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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Napredne metode vodenja avtonomnih sistemov | | | | | | | | | | | | | | |
| **Course title:** | | | Advanced control of autonomous systems | | | | | | | | | | | | | | |
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| **Študijski program in stopnja**  **Study programme and level** | | | | | **Študijska smer**  **Study field** | | | | | | | | **Letnik**  **Academic year** | | **Semester**  **Semester** | | |
| doktorski študijski program tretje stopnje Elektrotehnika | | | | | Ni smeri | | | | | | | | 1 | |  | | |
| 3rd cycle: doctoral study programme Electrical Engineering | | | | |  | | | | | | | | **1** | |  | | |
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| **Vrsta predmeta / Course type** | | | | | | | | | | | | Izbirni /Elective | | | | | |
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| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64836 | | | | | |
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| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | | **Klinične vaje**  **work** | | | | **Druge oblike študija** | | | **Samost. delo**  **Individ. work** | |  | **ECTS** |
| **30** | **45** | | |  | | |  | | | |  | | | **50** | |  | **5** |
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| **Nosilec predmeta / Lecturer:** | | | | | izr. prof. dr. Gregor Klančar | | | | | | | | | | | | |
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| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | **Slovenski/slovene (**v primeru večjega števila tujih študentov angleški**)** | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | | **Slovenski/slovene (**v primeru večjega števila tujih študentov angleški**)** | | | | | | | | | | | |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** | | | | | | | | |  | **Prerequisits:** | | | | | | | |
| Skladno s pogoji za vpis. | | | | | | | | |  | In accordance with the terms and conditions for subscription. | | | | | | | |
| **Vsebina:** | | | | | | | |  | | **Content (Syllabus outline):** | | | | | | | |
| * Uvod v avtonomne sisteme – mobilni sistemi, brezpilotne letalne naprave, vesoljska plovila * Metode za lokalizacijo in kartiranje, hkratna lokalizacija in kartiranje (angl. kratica SLAM), razširjeni Kalmanov filter in sekvenčne naključne metode ocenjevanja (angl. particle filter) položaja, orientacije in značilk okolja * Vodenje na najvišjem nivoju – strategije vodenja večagentnih sistemov * Načrtovanje poti – princip optimalnosti, optimizacija poti z omejitvami (izogibanje oviram, neholonomnost, dinamične omejitve, omejitve aktuatorjev), tirnice umetnih satelitov * Optimalno vodenje ob upoštevanju motenj * Metode načrtovanja robustnega vodenja v frekvenčnem prostoru * Vodenje avtonomnih sistemov po predpisani poti * Vodenje avtonomnih sistemov s končno definiranim ciljem * Adaptivno vodenje avtonomnih sistemov * Vodenje avtonomnih sistemov z reševanjem linearnih matričnih neenačb | | | | | | | |  | | - Introduction to autonomous systems – mobile systems, unmanned aerial vehicles, space crafts  - Methods for localisation and mapping, simultaneous localisation and mapping, extended Kalman filter, position, orientation and feature estimation methods - particle filter  - Higher level control – strategies of multi-agent systems control  - Path planning – the principle of optimality, path optimisation with constraints (obstacle avoiding, nonholonomity, dynamic constraints, actuator constraints), satellite orbits  - Optimal control in the presence of disturbances  - Frequency domain robust control design methods  - Trajectory tracking control of autonomous systems  - Control of autonomous systems to the final state  - Adaptive control of autonomous systems  - Matrix inequality control of autonomous systems | | | | | | | |
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| **Temeljni literatura in viri / Readings:** | | | | | |
| Gregory Dudek, Michael Jenkin: Computational Principles of Mobile Robotics, Cambridge University Press, New York, 2010.  Howie Choset, Kevin M. Lynch, Seth Hutchinson, George A. Kantor, Wolfram Burgard, Lydia E. Kavraki, Sebastian Thrun, Principles of Robot Motion: Theory, Algorithms, and Implementations (Intelligent Robotics and Autonomous Agents series), MIT Press, Cambridge, 2005.  Sebastian Thrun, Wolfram Burgard, Dieter Fox: Probabilistic Robotics (Intelligent Robotics and Autonomous Agents series), MIT Press, Cambridge, 2006.  Michael Wooldridge: An Introduction to MultiAgent Systems, Second Edition, John Wiley & Sons, Chichester, England, 2009.  J. Andrade-Cetto, A. Sanfeliu, Environment Learning for Indoor Mobile Robots, Springer, 2006.  G. Balas, R. Chiang, A. Packard, M. Safonov, Robust Control Toolbox 3, User’s Guide, MathWorks, 2008  K. J. Åström, B. Wittenmark, Adaptive Control, Second Edition, Addison-Wesley Publishing Company, Inc., Reading, 1995. | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| * predstaviti problematiko vodenja avtonomnih sistemov * predstaviti metode za lokalizacijo in kartiranje * predstaviti problematiko vodenja na višjih nivojih * predstaviti problematiko optimalnega in adaptivnega vodenja avtonomnih sistemov * predstaviti orodja za robustno vodenje avtonomnih sistemov | |  | | * to present problems of autonomous systems control * to present methods of localisation and mapping * to present problems of higher level control * to present problems of optimal and adaptive control of autonomous systems * - to present the tools for robust control of autonomous systems | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| * osnovna znanja iz področja avtonomnih mobilnih sistemov in večagentnih sistemov * napredni pristopi pri vodenju avtonomnih sistemih * uporaba osvojenih znanj pri projektnem delu | | |  | * basic knowledge from autonomous mobile systems and multiagent systems * advanced approaches in autonomous system control * use of obtained knowledge at project work | |
|  | | |  |  | |
| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| Predavanja, seminarsko delo. | | |  | Lectures, Seminar work. | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| **Seminar**  **Ustni izpit** | **70%**  **30%** | | | | **Seminar**  **Oral exam** |
| **Reference nosilca / Lecturer's references:** | | | | | |
| •Klančar G, Teslić L, Škrjanc I (2013) Mobile-robot pose estimation and environment mapping using an extended Kalman filter. International Journal of Systems Science 45(12):2603-2618  •Blažič S, Matko D, Rodič T, Dovžan D, Mušič, G, Klančar G (2013) The design of observers for formation-flying control. Acta Astronautica 82( 1):60–68  •Klančar G, Blažič, S, Matko D, Mušič G (2012) Image-based attitude control of a remote sensing satellite. *Journal of intelligent & robotic systems*. 66(3):343-357  •Klančar G, Matko D, Blažič S (2011) A Control Strategy for Platoons of Differential-Drive Wheeled Mobile Robot. Robotics and Autonomous Systems 59( 2):57-64  •Klančar G, Škrjanc I (2007) Tracking-error model-based predictive control for mobile robots in real time. Robotics and Autonomous Systems 55(6):460-469 | | | | | |