

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet: Tehnologije razširjene resničnosti
Course title: Extended Reality Technologies

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Razvoj videoiger in razširjenih resničnosti, visokošolski strokovni študijski program prve stopnje	-	Tretji	Peti
Game and Extended Reality Development, first cycle Professional Study Programme	-	Third	Fifth

Vrsta predmeta / Course type

Obvezni / Obligatory

Univerzitetna koda predmeta / University course code:

4-RVRR-VS-TRR-2025-09-19

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30	-	50	-	-	100	6

Nosilec predmeta / Lecturer: Doc. Nadav Sagir

Jeziki / Languages:

Predavanja / Lectures: Slovenski / Slovenian, Angleški / English

Vaje / Tutorial: Slovenski / Slovenian, Angleški / English

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

Študenti predhodno osvojijo vsebine predmetov 3D modeliranje in 3D animacija likov.

Projektna naloga in interaktivni prototip morata biti pozitivno ocenjena.

Prerequisites:

Students first study the content of the courses in 3D modeling and 3D Character Animation.

The projects assignment and an interactive prototype must be positively evaluated.

Vsebina:

Predmet predstavi sodobne kreativne tehnologije na področju razširjene resničnosti, strojno programsko opremo in njihove aplikacije. Razvoj tehnologij od začetnih zaslonov HMD (head mounted display; slovensko: naglavni zaslon) do najnovejših potrošniških izdelkov mešane resničnosti. Predmet se bo specializiral za

Content (Syllabus outline):

The course presents the latest creative technologies in the field of extended reality the hardware software and their applications. The emergence of the technologies from the initial HMD (head mounted display - to the latest mixed reality consumer products). The course will specialize and detail in the upcoming

prihajajoče tehnologije in podrobno obravnaval njihov potencial in glavne razlike, pri čemer bodo obravnavani in podrobno razdelani izrazi, kot so obogatena resničnost (AR), navidezna resničnost (VR), mešana resničnost (MR) ali nadpomenka - razširjena resničnost (XR) in sicer tako razlike v strojni opremi kot tudi konceptualni primeri uporabe. Predmet bo tudi obravnaval primere uporabe tehnologij umetne inteligence v ustvarjalnem prostoru, generatorjev slik in videov umetne inteligence ter obrobnega pregleda ustvarjanja sredstev umetne inteligence in prostorskega ustvarjanja.

Predmet je razdeljen na dva dela.

V prvem, uvodnem delu se bodo študenti seznanili s teoretičnim in zgodovinskim diskurzom, ki zajema zgodovinski razvoj tehnologij XR od začetkov do sodobnih trendov. Študenti bodo spoznali širok spekter ustvarjalnih tehnologij, od eksperimentalnih do nastajajočih tehnologij. Spoznali bodo uporabo tehnologij kot so projekcijsko mapiranje, veččutna doživetja, razširjena in navidezna resničnost, holografske podobe in interaktivne instalacije ter uporabo prelomnih tehnologij.

Razpravljali bomo o priložnostih in izzivih XR tehnologij, študenti pa si bodo lahko predstavljali sedanje in prihodnje digitalne tehnologije. Z osebnim doživljanjem teh tehnologij in analizo resničnih primerov se bodo študenti odločili za temo projekta. Študenti se bodo na podlagi osebnih izkušenj s takšnimi tehnologijami in pregledom študij primerov iz resničnega sveta odločili za oblikovanje projektne teme. Projekt bo utemeljen na domišljiji in se bo meril z idejami in ustvarjalnostjo pri uporabi teh novih tehnologij.

Konceptualno delo študentov bo temeljilo na obstoječih izkušnjah in resničnih študijah primerov naprav, od odkrivanja uporabe zaslonov, nameščenih na glavo, ne le za potopitveno gledanje, temveč tudi za uporabo tehnologij in zmožnosti skeniranja takšnih naprav za zbiranje podatkov iz

technologies and discuss their potential and main differences, Terms such as Augmented Reality (AR), Virtual Reality (VR), Mixed Reality (MR), or superlative Extended Reality (XR) will be discussed and elaborated on, through seeing both the differences in hardware as well as conceptual use cases. The course will also explore the use case of artificial intelligence (AI) technologies in the creative space, AI image and video generators as well as a peripheral review of AI asset creation and Spatial creation.

The course is divided into two parts.

In the first, introductory part, students will be introduced to theoretical and historical discourse covering the historical development of XR technologies from its beginnings to contemporary trends. Students will be introduced to a broad range of creative technologies from experimental technologies to emerging technologies - the use of technologies such as projection mapping, multi sensory experiences, augmented and virtual reality, to holographic imagery and interactive installations and the use of disruptive technologies.

It will be followed by discussion of the possibilities and challenges of XR technologies which will allow the students to conceptualize current and future digital technologies. Based on personal experience with such technologies and a review of real-world case studies, students will decide on a project topic. The project will be fictional and be measured by the ideas and creativity of using these emerging technologies.

The conceptual work of the students will be reliant on existing experiences and real case studies, of such hardwares, from teasing out the use of head mounted displays not just for immersing the viewers but also to use the technologies and scanning capabilities of such devices, to collect real world data, interpret a world around us.

resničnega sveta, za interpretacijo sveta okoli nas.

Primeri XR tehnologij v praksi v sedanjosti ter pogled v prihodnost glede možnosti in razširitev teh tehnologij.

Drugi del se osredotoča na oblikovanje arhitekture projekta z uporabo XR tehnologij. Študenti si bodo ogledali študije primerov, zlasti s področja navidezne ali mešane resničnosti, nato pa se bodo naučili orodij in tehnik za ustvarjanje lastne aplikacije za navidezno resničnost z uporabo UNITY 3d pogona. Predmet bo zajemal uvod in osnove igralnega pogona Unity 3d ter osnove vizualnega skriptiranja, nato pa se bo poglobil v osnove programskega jezika C#.

Študenti bodo spoznali osnove razvoja za Mešano ali Navidezno resničnost, nato pa bodo vsak zase ali v manjših skupinah izdelali svoj ustvarjalni tehnološki projekt z uporabo HMD. od začetne zasnove do dokončanja funkcionalne aplikacije. Poudarek bo na izkoriščanju moči in edinstvenosti teh tehnologij pri ustvarjanju izkušenj.

Ogledali si bomo tudi orodja umetne inteligence za ustvarjanje slik in videoposnetkov za pomoč pri oblikovanju in zagotavljanju virov ustvarjenih izkušenj. Ob spoznavanju najboljših praks za XR tehnologije in raziskovanju edinstvenih priložnosti za uporabniško izkušnjo v teh okoljih bomo pridobljeno teoretično znanje ter praktične študije primerov in izkušnje uporabili pri ustvarjanju projekta Proof of Concept z uporabo najnovejše tehnologije in strojne opreme, kar bo študentom omogočilo raziskovanje možnosti ter ustvarjanje lastnih interpretacij in prilagoditev teh struktur.

TEME:

1. DEL

- Zgodovinski pregled XR tehnologij od njihovega nastanka do danes
- XR tehnologije, eksperimentalne in uveljavljene
- Vpliv XR tehnologij na umetnost, zabavo in izobraževanje

Examples of XR technologies in practice at current times, and looking to the future on the possibilities and expansions of these technologies.

The second part focuses on the creation of a project architecture utilizing XR technologies, The students will review case studies specifically in Virtual reality or mixed reality, and would then learn the tools and techniques to create their own Virtual reality application using UNITY 3d Engine. The course will go through the introduction and fundamentals of Unity 3d game engine, as well as the foundations to first visual scripting, and then we will dive into the basics of C# programming language.

The foundation of development specifically for Mixed reality or virtual reality will be covered and the students will each or in small groups produce their own creative technology project using HMD. from the initial concept to the completion of a functional application. The emphasis will be on utilizing the power and uniqueness of these technologies in the creation of the experiences.

We will also review AI tools for image and video creation, to help in the conceptualizing and production of assets of the created experiences. Seeing what are the best case practices for XR technologies and exploring the unique opportunities for user experience in these environments, we will use the theoretical knowledge gained as well as practical case studies and experiences to create a Proof of concept project using the latest technology and hardware, allowing the students to explore the possibilities and create their own interpretations and adaptations for these structures.

TOPICS:

1. PART

- The historical review of XR technologies from their emergence to the present
- XR technologies, the experimental and the one that is established

- XR tehnologije v središču vsakdanjih stvari
- Ustvarjanje konceptov z XR tehnologijami - dotikanje meja
- Napoved prihodnosti XR tehnologij

2.DEL

- Študije primerov in uvod v igralni pogon Unity
- Namestitve igralnega pogona Unity in ustvarjanje novega projekta
- Pregled gonilnika Unity: Uvod in uporabniški vmesnik.
- Izdelava osnovnega uporabniškega vmesnika menija za mešano resničnost
- Uvoz sredstev 2D in 3D ter ustvarjanje predpomnilnikov (Prefabs)
- Ustvarjanje in uporaba senčilnikov in materialov
- Osvetlitev Unityja in njena osnovna uporaba
- Kamere in naknadna obdelava
- Kamera Cinemachine in mehanika kamere
- Okolje Unity s programom ProBuilder
- Ustvarjanje vzdušja v programu Unity
- Toga telesa in dinamika v programskem okolju Unity
- Uvod v vizualno skriptiranje v programu Unity
- Vizualno skriptiranje - upravljanje scene, čas, zbirke in sprožilci
- Vizualno skriptiranje - skripte za zakasnitev, zvočne interakcije
- Vizualno skriptiranje - osnovno ustvarjanje tekalne igre, rezultat, eliminacija igralcev in sovražnikov
- C# Uvod v kodo - Visual Studio
- C# gibanje igralca, načelo kode za začetek in posodobitev
- Javno in zasebno v jeziku C# - koncepti kode
- Interakcija C#, rezultat, trki, časovnik,
- Upravljalci prizorišč C#, stavki if
- Ustvarjanje osnovne igre z ovirami z uporabo C#
- Ustvarjanje projekta mešane resničnosti,
- Študentski projekt v mešani resničnosti - koncept in izvedba v gonilniku Unity

Opomba:

- The impact of XR technologies, on the arts, entertainment and education
- XR technologies at the heart of everyday things
- Creation of concepts with XR technologies - touching the limits
- The future of XR technologies, The prophecy

2. PART

- Testing case studies and introduction to the unity game engine
- Installing the unity game engine and creating a new project
- Unity Engine overview: Introduction and user interface.
- Creation of a basic Menu UI for Mixed Reality
- Importing 2d & 3d assets and the creation of Prefabs
- Creating and applying shaders and materials
- Unity lighting and its basic applications
- Cameras and post process
- Cinemachine camera and camera mechanic
- Unity environment with ProBuilder
- Unity creation of experience atmosphere
- Unity rigid body and dynamics
- Introduction to visual scripting in Unity
- Visual Scripting - SceneManagement, Time, Collectables and triggers
- Visual Scripting - Delay scripts, audio interactions
- Visual Scripting - basic runner game creation, score, player kill and enemy
- C# Introduction to code - Visual Studio
- C# movement of Player, code principales start and Update
- C# public and private - code concepts
- C# interaction, score, collisions, timer,
- C# scene managers if statements
- Creation of a basic obstacle game using C#
- Creation of A Mixed Reality project set up
- Student project in mixed reality - concept and implementation in UNITY Engine

NOTE:

The practical exercises for the course are conducted using virtual reality (VR) and augmented reality (AR) headsets along with

Vaje pri predmetu se izvajajo z uporabo očal za navidezno resničnost (VR) in razširjeno resničnost (AR) ter pripadajoče opreme, prilagojene specifičnim potrebam posameznih vaj.

accompanying equipment, tailored to the specific requirements of each exercise.

Temeljni literatura in viri / Readings:

- Papagiannis, H., Augmented Human: How Technology Is Shaping the New Reality. O'Reilly Media, 2017.
- Scott, L., Picnic Comma Lightning: In Search of a New Reality, 2019. (Audiobook)
- Scoble, R., Shel, I.,: The Fourth Transformation. CreateSpace Independent Publishing Platform, 2016.
- Bosworth, M., Lakshmi, S.: Crafting Stories for Virtual Reality Paperback , Routledge, 2018.
- Sean Morey,S. (Editor).: Tinnell,J.(Editor): Augmented Reality: Innovative Perspectives Across Art, Industry, and Academia , 2016.
- Buttfield-Addison,P., Manning,J., Nugent,T.,: Unity Game Development Cookbook: Essentials for Every Game. O'Reilly Media, 2018.
- Ferrone, H.,: Learning C# by Developing Games with Unity – Seventh Edition: Get to grips with coding in C# and build simple 3D games in Unity 2022 from the ground up Paperback, Packt Publishing, 2022
- Borromeo, N., A.,: Hands-On Unity 2022 Game Development - Third Edition: Learn to use the latest Unity 2022 features to create your first video game in the simplest way possible Packt Publishing, 2022.

Cilji in kompetence:

Ob zaključku tega predmeta bodo študenti imeli poglobljeno znanje o XR tehnologijah, njihovem izvoru ter njihovem vplivu na naš svet in vsakdanje življenje.

Učna enota prispeva k razvoju naslednjih splošnih in predmetno-specifičnih kompetenc:

Splošne kompetence:

- Raziskovanje, dokumentiranje, analiza in interpretacija razvojnih in oblikovnih konceptov v kontekstih videoiger in razširjenih resničnosti.
- Prepoznavanje in ocenitev aktualnih in nastajajočih tehnologij in sodobnih metod, veščin in tehnik s področij videoiger in razširjenih resničnosti ter ocenitev njihove uporabnosti za reševanje potreb uporabnikov.

Objectives and competences:

At the end of this curriculum, students will have an in-depth knowledge of XR technologies their origins and their impact on our world and everyday life.

The instructional unit contributes to the development of the following general and subject-specific competences:

General competences:

- Research, documentation, analysis and interpretation of development and design concepts in the contexts of video games and extended reality.
- Identification and evaluation of current and emerging technologies and contemporary methods, skills and techniques in the fields of video games and extended reality and assessment of their applicability to address user needs.

- Sposobnost interdisciplinarnega povezovanja in nadgradnje znanj iz drugih sorodnih kreativnih področij.
- Sposobnost samostojnega sledenja najnovejšim tehnološkim dosežkom in pridobivanja novih znanj, ki so uporabna v produkciji videoiger in razširjenih resničnosti.
- Usposobljenost za skupinsko delo v vseh fazah razvoja in oblikovanja programske opreme.

Predmetno-specifične kompetence:

- Poznavanje zgodovine XR tehnologij in ključne strojne opreme;
- Ustvarjanje konceptualnih primerov uporabe in razumevanja XR tehnologij;
- Raziskovanje študij primerov iz resničnega sveta na področju XR tehnologij;
- Uvod v pogon Unity 3D;
- Podroben pregled delovnega postopka gonilnika Unity in specifičnega načrtovanja delovnega poteka za Mešano resničnost (MR);
- Ustvarjanje interaktivnih izkušenj mešane resničnosti;
- Vizualno pisanje skript z uporabo programa Unity;
- Osnove kodnega jezika Visual Studio C#;
- Povezovanje strojne in programske opreme z uporabo gonilnika Unity.

- Ability to interdisciplinarily integrate and build on knowledge from other related creative fields.
- Ability to independently keep up to date with the latest technological developments and gain new skills useful in video game and extended reality production.
- Ability to work as part of a team in all phases of software development and design.

Subject-specific competences:

- Knowledge of the XR technology history and key hardware;
- Creating conceptual use cases and understanding of XR technology;
- Exploring real world case studies in XR technologies;
- Introduction to Unity 3D engine;
- Detailed overview of the Unity engine workflow, and specific mixed reality pipeline;
- Creation of mixed reality interactive experiences;
- Visual scripting using Unity;
- Visual studio c# code language fundamentals;
- Connecting hardware and software using Unity engine.

Predvideni študijski rezultati:

Znanje in razumevanje:

Študent/študentka:

- ima temeljito znanje o XR tehnologijah, njihovi zgodovini, uporabi v vsakdanjem življenju in njihovih možnostih.
- zna strukturirati in upravljati konceptualno projektom XR tehnologije ter argumentirati prednosti svojih primerov.
- zna uporabljati osnovna orodja umetne inteligence za vizualizacijo in pomoč pri razlagi ali ustvarjanju konceptov predlaganega projekta.
- temeljito razume gonilnik Unity 3D in je seznanjen z vmesnikom.

Intended learning outcomes:

Knowledge and understanding:

The student:

- Has a thorough understanding of the XR technologies, their history, implementation in our daily lives, and their possibilities.
- Is able to structure and manage a XR technology project concept and give argumentation for the benefits of its cases.
- Knows how to use basic AI tools to visualize and help in explaining or creating concepts for proposed project
- Gains a thorough grasp of the unity 3d engine, and is familiar with the interface

<ul style="list-style-type: none"> • razume osnove ustvarjanja za ustvarjalno tehnološko strojno opremo z uporabo gonilnika Unity 3D. • Ustvarjanje optimiziranega okolja za mešano resničnost. • Pridobi osnovno razumevanje vizualnega skriptiranja za ustvarjanje interaktivne aplikacije. • Spoznavanje osnov programa Visual Studio in kodiranja v jeziku C# , osnov kode za ustvarjanje funkcionalne aplikacije za določeno strojno opremo. • Razumevanje mehanike kamere v programu Unity3D in kamer za mešano resničnost za pripovedovanje zgodb. • Postopek izdelave gonilnika Unity za HMD za mešano resničnost. • Zna predstaviti funkcionalni projekt za dokaz koncepta na HMD ter razložiti koncept in utemeljitev uporabe XR tehnologij ter njihove prednosti. 	<ul style="list-style-type: none"> • Understands the fundamentals of creation for creative technology hardware using the Unity 3d engine • Creation of an optimized environment for mixed reality • Gaining the basic understanding of visual scripting to create interactive application • Learning the fundamentals of visual studio and coding in C#, the basics of code to create a functional application for a specific hardware. • Understanding camera mechanics in Unity 3D, and mixed reality cameras for story telling. • Unity engine build process for mixed reality HMD • Can present a functional Proof of concept project on HMD, and explain a concept and the reasoning for use of XR technologies, and its benefits.
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Metode poučevanja in učenja:

Predmet je organiziran kot kombinacija predavanj, vaj, samostojnega učenja in mentorstva. Poučevanje na skupnih predavanjih in posameznih delovnih / individualnih nalogah. Študenti bodo v majhnih skupinah sodelovali pri skupnih projektih z najsodobnejšo VR tehnologijo.

Learning and teaching methods:

The lectures are structured as a combination of lectures, practical exercises, weekly projects, self-study and supervision. Teaching in group sessions and individual work/individual assignments. Students will work in small teams on collaborative projects with the latest VR technology.

Načini ocenjevanja:

Način (pisni izpit, ustno izpraševanje, naloge, projekt):

- vaje
- skupni projekti
- končni interaktivni prototip (strojna oprema za mešano resničnost)

Delež (v %) /

Weight (in %) **Assessment:**

Type (examination, oral, coursework, project):

- exercises
- collaborative projects
- final interactive prototype (Mixed reality hardware)

Reference nosilca / Lecturer's references:

Štrokevne izkušnje:

2006–danes: Soustanovitelj, CEO in Kreativni direktor Direktor, CtrlArt Llc, Ljubljana, Slovenia (3D animacijski studio, 3D vizualizacije)

2018–danes: direktor Cardotour Animation Mentor - SAE Institute Ljubljana

2014–2016: soustanovitelj, direktor marketinga in financ, Revolv-AR, Izrael

Ekshibicije / projekcije

2021; Grad Škofja Loka, redna razstava 2021; Grad Visoko; projekcija Cveti v Jeseni

2022–2023: The Annunciation of St.Mary - Bazilika Brezje Slovenija - Holographic display
<https://www.ctrlart.com/annunciation-of-mary---basilica-of-the-virgin-mary-brezje.html>

2015: Slovenski etnografski muzej dostopen za vse »Dostopnost«

<https://www.ctrlart.com/slovene-ethnographic-museum-accessible-for-all---dostopnost.html>

2014; ELLE Style Awards (Renault AR event presentation of new model Twingo); vodja projekta;

2012; i-Emona Exhibition and Film; <https://www.ctrlart.com/3d-model-of-1st-century-roman-city---emona.html>;

2008; MGML Ljubljana, redna razstava portret Auserperg 2004; Maribor, Utripajoča Škatla, Video Art ekshibicija

Razvoj aplikacij

2022; Aplikacija Crime Door - Alexander Hamilton and Aaron Burr Duel (ZDA); vodja projekta; <https://www.ctrlart.com/crimedoor---hamilton-burr-duel.html>

2021; Aplikacija TravelAR Slovenija – Ptuj; vodja projekta;

<https://www.ctrlart.com/travelar-ptuj.html>

2021; Aplikacija Kurentova Simfonija; <https://www.ctrlart.com/kurentovanje-simfonija.html>

2019–2021; Aplikacija CardoTour Jerusalem AR (Izrael); vodja projekta;

<https://cardotour.com/>; <https://www.ctrlart.com/cardotour.html>

2020–2023; DI-Gozd forestry inventory technology application; <https://di-gozd.si/>;

<https://www.ctrlart.com/di-gozd.html>

2016 – danes; Interaktivna aplikacija in delavnice TravelAR Slovenia;

<https://www.travelarslovenia.com/>; <https://www.ctrlart.com/travelarslovenia.html> 2016;

Gorenje 'Life Simplified' AR application (Nemčija); vodja projekta;

<https://www.ctrlart.com/lifesimplified.html>

2015; Multiplayer AR game 'Akes, finding the right one' for Abanka.

<https://www.ctrlart.com/abanka---akescaron--finding-the-right-one.html>

Razvoj platforme

2019–2021; platforma WErPix (Izrael); <https://www.ctrlart.com/werpix--augmented-reality-platform.html>

Delavnice:

Crafty Builders Workshops/Creator Workshops za odrasle; <http://www.craftybuilders.com/>

Članek:

Aldouby, H., Hasler, B. S., Nadav, T., & Friedman, D. (2022). Viewing images of jagged texture in digital artwork affects body sensations: A virtual reality study. *Psychology of Aesthetics, Creativity, and the Arts*. Advance online publication.

<https://doi.org/10.1037/aca0000522>