|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Robotski vid | | | | | | | | | | | | | | |
| **Course title:** | | | Robot Vision | | | | | | | | | | | | | | |
|  | | | | |  | | | | | | | |  | |  | | |
| **Študijski program in stopnja**  **Study programme and level** | | | | | **Študijska smer**  **Study field** | | | | | | | | **Letnik**  **Academic year** | | **Semester**  **Semester** | | |
| Podiplomski magistrski študijski program druge stopnje Elektrotehnika | | | | | Robotika | | | | | | | | 1 | | 2 | | |
| 2nd cycle masters study programme in Electrical Engineering | | | | | Robotics | | | | | | | | 1 | | 2 | | |
|  | | | | | | | | | | | | | | | | | |
| **Vrsta predmeta / Course type** | | | | | | | | | | | | Obvezni-strokovni / Compulsory professional | | | | | |
|  | | | | | | | | | | | |  | | | | | |
| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64235 | | | | | |
|  | | | | | | | | | | | | | | | | | |
| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | | **Klinične vaje**  **work** | | | | **Druge oblike študija** | | | **Samost. delo**  **Individ. work** | |  | **ECTS** |
| **30** |  | | | **45** | | |  | | | |  | | | **75** | |  | **6** |
|  | | | | | | | | | | | | | | | | | |
| **Nosilec predmeta / Lecturer:** | | | | | Franjo Pernuš | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | |
| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | slovenski / Slovenian | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | | slovenski / Slovenian | | | | | | | | | | | |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** | | | | | | | | |  | **Prerequisits:** | | | | | | | |
| Vpis v letnik. | | | | | | | | |  | Enrolment in the year of the course. | | | | | | | |
| **Vsebina:** | | | | | | | |  | | **Content (Syllabus outline):** | | | | | | | |
| **Vizualno zaznavanje**: svetloba, človeški vid, kamere, svetila, parametri kakovosti, vzorčenje in kvantizacija, prikazovanje, slikovni formati in standardi.  **Obdelava in obnova digitalnih slik:** glajenje in ostrenje, statistično in morfološko filtriranje, prevzorčenje in podvzorčenje, geometrijske preslikave.  **Robustno iskanje 2D objektov:** točke, premice, oglišča, poligoni, krogi, elipse, predloge in neparametrični modeli.  **Kalibracije slikovnih sistemov:** geometrija, občutljivost, prostorska homogenost, časovna stabilnost, samodejna kalibracija.  **Rekonstrukcija 3D oblik:** stereo vid, strukturirana svetloba, oblika iz senc, prileganje 3D modelov na 2D slike.  **Vizualna navigacija:** sledenje, filtriranje in analiza gibanja, koncepti vizualnega povratno-zančnega vodenja robotov.  **Primeri uporabe robotskega vida:** vizualna kontrola kakovosti in sortiranje izdelkov, razpoznavanje objektov in ovir, modeliranje okolja in načrtovanje gibanja. | | | | | | | |  | | **Visual perception**: light, human vision, cameras, illumination, image quality, sampling and quantification, image formats and standards.  **Digital image processing and restoration**: smoothing and sharpening, statistical and morphological filtering, image resampling, geometrical transformations.  **Robust extraction of 2D objects**: points, lines, corners, polygons, circles, ellipses, templates and nonparametric models.  **Calibration of imaging systems**: geometry, sensitivity, spatial homogeneity, temporal stability, self-calibration.  **3D object reconstruction**: stereo vision, structured light, shape from shading, fitting 3D models to 2D images.  **Visual navigation**: tracking, filtration and motion analysis, visual feedback-based robot control.  **Applications of robot vision**: visual quality control, product sorting, object and obstacle detection, environment modelling, trajectory planning. | | | | | | | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. Wilhelm Burger in Mark J. Burge. Principles of Digital Image Processing: Fundamental Techniques, Springer, 2009. 2. Wilhelm Burger in Mark J. Burge. Principles of Digital Image Processing: Core Algorithms, Springer; 1st Edition. 2nd Printing, 2011. 3. Rafael C. Gonzales in Richard E. Woods. Digital Image Processing, Pearson; 3rd edition, 2007. 4. Richard Szeliski. Computer Vision: Algorithms and Applications, Springer; 2011 edition, 2010. 5. Navodila za vaje in ostala gradiva v spletni učilnici FE: <https://e.fe.uni-lj.si> in na spletni strani <http://lit.fe.uni-lj.si> | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| Spoznati tehnologije, naprave in postopke za vizualno robotsko zaznavanje, merjenje in razpoznavanje objektov ter navigacijo. | |  | | The objective of this course is to: introduce the main building blocks of a robot vision system and the fundamental associated problems; to introduce the main concepts and techniques used to solve those problems; to enable students to implement solutions for rather simple problems; to enable students to understand the basic methodology that is discussed in the robot vision literature. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Študenti bodo pridobili osnovna znanja o tehnologijah, gradnikih in sistemih z robotskim vidom ter osnovna znanja o postopkih za obdelavo in analizo slik, ki vključujejo postopke za detekcijo, prepoznavanje in meritve objektov v sceni ter za vodenje robotov na osnovi vida. | | |  | The students will obtain an overview of robot vision technologies and systems, basic building blocks of the systems, and basic image processing and analysis methods for the detection, recognition and measurement of objects in a scene, and for visual guidance of robots. | |
|  | | |  |  | |
| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| Teoretične osnove, postopke in primere uporabe študentje spoznajo na predavanjih, praktična znanja pa pridobijo z reševanjem nalog na laboratorijskih vajah. | | |  | Lectures, lab works and individual assignements. | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| Način: domače naloge, pisni izpit ustni izpit.  Ocene od 1 do vključno 5 so negativne, ocene od 6 do 10 so pozitivne.  Pozitivna ocena domačih nalog je pogoj za pristop k pisnemu izpitu. Pozitivna ocena pisnega izpita je pogoj za pristop k ustnemu izpitu.  Prispevki k oceni:   * domače naloge * pisni izpit * ustni izpit | 35%  35%  30% | | | | Type: homework, written and oral exam.  Negative grades: from 1 to 5, positive grades: from 6 to 10.  Positive evaluation of homework is a prerequisites for the written exam. Positive evaluation of the written exam is a prerequisites for the oral exam.  Contributions to the final grade:   * homework * written exam * oral exam |
| **Reference nosilca / Lecturer's references:** | | | | | |
| 1. ŠPICLIN, Žiga, LIKAR, Boštjan, PERNUŠ, Franjo. Groupwise registration of multi-modal images by an efficient joint entropy minimization scheme. IEEE Tr on Image Processing, 2012, vol. 21, no. 5, str. 2546-2558. 2. MOŽINA, Miha, TOMAŽEVIČ, Dejan, PERNUŠ, Franjo, LIKAR, Boštjan. Automated visual inspection of imprint quality of pharmaceutical tablets. Machine Vision and Applications, 2013, vol. 24, no. 1, str. 66-73. 3. BRATANIČ, Blaž, PERNUŠ, Franjo, LIKAR, Boštjan, TOMAŽEVIČ, Dejan. Real-time rotation estimation using histograms of oriented gradients. PLOS ONE, 2014, vol. 9, no. 3, str. e92137. 4. IBRAGIMOV, Bulat, LIKAR, Boštjan, PERNUŠ, Franjo, VRTOVEC, Tomaž. Shape representation for efficient landmark-based segmentation in 3D. IEEE Tr Medical Imaging, 2014, vol. 33, no. 4, str. 861-874. 5. GALIMZIANOVA, Alfiia, PERNUŠ, Franjo, LIKAR, Boštjan, ŠPICLIN, Žiga. Robust estimation of unbalanced mixture models on samples with outliers. IEEE Tr Pattern Analysis and Machine Intelligence, 2015, vol. 37, no. 11, str. 2273-2285. | | | | | |