UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Računalniški vid
Course title:	Computer Vision

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Senzorske tehnologije, 3. stopnja	/	1	1
Sensor Technologies, 3rd cycle	/	1	1

Vrsta predmeta / Course type	Izbirni / Elective
Univerzitetna koda predmeta / University course code:	ST3-554

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
15	15			15	105	**5**

**Navedena porazdelitev ur velja, če je vpisanih vsaj 15 študentov. Drugače se obseg izvedbe kontaktnih ur sorazmerno zmanjša in prenese v samostojno delo. / This distribution of hours is valid if at least 15 students are enrolled. Otherwise the contact hours are linearly reduced and transfered to individual work.*

Nosilec predmeta / Lecturer:	Prof. dr. Aleš Ude

Jeziki / Languages:	**Predavanja / Lectures:**	Slovenski ali angleški / Slovene or English
	Vaje / Tutorial:	Slovenski ali angleški / Slovene or English

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Zaključen študij druge stopnje ustrezne (naravoslovne ali tehniške) smeri ali zaključen študij drugih smeri z dokazanim poznavanjem osnov področja predmeta (pisna dokazila, pogovor).	Completed second cycle studies in natural sciences or engineering or completed second cycle studies in other fields with proven knowledge of fundamentals in the field of this course (certificates, interview).

Vsebina:	**Content (Syllabus outline):**
Uvod • Pregled predmeta. • Praktična uporaba računalniškega vida. • Uvod v Matlab. Nastanek slike • Fotometrični modeli in optika. • Človeški vid. • Kalibracija kamer. • Projektivna geometrija in invariante. Obdelava dvodimenzionalnih slik • Zajemanje in predstavitev digitalnih slik. • Digitalni filtri in detekcija robov.	Introduction • Introduction to computer vision. • Practical applications of computer vision. • Introduction to Matlab. Image formation • Photometrical models and optics. • Human vision. • Camera calibration. • Projective geometry and invariances. 2-D image processing • Acqusition and representation of digital images. • Digital filters and edge detection.

- Segmentacija slik in predstavitev regij.
- Morfologija.
- Barva in histogrami.
- Ujemanje šablon.
- Aplikacija: prilagajanje kontrasta.

Tridimenzionalni vid
- Stereo slike; kalibracija, problem korespondence, trianglucija.
- Globinske slike.
- Rekonstrukcija geometrijskih modelov.
- Aplikacija: modeliranje kulturne dediščine.

Detekcija gibanja in zasledovanje
- Optični tok.
- Aproksimacija gibanja.
- Zasledovanje objektov in Kalmanov filter.
- Navigacija.
- Aplikacija: zasledovanje glave človeka.

Razpoznavanje objektov
- Problemi in mehanizmi za razpoznavanje objektov.
- Razpoznavanje iz množice pogledov.
- Generacija hipotez in verifikacija.
- Razpoznavanje po delih.
- Aplikacija: razpoznavanje obrazov.

- Image segmentation and region detection.
- Morphology.
- Color and histogramms.
- Pattern matching.
- Application: Contrast adjustment.

3-D computer vision
- Stereo vision; calibration, correspondence problem and triangulation.
- Range images.
- Reconstruction of geommetrical models.
- Application: modeling cultural heritage.

Motion detection and tracking
- Optical flow.
- Motion approximation.
- Object tracking and Kalman filter.
- Navigation.
- Aplication: human head tracking.

Object recognition
- Issues in object recognition and computational mechanisms.
- View-based approaches.
- Hypotheses generation and verification.
- Recognition by parts.
- Application: face recognition.

Temeljni literatura in viri / Readings:

Knjige / Books:
- R. Szeliski, Computer Vision; Algorithms and Applications, Springer, London, Dordrecht, Heidelberg, New York, 2010.
- P. Cork, Robotics, Vision and Control, Springer-Verlag, Berlin, Heidelberg, 2011.

Revije / Periodicals:
- IEEE Transactions of Pattern Analysis and Machine Intelligence.
- International Journal of Computer Vision.

Cilji in kompetence:

Cilji:
Študent je zmožen ovrednotiti svojo izbiro metod za pridobivanje informacij iz digitalnih slik. Svojo izbiro utemeljuje na podlagi teoretičnih izhodišč in izkušenj, ki jih je pridobil s praktičnim delom. Pri vrednotenju izhaja iz primerjave začetnih zahtev ter končnih značilnosti naloge oziroma lastnosti realiziranega sistema.

Objectives and competences:

Objectives:
The student is able to assess problems and chose appropriate methods to acquire information from digital images. He can justify his choice based on his theoretical knowledge and experience gained by practical work. His choice of methods is based on requirements of the practical problem and design properties of the technical system to be implemented.

Kompetence:	Competences:
• Zna oceniti, ali so metode računalniškega vida primerne za reševanje nekega konkretnega problema. • V primerih iz prakse razume funkcionalno vlogo in pomen izbranih metod za obdelavo slik. • Obravnavane metode zna samostojno aplicirati na probleme iz prakse. • Zna implementirati in praktično preizkusiti algoritme za reševanje problemov, kot so razpoznavanje in zasledovanje objektov. • Pri reševanju novih problemov zna samostojno poiskati primerne metode iz literature.	• Assessing if computer vision methods can be used to solve a given technical problem. • Understanding the functionality of different computer vision methods in practical problems. • The ability to independently apply appropriate methods to practical problems. • The ability to implement and practically test different algorithms for problems like object recognition and tracking. • Knowing how to find appropriate methods in the literature when faced with a new problem.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: • Poznavanje osnovnih problemov računalniškega vida in metod, ki se uporabljajo pri njihovem reševanju. • Razumevanje nastanka digitalnih slik in fizikalnih modelov, s katerimi lahko modeliramo ta proces. • Razumevanje teoretičnih osnov metod, ki se uporabljajo v računalniškem vidu. • Implementacija metod za obdelavo digitalnih slik.	Knowledge and understanding: • Knowing basic problems of computer vision and methods which are used to solve them. • Understanding the process of acquiring digital images and physical models which can be applied to model this process. • Understanding theoretical underpinnings of methods used in computer vision. • Implementation of methods for digital image processing.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Interaktivno delo s študentom v okviru predavanj in seminarske naloge z namenom prepoznavanja struktur in vzorcev znanja in usmerjanega reševanja realnih problemov.	Interactive work with a student in the frame of lectures and seminar work, aiming at recognition of knowledge structures and patterns, and supervised solving of real problems.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Seminarska naloga s predstavitvijo in zagovorom rešitve izbranega problema iz študentovega raziskovalnega dela.	60 %	Seminar work with presentation and defence of the proposed solution for the selected problem from student's research work.
Ustni izpit.	40 %	Oral exam.

Reference nosilca / Lecturer's references:

- D. Schiebener, J. Morimoto, T. Asfour and A. Ude (2013) Integrating visual perception and manipulation for autonomous learning of object representations, Adaptive Behavior, vol. 21, no. 5, pp. 328-345.
- A. Ude, D. Schiebener, N. Sugimoto, and J. Morimoto (2012) Integrating surface-based hypotheses and manipulation for autonomous segmentation and learning of object representations, IEEE International Conference on Robotics and Automation (ICRA), Saint Paul, Minnesota, pp. 1709-1715 (pdf file). Finalist for Best Cognitive Robotics Paper award.

- D. Omrčen and A. Ude (2010) Redundancy control of a humanoid head for foveation and three-dimensional object tracking: A virtual mechanism approach, Advanced Robotics, vol. 24, no. 15, pp. 2171-2197.
- A. Ude, D. Omrčen, and G. Cheng (2008) Making object learning and recognition an active process, International Journal of Humanoid Robotics, vol. 5, no. 2, pp. 267-286.