Subject Description Form

Subject Code	COMP5424
Subject Title	Extended Reality
Credit Value	3
Level	5
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	The objectives of this subject are to: 1. provide students with a in-depth view of extended reality and relevant interactive technologies including selected topics of the latest trends in both academic and industrial contexts; 2. equip students with interdisciplinary knowledge regarding both the technological, perceptual, and psychological aspects of extended reality; 3. provide students with the knowhow of user experience design for extended reality applications; 4. equip students with knowledge and skills in design, development, and evaluation of extended reality applications; and 5. nurture students' humanistic thinking and aesthetic sense in the design of extended reality applications.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: *Professional/academic knowledge and skills* 1. grasp and consolidate the main theories and concepts in extended reality; 2. demonstrate a deep understanding and practical knowhows in extended reality and relevant interactive technologies; 3. apply the theoretical foundations and practical knowhows creatively in the design of extended reality applications to address real-world problems; 4. critically evaluate and analyze extended reality applications from the perspectives of academic research and industrial practice through empirical approaches; 5. critically synthesize design ideas from the latest trends and challenges in extended reality; and 6. enhance humanistic thinking and aesthetic sense in the design of extended reality and relevant interactive applications.

	Attributes for all-roundedness 7. effectively perform tasks by using systematic approaches and applying necessary project management skills in groups; 8. quickly prototype extended reality applications; and 9. formally present the design idea and development process to a range of audiences.
Subject Synopsis/ Indicative Syllabus	Topic **1. Introduction to Extended Reality** Definitions of extended reality; historical context of extended reality (analogue & digital); interdisciplinary nature of extended reality. **2. Perceptual, Cognitive and Psychological Aspects of Extended Reality** Depth perception; color perception; auditory and vestibular systems; sensorimotor contingency; motion sickness and simulator sickness; definition of immersion; hardware design; presence and immersion; place illusion; plausibility illusion; embodiment illusion; self-avatar. **3. Spatial User Interface and User Experience Design** Fitts' law and Fitts' law in spatial user interface; common user interface design decisions in extended reality applications; basics of user experience design; accessibility of spatial user interfaces; hybrid user interface. **4. XR Application Design and Development** Exemplary applications; development process and cycles; game engines and XR development environments; 3D modelling basics; spatial user interface prototyping using OpenVR; **5. Application Evaluations** Technology acceptance; importance of evaluation; hypothesis and null hypothesis; variables and variable types; research model; user study and experiment design; exploratory analysis; confirmatory analysis. **6. Latest Trends and Challenges in Extended Reality** ***Multimodal Interfaces and Tangible Interfaces*** Spatial audio and psychoacoustics; rendering techniques; raytracing; haptics and tactile; pseudo haptics; sensor fusion; tangible interface and haptic retargeting; exemplary applications; ***Collaborative Virtual Environment and social XR*** Co-presence, tele-presence, and social presence; the uncanny valley hypothesis; embodied agents and self-avatars; collaborative interactions; social XR and Metaverse; affective computing; privacy and ethical issues.

Teaching/ Learning Methodology

Lectures, Tutorials and Labs

The subject material will be delivered through lectures, tutorials, and labs. Lectures will focus on the delivery of the theories, definitions, facts, and guidelines with examples from both academic and industrial contexts. Guest lectures from academic and/or industry will be invited to introduce the latest trends in extended reality research and practice. Tutorials and labs will provide students with knowhow in de-facto standards and platforms for extended reality application development. Tutorials and labs will also help students gain hands-on experiences in design, development, and evaluation of extended reality applications in groups.

Group Project and Individual Assignments

The group projects and individual assignments will provide students with in-depth opportunities to practice the lecture concepts, as well as to assess their ability to apply these concepts in practical scenarios.

Examination
The final examination will assess students on their grasp of the subject materials.

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed								
		a	b	c	d	e	f	g	h	i
Continuous Assessment	**55%**	✓	✓	✓	✓	✓	✓	✓	✓	✓
1. Individual Assignments	30%	✓	✓	✓	✓	✓	✓			
2. Group project	25%	✓	✓	✓	✓	✓	✓	✓	✓	✓
Final Examination	**45%**	✓	✓	✓	✓	✓				
Total	100%									

The course will be accessed by individual assignments, group project, and the final examination.

Individual assignments are designed to reinforce the theoretical foundations, important algorithms, and practical knowhows learned during the lectures. The Group project is used to develop students' ability in solving problems by using systematic approaches, collaboration with peer students, and quick prototyping of extended reality applications using de-facto standards and platforms when facing real-world scenarios. Individual contributions to the group project will be evaluated through self-reported contribution lists and workload distribution lists. The final examination is used to assess students on their grasp of the subject materials.

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<tr><td rowspan="5">Student Study Effort Expected</td><td colspan="2">Class contact:</td></tr>
<tr><td>▪ Lectures, Tutorials, and Labs</td><td>39 Hrs.</td></tr>
<tr><td colspan="2">Other student study effort:</td></tr>
<tr><td>▪ Group Project, Individual Assignments, and Final Examination</td><td>66 Hrs.</td></tr>
<tr><td>Total student study effort</td><td>105 Hrs.</td></tr>
<tr><td>Reading List and References</td><td colspan="2">
Textbook:
1. LaValle, S. M. (2016). Virtual Reality. Cambridge University Press.
2. LaViola, J., Kruijff, E., Bowman, D., McMahan, R., & Poupyrev, I. (2017). 3D User Interfaces: Theory and Practice. Addison-Wesley Professional.

Reference Books:
3. Akcayir, G., & Demmans Epp, C. (Eds.). (2020). Designing, Deploying, and Evaluating Virtual and Augmented Reality in Education. IGI Global.
4. Aron, A., & Aron, E. N. (2012). Statistics for Psychology 6th Edition. Pearson.
5. Valve Software. (2020). OpenVR API Documentation. Retrieved from https://github.com/ValveSoftware/openvr/wiki/API-Documentation

Reading List:
6. Benford, S., Bowers, J., Fahlén, L. E., Greenhalgh, C., & Snowdon, D. (1995). User embodiment in collaborative virtual environments. In Proceedings of the SIGCHI conference on Human factors in computing systems (pp. 242-249).
7. Brooks, F. P. (1999). What's real about virtual reality?. IEEE Computer graphics and applications, 19(6), 16-27.
8. Cruz-Neira, C., Sandin, D. J., DeFanti, T. A., Kenyon, R. V., & Hart, J. C. (1992). The CAVE: audio visual experience automatic virtual environment. Communications of the ACM, 35(6), 64-73.
9. Fitts, P. M. (1954). The information capacity of the human motor system in controlling the amplitude of movement. Journal of experimental psychology, 47(6), 381.
10. Kilteni, K., Groten, R., & Slater, M. (2012). The sense of embodiment in virtual reality. Presence: Teleoperators and Virtual Environments, 21(4), 373-387.
11. Mori, M., MacDorman, K. F., & Kageki, N. (2012). The uncanny valley [from the field]. IEEE Robotics & Automation Magazine, 19(2), 98-100.
12. Murata, A., & Iwase, H. (2001). Extending Fitts' law to a three-dimensional pointing task. Human movement science, 20(6), 791-805.
13. Obrenovic, Z., Abascal, J., & Starcevic, D. (2007). Universal accessibility as a multimodal design issue. Communications of the ACM, 50(5), 83-88.
14. Shin, D. (2018). Empathy and embodied experience in virtual environment: To what extent can virtual reality stimulate empathy and embodied experience?. Computers in Human Behavior, 78, 64-73.
15. Skarbez, R., Brooks, Jr, F. P., & Whitton, M. C. (2017). A survey of presence and related concepts. ACM Computing Surveys (CSUR), 50(6), 1-39.
16. Yuan, Y., & Steed, A. (2010). Is the rubber hand illusion induced by immersive virtual reality?. In 2010 IEEE Virtual Reality Conference (VR) (pp. 95-102). IEEE.
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