

Erasmus XR – Immersive Experiences in European Academic Institutions

Adnan Hadzi

Abstract

This paper discusses the Erasmus XR project which responds to the urgent need to enrich the existing educational programs for both cultural and media managers, but also for artists aspiring to connect with their audiences in the digital sphere. The project's overall goal is to develop an educational offer for these groups in the field of immersive media (XR), and ways of using these media to engage audiences. More specifically, the project aims at increasing the skills and competences of the participants in designing and evaluating immersive experiences in order to effectively manage, disseminate, and produce culture in the digital sphere.

Erasmus XR – Immersive Experiences in European Academic Institutions

The Erasmus Extended Reality [1] (Erasmus XR) project [2] is increasing the knowledge and competences of the academic staff working with immersion technologies [3], in order to effectively manage, disseminate, and produce digital culture [4] in an academic environment. Erasmus XR will also elaborate open educational resources (OER) [5] in the field of experience management [6], [7] and culture with the use of immersive technologies. Erasmus XR's aim is to help building an open attitude [8] of students and academic staff towards the application of new technologies in the humanities. Due to the technological aspect [9] of the project, there will be a bridging of the gap in terms of access to solutions and their use by groups which have not had the opportunity to use them so far (in particular in the field of culture). In order to introduce educational programs, it is necessary to take an innovative approach to the creation of an educational program. Due to the limited resources of scientific publications on building and managing experience in the virtual world, Erasmus XR will draw knowledge [10] directly from artistic practices which are an interesting basis for building theory - knowledge. Documenting works and artistic activities constituting the so-called 'research as a practice' [11]–[13] will allow for the Erasmus XR project to gain new, previously unpublished knowledge, which will serve to build an educational program and prepare materials necessary for its implementation.

Erasmus XR includes training of academics in new and innovative pedagogical methods [14]–[16], including interdisciplinary approaches [13], [17]. Academics representing theoretical knowledge in the field of cultural [18] and media management [19] will be acquainted with new research-development practices in the area of creating works/transmissions in virtual reality [20]. The direction of knowledge transfer [21] in the project also determines the need to adopt new methods of curriculum development [13], where working in interdisciplinary working teams will allow to combine education with research, art [22] and innovation [23]. The inspiration to adopt such a way of knowledge creation came from the work of representatives of three partner institutions in the European cooperation network and the development of the EFAP Charter [24]: European Forum for Advanced Practices (EFAP). This informal forum of artists, theorists, philosophers, educators, performers, curators, musicians, urban planners, anthropologists and other cultural activists in Europe and beyond, proposes new ways of recognising the value of contemporary cultural practices. According to EFAP, experiments in the field of creative practice should also be

recognized as research [25]. This creative research offers new ways of generating, multiplying and disseminating knowledge thanks to the paradigm of openness (open source) [26], [27], in contrast to the very often promoted new forms of excellence that are confined, for example, within the confines of high-profile journals with limited access. The project activities are part of the development of new practices based on participatory action research [13] and creativity (creative practice and practice as a research [25]).

The results of Erasmus XR can be used by independent artists who, having access to the developed syllabuses and Open Educational Resources (OER), will be able to independently expand their passions and interests within the informal education path. The users of OER will include students and lecturers who are interested in immersive creative, artistic and research projects created by prominent European creators, educators and researchers, as well as people who want to explore these topics in a self-study format. The target groups are not restricted and due to open licensing [28] and availability of materials, there are no formal restrictions on their use for educational purposes.

Erasmus XR is an innovation because of the process of knowledge generation [29], [30] (and the course of knowledge transfer from universities/artistic departments to academic theory) for the creation of an educational program, and because of the subject matter, which in the field of media and cultural management has not yet been developed and integrated into existing curricula of higher education institutions. Practicing art in VR [18], [31], [32] escapes the existing schemes and, due to the limitations of the developed workshop, constitutes a field of continuous research and searching for answers how to realize the assumed concepts, which should be developed and introduced into both scientific circulation and constitute the basis for educational programs for personnel involved in the management and creation of virtual experiences [33], [34]. For these reasons, Erasmus XR should be considered innovative in terms of process (methods of work) and subject (result). Erasmus XR brings together the experience of the partners and generates new knowledge on educational practices and thus contributes to the improvement of the quality of education in the participating countries. The innovation of the result stems from the methodology of work that does not refer to the canon of culture [35], existing divisions and systematics, but starts from the experience of participation - use, especially the creation of virtual space [36] (research as a practice) and on its basis develops individual subjects, their syllabuses and materials.

Translation from one immersive experience to another [37], both in terms of application domain as well as of immersive technology used, will be especially investigated, through an in-depth exploitation in both theoretical and practical learning sessions of a design methodology that focus on five steps: design of the User Experience [38], [39], Arts and Graphics [40], Logic Development [41], Audio Development [42] and Synchronization and Design Supervision [43].

1) User Experience Design (UED)

Designing the User Experience is the first basic step to creating an immersive experience. It involves defining the key messages we want to signal, determining the shapes we want to use to convey them, calibrating the color combinations of light and sound, and selecting the technological human-machine interfaces

that can deliver the desired experience (e.g., headsets or large projection screens, controllers or hand/body gestures [21], artificial or physical means of locomotion [42] such as omnidirectional treadmills [44], etc.).

2) Art and Graphics

The second basic step is Art and Graphics: every concept, object and action that we intend to present must be properly associated with a specific graphic style capable of supporting the intended visual perception. To this end, real world acquisition [45], 2D and 3D modeling and animation, graphical texture creation and mapping, lighting, and optimization techniques such as mesh decimation [46] must be mastered to guarantee an immersive simulation with the best real-time performance and quality. Furthermore, the integration with physics and other simulations, along with the use of specific visual effects, plays an important role in enhancing the level of realism and the ability to convey the emotions of IX.

3) Logic development

The third step is Logic Development, which is the creation of the mechanics that govern the simulation. This is the core, the 'engine' of the entire process and encompasses all software development processes leading to the implementation of the software logic, including virtual object capabilities/functionality, simulation triggers, effect sequencing, animation of playing and non-playing characters, etc. Most of these elements are often referred to as AI [47], [48] and in fact are increasingly being developed by invoking machine learning [49] and other process automation techniques.

4) Sound development and Synchronization,

The fourth step is audio development and synchronization. This step involves the creation, refinement, and synchronization of all sound effects [50], including background noise, sounds environment, character dialogues and music.

5) Design Supervision

All the above-mentioned steps must be continuously supported by a dedicated Project Supervision process to optimize and coordinate the use of resources by minimizing overlap/debugging, avoiding bottlenecks, ultimately ensuring that the final immersive simulation meets the expected requirements in terms of quality and user needs.

The training will be delivered through a Summer Academy by experienced researchers and specialists from University of Malta (UM), Faculty of Media & Knowledge Sciences (MAKS) assisted by individuals from Filmschool Lodz (VNLab) and University of Athens (NKUA) with long-standing expertise in each of the above phases [51]–[53], as well as freely creating in the arts and culture field, which is the project area. Therefore the Summer Academy is the first activity aimed at students, which will be conducted by coach-trainee tandems, where the adepts will be the participants of the cadre training [54], who make their debut as tutors. The Summer Academy for post-graduates will also take place at CAVE [55] MAKS UM and will include an adequate introduction to the basic goals of immersion projects, both in terms of converting pieces from one space to another, as well as another technical configuration. The immersive experience (IX) audiovisual Summer Academy is a demonstration of the primary goals of the Erasmus

XR project, also for the conversion of works from one space to another with a different technical setup.

The technical setup of the audiovisual facility at University of Malta comprises of a CAVE system, stereoscopic VR displays [56] as well as a number of different wearable XR solutions (headset, full-body suits [57] tailored to both indoor and outdoor settings) connected to each other for distributed experiences. As in immersive experiences the audience is dynamic, not static, several omni-directional treadmills for the exploration of large-scale virtual environments [58], [59] are also available, together with technologies for untethered virtual experiences. All of the above will enable trainees to experiment in a learning-by-doing context a comprehensive set of simulated immersive experiences, moving from those created through the collaboration of the partners in a number of diverse contexts (from industry, healthcare, cultural heritage, to name a few) to those of interest in particular for Maltese, Greek and Polish trainees. The training activities are necessary to achieve the Erasmus XR project objectives and to create a space to learn about the tools of creative practices of XR artists, as well as to train staff capable of successfully implementing the new curriculum content included in the educational module under development.

One major aspect the training program offers is the engagement with Maltese cultural and historical sites. Museums are sites of knowledge and memory [60], heritage and culture. Museums and historical sites in the Malta also are publicly funded institutions that have a social responsibility to reach out to a wide range of demographics. However, participation in culture is often significantly lower among those from a lower socio-economic background. There is strong evidence of arts and culture's intrinsic, social and economic value. The government expects that all publicly-funded arts organisations must increase access for people from disadvantaged backgrounds and open up arts and culture for all. Furthermore, even when visiting museums and sites of cultural heritage, many visitors only engage with the 'star' exhibits, missing out on other, equally important if less celebrated or spectacular elements of the exhibition, either because they do not have an incentive to visit certain parts of the exhibition or because items are hidden in the storage. This can lead to educationally limited visits of cultural and heritage sites.

Where the Erasmus XR project will put those activities into practice concerning the museum context is with Heritage Malta and the MUŻA museum [61]. MUŻA is the chosen name for Malta's new museum of art and is a flagship project for the Valletta European Capital of Culture in 2018 [62]. The community-oriented project is a national museum, the first of its kind, which shares a common vision with the Foundation's objectives in promoting art and museums as a tool for social transformation. The program also supports the local Research Cluster in Digital Technology for Culture and the Arts, an interdisciplinary constellation of researchers from creative computing, visual and museum studies, archaeology, curation, artificial intelligence, theatre and performance, to learn how to use an immersive experience that will aim to make cultural sites meaningful and relevant to a diverse range of people and communities, extending, deepening and enriching their visits. Malta's creative industries as one of the three sectors which offer the largest scope to benefit from immersive experience innovation. This program will look into the potential for an immersive experience environment that can transform

Malta's museums, heritage and galleries sector, helping to support this ambition:

1. Diversity of audiences and narratives displayed: The diversity of audiences [63] does not currently reflect the demographics of Malta as a whole. A contributing factor to this challenge is a widely-held perception that the story of the past, as the dominant narrative currently presented by mainstream cultural institutions, is primarily that of wealthy, heterosexual, white males. As a result, audiences from different ethnic and religious communities, or with particular protected characteristics, can feel disconnected from this cultural narrative. Maltese heritage sites, museums and galleries are urgently seeking to address this through examining how cultural sites can better contribute to cultural and social developments by encouraging and facilitating diverse communities to contribute to culture within Malta. It responds to demands for more inclusive representation of Maltese history, and the recognition of its dependence on other countries and cultures. The case for diversity aims to both increase and widen cultural participation in Malta, including all citizens.

2. Visitors only engage with 'star' exhibits, resulting to educationally limited experiences: According to C. Waltl "the process of establishing museums for the many goes hand in hand with a transformation of museums which (...) 'change from being product-led to audience-centred'" [64]. Cultural institutions [65] today seek to offer more engaging, enriching and relevant experiences to visitors, encouraging them to extend and diversify their visits. They want visitors to engage with the wider collection beyond the star exhibits, which would enrich the visitors' experience [66], offering a broader contextual understanding and instigating 'surprise encounters' with objects or ideas they might have not previously encountered, thus audiences would learn more and deepen their enjoyment of visits.

3. Physical space and resources limit the range of collections and archives that can be displayed: Cultural institutions tend to only display a proportion of their collection to visitors at any time. A great deal of it remains 'hidden' either because of a lack of space or because of the fragility of the artefacts. However, the 'hidden' artefacts are often those which are most pertinent to the under-represented communities [67].

The impact of the Erasmus XR project will include the improvement of pedagogical, scientific and innovative competences in managing immersive experiences at the Jagiellonian University, as well as at the Film School in Lodz, the University of Athens and the University of Malta. The acquisition of the necessary skills by future cultural and media managers and artists will allow the cultural and creative sector (CCI, digital media, arts and games) to better exploit immersive technologies involving different dimensions of virtual [53], augmented and mixed reality to provide audiences with a new quality of cultural participation despite the existing social distance [18].

The cooperation between the partner institutions on the development of a common learning module will have a great impact on the development of this academic area in Poland, Greece and Malta, in particular the acquisition of new competences enabling the teaching of courses [68] and classes on these new and poorly developed aspects of cultural management cannot be overestimated. Improving the knowledge and skills of the

academic staff will allow for better educational results, the development of further levels of study such as masters and doctoral studies (e.g. at local level, meeting local priorities setting Malta's target of 0.6% of the population educated to doctoral level). The training of competent XR managers [69]–[71] and artists will strengthen local markets, accelerate the ongoing modernisation of the cultural field and also indirectly impact the educational field through cultural, media and film education.

Erasmus XR will also strengthen the participation of representatives of partner institutions in local bodies which give direction to the development of culture, arts and creative industries [72]. UM MAKs employees will strengthen their position and impact in the Research Cluster, which brings together senior researchers in fields such as Digital Arts, Artificial Intelligence, Computer Games, Control Systems and Engineering, Classics and Archaeology, and Conservation and Material Heritage) will bring in younger researchers pursuing Master's, PhD, and postdoctoral studies. The planned cluster is a center for research activities that focus mainly on the use of IX technologies in cultural production [73], as well as for sustainable development. Erasmus XR will also allow the development of networks, stimulate discussion on the role of culture and arts in innovation and research processes (research as a practice) of new solutions. The ambition of the partners is to create a broad coalition of universities working on XR and a new mission of culture, which should not build its value on elitism and limited access, but provide a common platform for understanding, creativity and creation of new values, relevant for development and future generations.

References

- [1] B. Marr, 'What Is Extended Reality Technology? A Simple Explanation For Anyone', Forbes, 2019.
<https://www.forbes.com/sites/bernardmarr/2019/08/12/what-is-extended-reality-technology-a-simple-explanation-for-anyone/> (accessed Dec. 11, 2020).
- [2] K. Pijarski, 'Erasmus XR', Vnlab, 2022.
<http://vnlab.filmischool.lodz.pl/en/search/> (accessed Jan. 27, 2022).
- [3] F. Liptay and B. Dogramaci, *Immersion in the visual arts and media*. Boston: Brill, 2015.
- [4] V. Miller, *Understanding Digital Culture*. SAGE, 2020.
- [5] B. P. Woolf, *Building intelligent interactive tutors: student-centered strategies for revolutionizing e-learning*. Amsterdam ; Boston: Morgan Kaufmann Publishers/Elsevier, 2009.
- [6] M. Chau et al., 'Using 3D virtual environments to facilitate students in constructivist learning', *Decis. Support Syst.*, vol. 56, pp. 115–121, Dec. 2013, doi: 10.1016/j.dss.2013.05.009.
- [7] J. Y. Chen and G. Fragomeni, *Virtual, Augmented and Mixed Reality: Interaction, Navigation, Visualization, Embodiment, and Simulation: 10th International Conference, VAMR 2018, Held as Part of HCI International 2018, Las Vegas, NV, USA, July 15–20, 2018, Proceedings, Part I*, vol. 10909. New York: Springer, 2018.
- [8] I. Ahmed, V. Harjunen, G. Jacucci, N. Ravaja, and M. M. Spapé, 'Total immersion: designing for affective symbiosis in a virtual reality game with haptics, biosensors, and emotive agents', in *International Workshop on Symbiotic Interaction*, 2016, pp. 23–37.

- [9] J. C. P. Cheng, K. Chen, and W. Chen, 'State-of-the-Art Review on Mixed Reality Applications in the AECO Industry', *J. Constr. Eng. Manag.*, vol. 146, no. 2, p. 03119009, Feb. 2020, doi: 10.1061/(ASCE)CO.1943-7862.0001749.
- [10] A. Inglis, V. Joosten, and P. Ling, *Delivering Digitally: Managing the Transition to the New Knowledge Media*. Routledge, 2003.
- [11] L. Candy, 'Practice Based Research: A Guide', *Creativity & Cognition Studios*, University of Technology Sydney, Sydney, 2006.
- [12] P. Leavy, *Method Meets Art, Second Edition: Arts-Based Research Practice*. New York: Guilford Publications, 2015.
- [13] E. Barrett, B. Bolt, and D. B. Bolt, *Practice as Research: Approaches to Creative Arts Enquiry*. New York: I.B.Tauris, 2007.
- [14] D. E. Clover, K. Sanford, L. Bell, and K. Johnson, *Adult education, museums and art galleries: Animating social, cultural and institutional change*. New York: Springer, 2016.
- [15] P. Costes-Onishi, *Artistic Thinking in the Schools: Towards Innovative Arts /in/ Education Research for Future-Ready Learners*. Springer, 2019.
- [16] V. Geroimenko, *Augmented Reality in Education: A New Technology for Teaching and Learning*. New York: Springer Nature, 2020.
- [17] P. Leavy, Ed., *Handbook of Arts-Based Research*. London: Guilford Press, 2017. Accessed: Jun. 10, 2021. [Online]. Available: <https://www.guilford.com/books/Handbook-of-Arts-Based-Research/Patricia-Leavy/9781462540389/contents>
- [18] J. Wilson, *Artists in the University: Positioning Artistic Research in Higher Education*. London: Springer, 2017.
- [19] M. Westerlund, 'The Emergence of Deepfake Technology: A Review', *Technol. Innov. Manag. Rev.*, vol. 9, no. 11, pp. 39–52, Nov. 2019.
- [20] J. Lanier, 'Virtual Reality: The Promise of the Future', *Interact. Learn. Int.*, vol. 8, no. 4, pp. 275–79, 1992.
- [21] J. Y. Chen and G. Fragomeni, *Virtual, Augmented and Mixed Reality: Interaction, Navigation, Visualization, Embodiment, and Simulation: 10th International Conference, VAMR 2018, Held as Part of HCI International 2018, Las Vegas, NV, USA, July 15-20, 2018, Proceedings, Part I*, vol. 10909. New York: Springer, 2018.
- [22] O. Grau, *Virtual art: from illusion to immersion*. Cambridge, Mass: MIT Press, 2003.
- [23] A. D. Cheok, *Art and Technology of Entertainment Computing and Communication*. London: Springer London, 2010. doi: 10.1007/978-1-84996-137-0.
- [24] F. Schneider, 'A Charter for Advanced Practices | European Forum for Advanced Practices', *European Forum for Advanced Practices*, 2019. <https://advancedpractices.net/charter> (accessed Oct. 10, 2019).
- [25] R. L. Skains, 'Creative practice as research: discourse on methodology', *Media Pract. Educ.*, vol. 19, no. 1, pp. 82–97, 2018.
- [26] H. Mu, '18 Open source Virtual reality (VR), Augmented Reality (AR) & Mixed Reality (MR) Frameworks & Projects', *Medevel: Medical/ Open source Software Reviews*, Jul. 22, 2019. <https://medevel.com/16-virtual-reality-vr-frameworks/> (accessed Mar. 30, 2020).
- [27] Henry, 'Ways of Seeing Algorithmically - Lewis Bush - workflow', 2020. <https://henry-1.workflow.arts.ac.uk/ways-of-seeing-algorithmically-lewis-bush> (accessed Sep. 28, 2020).
- [28] M. Ioannides, N. Magnenat-Thalmann, and G. Papagiannakis, *Mixed reality and gamification for cultural heritage*, vol. 2. Springer, 2017.
- [29] P. Costes-Onishi, *Artistic Thinking in the Schools: Towards Innovative Arts /in/ Education Research for Future-Ready Learners*. Springer, 2019.
- [30] T. Ingold, *Making: Anthropology, Archaeology, Art and Architecture*. London: Routledge, 2013.
- [31] H. Bogacs, *Art-Based Research in New Media Art: On the Convergence of Art Practice, Scientific Inquiry, and Technological Innovation*. Saarbrücken, Deutschland: VDM Verlag Dr. Müller, 2011.
- [32] V. Geroimenko, Ed., *Augmented Reality Art: From an Emerging Technology to a Novel Creative Medium*, 2nd ed. Egypt: Springer International Publishing AG, 2018.
- [33] V. Geroimenko, Ed., *Augmented Reality Games I: Understanding the Pokémon GO Phenomenon*. Springer International Publishing, 2019. doi: 10.1007/978-3-030-15616-9.
- [34] V. Geroimenko, *Augmented Reality Games II: The Gamification of Education, Medicine and Art*. New York: Springer, 2019.
- [35] G. Delanty, Ed., *The handbook of contemporary European social theory*. Abingdon, Oxon ; New York: Routledge, 2006.
- [36] K. Hillis, *Digital sensations: space, identity, and embodiment in virtual reality*. Minneapolis: University of Minnesota Press, 1999.
- [37] B. Arnaldi, P. Guitton, and G. Moreau, *Virtual reality and augmented reality: Myths and realities*. London: John Wiley & Sons, 2018.
- [38] T. L. Taylor, 'Living Digitally: Embodiment in Virtual Worlds', in *The Social Life of Avatars: Presence and Interaction in Shared Virtual Environments*, R. Schroeder, Ed. London: Springer, 2002, pp. 40–62. doi: 10.1007/978-1-4471-0277-9_3.
- [39] M. Hassenzahl, 'User experience and experience design', *Encycl. Hum.-Comput. Interact.*, vol. 2, 2013.
- [40] Y. Ohta and H. Tamura, *Mixed Reality: Merging Real and Virtual Worlds*, 1st ed. New York: Springer Publishing Company, Incorporated, 2014.
- [41] C. Gray and J. Malins, *Visualizing Research: A Guide to the Research Process in Art and Design*. London: Routledge, 2016.
- [42] F. Steinicke, *Being Really Virtual: Immersive Natives and the Future of Virtual Reality*. New York: Springer, 2016.
- [43] C. A. Tomlinson and J. McTighe, *Integrating differentiated instruction & understanding by design: connecting content and kids*. Alexandria, Va: Association for Supervision and Curriculum Development, 2006.
- [44] A. Kemeny, J.-R. Chardonnet, and F. Colombet, *Getting Rid of Cybersickness: In Virtual Reality, Augmented Reality, and Simulators*. New York: Springer Nature, 2020.
- [45] B. J. Harris, *The History of the Future: Oculus, Facebook, and the Revolution That Swept Virtual Reality*. London: Dey Street Books, 2019.
- [46] D. Salinas, F. Lafarge, and P. Alliez, 'Structure-aware mesh decimation', in *Computer Graphics Forum*, New York, 2015, vol. 34, no. 6, pp. 211–227.
- [47] D. Gupta, A. E. Hassanien, and A. Khanna, *Advanced Computational Intelligence Techniques for Virtual Reality in Healthcare*. New York: Springer International Publishing, 2020.

- [48] G. N. Yannakakis and J. Togelius, *Artificial intelligence and games*, vol. 2. New York: Springer, 2018.
- [49] M. Mohammed, M. B. Khan, and E. B. M. Bashier, *Machine Learning: Algorithms and Applications*. CRC Press, 2016.
- [50] F. Zotter and M. Frank, *Ambisonics: A Practical 3D Audio Theory for Recording, Studio Production, Sound Reinforcement, and Virtual Reality*. New York: Springer International Publishing, 2019.
- [51] C. Tricart, *Virtual Reality Filmmaking: Techniques & Best Practices for VR Filmmakers*. London: Taylor & Francis, 2017.
- [52] J. Bucher, *Storytelling for Virtual Reality: Methods and Principles for Crafting Immersive Narratives*, 1st ed. New York and London: Routledge, Taylor & Francis Group, 2018.: Routledge, 2017. doi: 10.4324/9781315210308.
- [53] R. Hassan, 'Digitality, virtual reality and the "empathy machine"', *Digit. Journal.*, vol. 8, no. 2, pp. 195–212, 2020, doi: 10/gjv3sn.
- [54] M. Coler, 'Creativity in Technology and the Arts', *Leonardo*, vol. 1, pp. 265--272, 1968.
- [55] C. Cruz-Neira, D. J. Sandin, T. A. DeFanti, R. V. Kenyon, and J. C. Hart, 'The CAVE: audio visual experience automatic virtual environment', *Commun. ACM*, vol. 35, no. 6, pp. 64–73, Jun. 1992.
- [56] M. J. Tarr and W. H. Warren, 'Virtual reality in behavioral neuroscience and beyond', *Nat. Neurosci.*, vol. 5, no. 11, Art. no. 11, Nov. 2002, doi: 10.1038/nn948.
- [57] D. Parisi, *Archaeologies of Touch: Interfacing with Haptics from Electricity to Computing*, 1st edition. Minneapolis: Univ Of Minnesota Press, 2018.
- [58] T. Parisi, *Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile*. O'Reilly Media, Inc., 2015.
- [59] A. Grabowski, *Virtual Reality and Virtual Environments: A Tool for Improving Occupational Safety and Health*. London: CRC Press, 2020.
- [60] M. Shehade and T. Stylianou-Lambert, Eds., *Emerging Technologies and the Digital Transformation of Museums and Heritage Sites: First International Conference, RISE IMET 2021, Nicosia, Cyprus, June ... Computer and Information Science Book 1432*). New York: Springer, 2021.
- [61] A. Kumar, *VR Integrated Heritage Recreation*. New York: Springer, 2021.
- [62] S. Debono, 'MUŽA: Making art accessible to all', Valletta 2018, 2018. <https://valletta2018.org/infrastructure-projects/muza-making-art-accessible-to-all/> (accessed Nov. 19, 2020).
- [63] M. Biggs and H. Karlsson, *The Routledge Companion to Research in the Arts*. London: Routledge, 2010.
- [64] C. Waltl, 'Museums for visitors: Audience development-A crucial role for successful museum management strategies', *Intercom*, vol. 2006, pp. 1–7, 2006.
- [65] G. E. Raptis, C. Fidas, C. Katsini, and N. Avouris, 'A cognition-centered personalization framework for cultural-heritage content', *User Model. User-Adapt. Interact.*, vol. 29, no. 1, pp. 9–65, Mar. 2019, doi: 10.1007/s11257-019-09226-7.
- [66] G. Jacucci et al., 'Bodily Explorations in Space: Social Experience of a Multimodal Art Installation', in *Human-Computer Interaction – INTERACT 2009, Berlin, Heidelberg, 2009*, pp. 62–75. doi: 10.1007/978-3-642-03658-3_11.
- [67] M. Ioannides, N. Magnenat-Thalmann, and G. Papagiannakis, *Mixed reality and gamification for cultural heritage*, vol. 2. Springer, 2017.
- [68] V. Geroimenko, *Augmented Reality in Education: A New Technology for Teaching and Learning*. New York: Springer Nature, 2020.
- [69] B. Marr, *Extended Reality in Practice: 100+ Amazing Ways Virtual, Augmented and Mixed Reality Are Changing Business and Society*, 1st edition. Chichester, West Sussex, United Kingdom: Wiley, 2021.
- [70] J. G. Tromp, D.-N. Le, and C. Van Le, *Emerging Extended Reality Technologies for Industry 4.0: Early Experiences with Conception, Design, Implementation, Evaluation and Deployment*. London: John Wiley & Sons, 2020.
- [71] J. Flotyński, *Knowledge-Based Explorable Extended Reality Environments*. New York: Springer, 2020.
- [72] S. Rothe, D. Buschek, and H. Hußmann, 'Guidance in cinematic virtual reality-taxonomy, research status and challenges', *Multimodal Technol. Interact.*, vol. 3, no. 1, p. 19, 2019, doi: 10/gntfkq.
- [73] E. R. Williams, C. Love, M. Love, and A. Durado, *Virtual reality cinema: narrative tips and techniques*. New York: Routledge, 2021.

Author Biography

Adnan Hadzi is currently working as resident academic in the Department of Digital Arts, at the Faculty of Media and Knowledge Sciences, University of Malta. Hadzi has been a regular at Deckspace Media Lab, for the last decade, a period over which he has developed his research at Goldsmiths, University of London, based on his work with Deptford.TV. It is a collaborative video editing service hosted in Deckspace's racks, based on free and open source software, compiled into a unique suite of blog, cvs, film database and compositing tools. Through Deptford TV and Deckspace TV he maintains a strong profile as practice-led researcher.