

NAPREDNI SENZORSKI SISTEMI IN OMREŽJA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Napredni senzorski sistemi in omrežja
Course title:	Advanced Sensory Systems and Networks
Članica nosilka/UL Member:	UL FS

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Strojništvo - Razvojno raziskovalni program, druga stopnja, magistrski	Mehatronika in laserska tehnika (smer)	2. letnik	1. semester	obvezni

Univerzitetna koda predmeta/University course code:	0566822
Koda učne enote na članici/UL Member course code:	6062-M

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
30		30			65	5

Nosilec predmeta/Lecturer:	prof. dr. Primož Podržaj
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Izvajalci predavanj:	
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	Obvezni strokovni predmet na smeri Mehatronika in laserska tehnika, ki je izbirni strokovni predmet na ostalih smereh./Compulsory specialised course in the study of Mechatronics and laser technology, which is an elective specialised course in other fields of study.
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Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

Izpolnjevanje pogojev za vpis v Magistrski študijski program II. stopnje Strojništvo - Razvojno raziskovalni program.	Meeting the enrollment conditions for the Master's study programme of Mechanical Engineering - Research and Development program.
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Vsebina:

Content (Syllabus outline):

1. Predavanje: Osnove računalniške obdelave slik - Slika kot matrika - Zapis slike v računalniku - Barvna, črno-bela slika - Barvni prostori in pretvorbe med njimi 2. Predavanje: Točkovne operacije nad slikami - Linearne in nelinearne operacije - Histogram 3. Predavanje: Večtočkovne operacije nad slikami - Korelacija - Detekcija robov - Ostrenje slik 4. Predavanje: Naprednejši algoritmi - Razširjanje, krčenje - BLOB analiza 5. Predavanje: Strojni vid - Segmentacija - Značilnice - Sledenje 6. Predavanje: Uporaba Python-a za namene strojnega vida - Pregled najpomembnejših knjižnic - Praktični primeri 7. Predavanje: Nekonvencionalni senzorji - MEMS - Mikrosenzorji - Pametni senzorji in pametni senzorski sistemi 8. Predavanje: Mehka logika - Osnove mehkih množic - Mehko sklepanje - Krmiljenje na osnovi mehke logike 9. Predavanje: Nevronske mreže - Osnovni tipi nevronske mreže - Učenje nevronske mreže - Uporaba nevronske mreže 10. Predavanje: Fuzija senzorjev - Tipi fuzije - Aplikacije - Praktični pristopi 11. Predavanje: Internet - Delovanje - DNS - Usmerjanje z vektorjem razdalj - Usmerjanje s stanjem povezav 12. Predavanje: Spletno programiranje - Okolje Node.js, jezik JavaScript 13. Predavanje: Strežniki - Postavitev strežnika - Branje in pisanje na strežnik 14. Predavanje: Varnost - Enkripcija - Napadi na strani strežnika - Napadi na strani klienta - SQL vstavljanje - Pisanje skozi spletišče 15. Predavanje: Programiranje IoT aplikacij - Senzorski del (oddaljeni zajem)	1. Lecture: The basics of digital image processing - Image as a matrix - Image representation in a computer - Color, black and white image - Color spaces and transformations between them 2. Lecture: Point processing - Linear and nonlinear operations - Histogram 3. Lecture: Neighbourhood processing - Correlation - Edge detection - Image sharpening 4. Lecture: Advanced algorithms - Dilation, erosion - BLOB analysis 5. Lecture: Machine vision - Segmentation - Features - Tracking 6. Lecture: Application of Python for machine vision - Overview of the most important libraries - Applications 7. Lecture: Nonconventional sensors - MEMS - Microsensors - Smart sensors and smart sensory systems 8. Lecture: Fuzzy logic - The basics of fuzzy sets - Soft inference - Fuzzy logic based control 9. Lecture: Neural networks - The basic types of neural networks - Neural network learning - Application of neural networks 10. Lecture: Sensor fusion - Types of fusion - Applications - Practical approaches 11. Lecture: Internet - Functioning - DNS - Distance vector routing - Link-state routing 12. Lecture: Internet programming - Node.js environment, JavaScript programming language 13. Lecture: Servers - Server setup - Reading from and writing on a server 14. Lecture: Security - Encryption - Attacks on the server side - Attacks on the client side - SQL injection - Cross-site scripting 15. Lecture: Programming of IoT applications - Sensor part (remote acquisition)
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- Aktuatorski del (oddaljeno vodenje) - Razvoj IoT krmilne aplikacije na izbrani platformi	- Actuator part (remote control) - Development of IoT control application on the selected platform
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Temeljna literatura in viri/Readings:

1. Peter Corke: Robotics, vision and control : fundamental algorithms in MATLAB, Springer, [COBISS.SI-ID [15787291](#)]
2. Ali Zilouchian: Intelligent Control Systems Using Soft Computing Methodologies, CRC Press, 2001, [COBISS.SI-ID [4805659](#)]
3. Martin T. Hagan, Howard B. Demuth, Mark Hudson Beale: Neural network design, 1995, [COBISS.SI-ID [10855707](#)]
4. Andrew Tanenbaum: Computer networks - 4th edition. Prentice Hall, 2008, [COBISS.SI-ID [11023131](#)]

Cilji in kompetence:

Cilji:

1. Razviti sposobnost snovanja naprednih senzorskih sistemov in omrežij.
2. Razviti sposobnost prenosa teoretično pridobljenega znanja na realne sisteme.
3. Razviti sposobnost uporabe različnih programskih paketov in jezikov povezanih z naprednimi senzorskimi sistemi in omrežji.

Kompetence:

1. S2-MAG: Širitev sposobnosti kritičnega, analitičnega in sintetičnega mišljenja na področju naprednih senzorskih sistemov.
2. S7-MAG: Usposobljenost za uporabo pridobljenih znanj pri samostojnem reševanju tehničnih problemov na področju naprednih senzorskih sistemov in omrežij.
3. P3-MAG: Široka usposobljenost na področju naprednih senzorskih sistemov in omrežij, ki omogoča nadaljevanje študija na doktorskem študijskem programu.
4. P6-MAG: Sposobnost samostojnega razvoja naprednih senzorskih sistemov in omrežij.
5. P7-MAG: Na osnovi analize in sinteze razvita sposobnost iskanja optimalnih rešitev na področju naprednih senzorskih sistemov.

Objectives and competences:

Objectives:

1. Develop the capability of designing of advanced sensory systems and networks.
2. Develop the capability to transfer the theoretical knowledge to real systems.
3. Develop the capability to use various software packages and programming languages related to advanced sensory systems and networks.

Competences:

1. S2-MAG: Improved capability of critical, analytical and synthetical thinking in the field of advanced sensorial systems.
2. S7-MAG: The qualification to use the attained knowledge to autonomously solve technical problems in the field of advanced sensory systems and networks.
3. P3-MAG: A broad qualification in the field of advanced sensory systems and networks as a prerequisite for continuing the study on the doctoral study program.
4. P6-MAG: The ability to autonomously develop advanced sensory systems and networks.
5. P7-MAG: The ability to find optimal advanced sensory system and network solutions based on analysis and synthesis.

Predvideni študijski rezultati:

Znanja:

Intended learning outcomes:

Knowledge:

Z1: Poglobljeno teoretično, metodološko in analitično poznavanje naprednih senzorskih sistemov in omrežij. Spretnosti: S2.1: Obvladovanje zelo zahtevnih, kompleksnih matematičnih postopkov povezanih z naprednimi senzorskimi sistemi in omrežji. S2.3: Sposobnost izvirnih dognanj na področju naprednih senzorskih sistemov in omrežij.	Z1: Deeper theoretical, methodological and analytical knowledge of advanced sensory system and networks. Skills: S2.1: Mastering very demanding and complex mathematical procedures for advanced sensory systems and networks.. S2.3: Ability of unique innovations in the field of advanced sensory systems and networks.
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Metode poučevanja in učenja:

Learning and teaching methods:

P1 Avditorna predavanja z reševanjem izbranih - za področje značilnih - teoretičnih in praktično uporabnih primerov. P2 Obravnava snovi po urejeni in vnaprej razloženi sistematiki. P4 Laboratorijske vaje z namenski didaktičnimi pripomočki kot so osebni računalnik ali računalnik Raspberry Pi in različnimi programskimi jeziki.	P1 Auditorial lectures with solving selected field-specific theoretical and applied use cases. P2 Presenting the content according to the explained systematics. P4 Laboratory exercises with special-purpose didactic devices (PC or Raspberry Pi computer with various programming languages).
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Načini ocenjevanja:

Delež/Weight

Assessment:

Pisni izpit.	50,00 %	Written examination.
Ustno izpraševanje.	30,00 %	Oral examination.
Projekt.	20,00 %	Project.

Ocenjevalna lestvica:

Grading system:

5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10	5 - 10, a student passes the exam if he is graded from 6 to 10
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Reference nosilca/Lecturer's references:

Primož Podržaj:

- ROŽMAN, Nejc, CORN, Marko, KOZJEK, Dominik, VRABIČ, Rok, **PODRŽAJ, Primož**. Autonomous production unit: an architecture for blockchain-based shared manufacturing. Robotics and computer-integrated manufacturing. Dec. 2025, vol. 96, [article no.] 103035, str. 1-19, ilustr. ISSN 0736-5845. <https://www.sciencedirect.com/science/article/pii/S0736584525000894>, Repozitorij Univerze v Ljubljani – RUL, DOI: 10.1016/j.rcim.2025.103035. [COBISS.SI-ID [236982787](#)].
- BERLEC, Tomaž, CORN, Marko, VARLJEN, Sergej, **PODRŽAJ, Primož**. Exploring decentralized warehouse management using large language models : a proof of concept. Applied sciences. 2025, vol. 15, iss. 10, [art. no.] 5734, str. 1-35, ilustr. ISSN 2076-3417. <https://www.mdpi.com/2076-3417/15/10/5734>, Repozitorij Univerze v Ljubljani – RUL, DOI: 10.3390/app15105734. [COBISS.SI-ID [237539331](#)].
- MIHEVC, Andrej, **PODRŽAJ, Primož**. Analyzing the elbow method in predicting the optimal number of clusters in electronic communications dataset. V: 2025 24th International Symposium INFOTEH-JAHORINA (INFOTEH) : March 19-21, 2025 : Jahorina, East Sarajevo, Republic of Srpska, Bosnia and Herzegovina : proceedings. Danvers (MA): IEEE, cop. 2025. 7 str., ilustr. International Symposium on INFOTEH-JAHORINA (Online). ISBN 979-8-3315-1579-9. ISSN 2767-

9470. <https://ieeexplore.ieee.org/document/10959278>, DOI: 10.1109/INFOTEH64129.2025.10959278. [COBISS.SI-ID [237545987](#)].

4. MONTERO MARTÍN, Javier, **PODRŽAJ, Primož**, POŽRL, Tomaž. Basic implementation of a speed-limit traffic-sign recognition algorithm via PyTesseract. V: 2024 International Conference on Emerging Trends in Networks and Computer Communications (ETNCC) : 23-25 July 2024 High-Tech Transfer Plaza Select (HTTPS) NUST Lower Campus, Namibia : proceedings of ETNCC'24. International Conference on Emerging Trends in Networks and Computer Communications (ETNCC), 23-25 July 2024 High-Tech Transfer Plaza Select (HTTPS) NUST Lower Campus, Namibia. [S. l.]: IEEE, cop. 2024. Str. 279-284, ilustr. ISBN 979-8-3503-5326-6. <https://ieeexplore.ieee.org/document/10767545>, DOI: 10.1109/ETNCC63262.2024.10767545. [COBISS.SI-ID [237474307](#)].
5. **PODRŽAJ, Primož**, POŽRL, Tomaž, JENKO, Marjan, SELAK, Luka, ŠKULJ, Gašper, RIHAR, Lidija, VRABIČ, Rok, BRAČUN, Drago, BERLEC, Tomaž, KOZJEK, Dominik. The applicability of Arduino microcontroller with a LoRa shield as an element in IoT. V: WYLD, David C. (ur.), NAGAMALAI, Dhinakaran (ur.). 11th International Conference on Signal Image Processing and Multimedia : SIPM 2023 : May 27 ~ 28, 2023, Vancouver, Canada. [Chennai]: AIRCC, 2023. Vol. 13, nr. 9, str. [21]-31, ilustr. Computer science and information technology, vol. 13, nr. 9. ISBN 978-1-925953-95-4. ISSN 2231-5403. <https://aircconline.com/csit/papers/vol13/csit130903.pdf>. [COBISS.SI-ID [154249987](#)].