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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Modul C: Roboti v stiku s človekom | | | | | | | | | | | | | | |
| **Course title:** | | | Module C: Robot-Human Interaction | | | | | | | | | | | | | | |
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| **Študijski program in stopnja**  **Study programme and level** | | | | | **Študijska smer**  **Study field** | | | | | | | | **Letnik**  **Academic year** | | **Semester**  **Semester** | | |
| Podiplomski magistrski študijski program druge stopnje Elektrotehnika | | | | | Vse smeri | | | | | | | | 1 | | 2 | | |
| 2nd cycle masters study programme in Electrical Engineering | | | | | All study fields | | | | | | | | 1 | | 2 | | |
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| **Vrsta predmeta / Course type** | | | | | | | | | | | | Izbirni-strokovni /elective professional | | | | | |
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| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64262 | | | | | |
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| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | | **Klinične vaje**  **work** | | | | **Druge oblike študija** | | | **Samost. delo**  **Individ. work** | |  | **ECTS** |
| 30 |  | | | 45 | | |  | | | |  | | | 75 | |  | 6 |
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| **Nosilec predmeta / Lecturer:** | | | | | Matjaž Mihelj, Aleš Ude | | | | | | | | | | | | |
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| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | angleški / English | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | | angleški / English | | | | | | | | | | | |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** | | | | | | | | |  | **Prerequisits:** | | | | | | | |
| Vpis v letnik predmeta | | | | | | | | |  | Enrolment in the year of the course | | | | | | | |
| **Vsebina:** | | | | | | | |  | | **Content (Syllabus outline):** | | | | | | | |
| Vsebina predmeta je razdeljena v sledeče podsklope: 1) Problem in načini interakcije robota s človekom; 2) Človeški dejavnik: zaznavne in motorične sposobnosti, socialni vidiki interakcije z robotom, varnost; 3) Haptični roboti: kinematika, dinamika, zaznavanje dotika, modeliranje reakcijske sile, vodenje in stabilnost haptičnih robotov; 4) Teleoperacijski sistemi: zgradba teleoperacijskega sistema, skaliranje položajev in sil, vodenje teleoperacijskega sistema in virtualne omejitve; 5) Roboti z aktuatorsji s spremenljivo impedanco; 6) Medicinska robotika: kirurška robotika, robotsko podprta diagnostika, mikroroboti v človeškem telesu, nanorobotika na nivoju celic; 7) Rehabilitacijska robotika: motorična rehabilitacija spodnjih in zgornjih okončin, navidezna resničnost v rehabilitaciji, eksoskeletni roboti, robotska protetika, mobilne robotske platforme | | | | | | | |  | | The entire content is divided into the following topics: 1) Definition of human-robot interaction problem; 2) Human factors: perception, motor skills, social aspect of interaction, safety; 3) Haptic robots: kinematics, dynamics, collision detection, collision force rendering, control and stability analysis; 4) Teleoperation systems: architectures, force and position scaling, control, virtual fixtures, micro/nano manipulation; 5) Soft robots based on variable impedance actuators; 6) Medical robotics: surgical robotics, robot-supported diagnostics, micro-robots in the human body, nanorobots at the cell level; 7) Rehabilitation and assistive robotics: motor rehabilitation, exoskeletons, robotic prosthetics. | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. MIHELJ, Matjaž, PODOBNIK, Janez. Haptics for virtual reality and teleoperation, Springer, 2012. 2. ROSEN, Jacob, HANNAFORD, Blake, Satava, M. Richard, Surgical Robotics: Systems Applications and Visions, Springer, 2011 3. PONS, L. Jose, Wearable Robots: Biomechatronic Exosksletons, John Wiley & Sons, 2008. 4. DIETZ, Volker, NEF, Tobias, RYMER, W. Zev, Neurorehabilitation Technology, Springer, 2012 5. BURDET, Etienne, FRANKLIN, W. David., MILNER, E. Theodore, Human Robotics: Neuromechanics and Motor Control, The MIT Press, 2013 6. SICILIANO, Bruno, SCIAVICCO, Lorenzo, VILLANI, Luigi, ORIOLO, Giuseppe.: Robotics - Modelling, Planning and Control, Springer 2009. | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| Obravnavati večmodalno interakcijo med človekom in robotom z namenom izboljšave človekovih sposobnosti, pomagati prizadetim osebam, izboljšave učinkovitosti in varnosti ter nadomeščanja človekovih okončin:  Analiza robotskih sistemov, ki so namenjeni za interakcijo s človekom ali z živo materijo nasploh. Roboti v interakciji s človekom lahko delujejo na različnih nivojih. Človeku omogočajo natančnejše, enostavnejše in varnejše izvajanja nalog (kirurška in diagnostična robotika), s haptičnimi roboti moremo simulirati interakcije, ki zahtevajo fizični dotik človeka z okoljem, roboti lahko delujejo kot ojačevalniki človekove sile (eksoskeletni roboti), nadomeščajo amputirane dele telesa (robotske proteze), znotraj človeškega telesa pa omogočajo natančno diagnostiko in doziranje zdravilnih učinkovin. | |  | | To study multimodal interactions between a human and a robot for the purpose of augmenting human capabilities, assisting disabled persons, increasing human performance and safety, replacing human limbs:  Analysis of robotic systems, which are designed to interact with humans or with organic matter in general. The robots interacting with humans can operate at different levels. They enable the operator more accurate, easier and safer performance of tasks (surgical and diagnostic robotics), haptic robots can simulate interactions that require physical contact between the human and environment, robots can act as amplifiers of human force (exoskeletons), can replace amputated body parts (robotic prostheses), within the human body they enable precise diagnostics and delivery of medical substances. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Načrtovanje mehanizmov in vodenje robotskih manipulatorjev v dotiku s človekom. Varnostne zahteve za interakcijo robota s človekom. | | |  | Design of mechanisms and control of robots that operate in contact with humans. Safety requirements for the robot to interact with humans. | |
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| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| Predavanja, laboratorijsko delo v manjših skupinah, reševanje kompleksnejše nalog vodenja robota, kombinacija skupnega in individualnega dela. Praktične vaje potekajo na večjem številu sodobnih haptičnih robotov, dodatno opremljenih s senzorji sil. Pri predmetu je posebna pozornost posvečena varnosti pri delu z roboti. | | |  | Lectures, laboratory work in small groups, complex robot control problem solving, combination of individual and team work. Practical exercises take place on a number of modern robots for human-robot interaction equipped with additional force sensors. In this course, special attention is paid to safety. | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| Način: laboratorijske vaje, pisni in/ali ustni izpit.  Ocene od 1 do vključno 5 so negativne, ocene od vključno 6 do 10 so pozitivne.  Pozitivna ocena laboratorijskih vaj je pogoj za pristop k izpitu.  Praktične vaje se izvajajo v obliki projektnih nalog povezanih s tematiko predmeta (medicinska, rehabilitacijska industrijska robotika, ki temelji na stiku s človekom). Zahtevana je obvezna prisotnost pri praktičnih vajah. Študent lahko opravičeno izostane največ od ene vaje. Ustrezno opravljene obveznosti pri laboratorijskih vajah so potrebne za pristop k izpitu. Ustna javna predstavitev projektov pred komisijo asistentov in profesorjev.  Pisni izpit ali ustno preverjanje znanja pred komisijo prof. Matjaž Mihelj in doc. Aleš Ude  Prispevki k oceni:  laboratorijske vaje  pisni in/ali ustni izpit | 50 %  50 % | | | | Type: laboratory exercises, written and/or oral exam.  Negative grades: from 1 to 5, positive grades: from 6 to 10.  Positive evaluation of laboratory exercises is a prerequisite for the exam.  Practical exercises are carried out in the form of semester project related to the topics of the course (medical, rehabilitation, industrial robotics, based on contact with humans). Mandatory presence at practical courses. Student can justifiably miss maximally one practical course time slot. Adequately completed obligations in the laboratory are required for the exam. Oral presentation of projects in front of the committee consisting of teaching assistants and professors.  Written exam or oral examination in front of the exam committee: Prof. Matjaž Mihelj and Assoc. Prof. Aleš Ude  Contributions to final grade:  laboratory exercises  written and/or oral examination |
| **Reference nosilca / Lecturer's references:** | | | | | |
| 1. MIHELJ, Matjaž, PODOBNIK, Janez. Haptics for virtual reality and teleoperation, Springer, 2012. 2. MIHELJ, Matjaž, BAJD, Tadej, MUNIH, Marko. Vodenje robotov. Ljubljana: Založba FE in FRI, 2011. 3. MIHELJ, Matjaž, NOVAK, Domen, MILAVEC, Maja, ZIHERL, Jaka, OLENŠEK, Andrej, MUNIH, Marko. Virtual rehabilitation environment using principles of intrinsic motivation and game design. Presence, ISSN 1054-7460. [Print ed.], Feb. 2012, vol. 21, no. 1, str. 1-15. 4. NOVAK, Domen, MIHELJ, Matjaž, ZIHERL, Jaka, OLENŠEK, Andrej, MUNIH, Marko. Psychophysiological measurements in a biooperative feedback loop for upper extremity rehabilitation. IEEE transactions on neural systems and rehabilitation engineering, Aug. 2011, vol. 19, no. 4, str. 400-410. 5. KOENIG, Alexander, NOVAK, Domen, OMLIN, Ximena, PULFER, Michael, PERREAULT, Eric, ZIMMERLI, Lukas, MIHELJ, Matjaž, RIENER, Robert. Real-time closed-loop control of cognitive load in neurological patients during robot-assisted gait training. IEEE transactions on neural systems and rehabilitation engineering, ISSN 1534-4320. [Print ed.], Aug. 2011, vol. 19, no. 4, str. 453-464. | | | | | |