of automation and robotics.	
16. Course objectives: The course aims to familiarize students with state of the art in the field of vision systems used in automation and robotics. As a result of the subject, students should be able to both design the vision system for a particular application, as well as to construct a suitable algorithm for it, implement it and perform the necessary tests. The laboratory exercises realized as part of the subject will help achieve these goals.	

17. Description of learning outcomes:

Nr	Learning outcomes description	Method of assessment	Teaching methods	Learning outcomes reference code
1.	He/She knows the tasks and structures of vision systems and their functional components.	Final test	Lecture	K_W09
2.	He/She knows the basic concepts of following devices: illuminators, image sensors, lenses and cameras, such as lighting uniformity, fill factor, lens transmission and system speed.	Final test	Lecture	K_W05 K_W07
3.	He/She has knowledge about robot vision algorithms.	Final test	Lecture	K_W09
4.	He/She can configure the vision system for its specific application.	Laboratory report	Lab.	K_U15
5.	He/She can choose appropriate methods and construct the vision algorithms for specific application.	Laboratory report	Lab.	K_07
6.	He/She can use popular programming environments (Matlab, OpenCV, C++, etc.) to implement the robot vision algorithms.	Laboratory report	Lab.	K_U15
7.	He/She is able to make his own decisions on the best algorithms.	Laboratory report	Lab.	K_U15
8.	He/She is able to present and defend the proposed algorithmic-programming solution.	Laboratory report	Lab.	K_U15

18. Teaching modes and hours

Lecture / BA /MA Seminar / Class / Project / Laboratory

Sem 7 Lecture -15 h., Laboratory - 30 h

19. Syllabus description:

Basic concept of sensor. Idea of smart sensor. Sensory system in the structure of robot. Robot-human analogy. Comparison of human and robot vision. Lighting systems (traditional lighting and LEDs). Ring illuminators. Structured lighting. Grid projectors and line generators. Examples of advanced lighting systems. Camera obscura. Pin-hole camera. Optical systems (lenses for cameras, filters). Properties of lenses (aperture, magnification, vignetting, depth of field, distortions and aberrations). Choice of lens from nomogram. Spectral characteristics of colour filters. Image sensors (linear and matrix, CCD and CMOS). Layouts of the photosites. CCD architectures. Frome black and white to colour. Colour wheel. Mosaic colour filters (Bayer filter). Microlenses. Fill factor for CMOS sensors. Comparison: CCD vs. CMOS. Foveon three-layer CMOS technology. Monochrome and color cameras. Multicamera systems. High-speed cameras (fps). Smart camera and its software. Webcams. 3CCD cameras. Multispectral cameras. Spectral sensitivites of colour camera. Special cameras (pill camera, HDR camera). Framegrabbers. Image processors. Look-up tables (LUT) and their applications for image processing. Camera interfaces (IEEE 1394, USB, CameraLink, Ethernet etc.). Image acquisition: noise and ISO. Dark current image. Interpolation artefacts (demosaicking). Human vision system: light receptors. Spectral characteristics of cones. Opponent colours. Defective colour vision: Ishihara tests. Colour matching system. Metameric pairs. Colour sensors. The colour and colour spaces. Discrete structure of RGB cube. Colorimetric and TV colour spaces. Munsell colour system. Simple colour image processing (swapping and negation). Colour image quantization (splitting and clustering methods). The problem of empty clusters. Calibration of colour vision systems. Segmentation of the image. Thresholding of the image. Region-based segmentation techniques. Features: moments of geometric shape factors, topological characteristics. Recognition of objects using models. Overview of sensory systems, vision applications in automation and robotics. Universal and specialized systems. Examples of real applications of robot vision systems.

20. Examination: end of semester …

21. Primary sources:

Corke P., Robotics, Vision and Control, Springer, Berlin 2011.
Szeliski R., Computer Vision: Algorithms and Applications, Springer, Berlin 2010.
Horn B.K.P., Robot Vision, The MIT Press, Cambridge 1986.
Niemann H., Pattern Analysis and Understanding, Springer, Berlin 1990.

22. Secondary sources:

Low A., Introductory Computer Vision and Image Processing, McGraw-Hill, London 1991.
Haralick R.M., Shapiro L.G., Computer & Robot Vision, vol.I, Addison-Wesley, Reading 1992.
Haralick R.M., Shapiro L.G., Computer & Robot Vision, vol.II, Addison-Wesley, Reading 1992.

23. Total workload required to achieve learning outcomes

Lp.	Teaching mode :	Contact hours / Student workload hours
1	Lecture	15/10
2	Classes	0/0
3	Laboratory	30/25
4	Project	0/0
5	BA/ MA Seminar	0/0
6	Other	0/0
	Total number of hours	45/35

24. Total hours: 80

25. Number of ECTS credits: 3

26. Number of ECTS credits allocated for contact hours: 1

27. Number of ECTS credits allocated for in-practice hours (laboratory classes, projects): 2

26. Comments:

Approved:

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(date, Instructor's signature)

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(*date , the Director of the Faculty Unit signature)*