Subject Description Form

Subject Code	COMP4424
Subject Title	Extended Reality: Theory and Practice
Credit Value	3
Level	4
Pre-requisite / Co-requisite / Exclusion	**Pre-requisite:** COMP2222 or COMP3423 Basic knowledge in Unity programming is preferred. **Exclusion:** N/A
Objectives	The objectives of this subject are to: 1. provide students with a broad view of both theoretical foundations and practical knowhows in extended reality and relevant interactive technologies, given both academic and industry contexts; 2. equip students with interdisciplinary knowledge regarding both the technological and psychological aspects of extended reality and its applications; 3. equip students with knowledge and skills in design, development, and evaluation of extended reality applications; and 4. 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* (a) understand the theoretical foundations and practical knowhows in extended reality and relevant interactive technologies; (b) apply the theoretical foundations and practical knowhows in the design of extended reality applications to address real-world problems; (c) possess the ability to develop and evaluate extended reality systems for different domains of applications; (d) enhance humanistic thinking and aesthetic sense in the design of extended reality and relevant interactive applications; *Attributes for all-roundedness* (e) solve problems by using systematic approaches in groups; and

	(f) quick prototyping of interactive computing systems.
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. **Perception and Immersion** Depth perception; colour perception; audio sense; vestibular sense; sensorimotor contingency; extended reality hardware design and immersion. 3. **Computer Graphics and Multimodal Interface** Computer graphics basics; foveated rendering in virtual reality; volumetric rendering; photogrammetry and reconstruction; level of details (LoD); rendering optimisation for extended reality applications; motion capture; multimodal interface design; haptics; haptic retargeting and rubber hand illusion. 4. **Psychological Aspects of Extended Reality** Presence and immersion; place illusion; plausibility illusion; embodiment illusion; self-avatar; co-presence and social presence; uncanny valley hypothesis. 5. **Applications and Evaluations** Extended reality applications in education, healthcare and rehabilitation, creative arts (including cinematics), building information management (BIM), and entertainment; three-dimensional user interface and prototyping; importance of evaluation; variables and variable types; user study and experiment design; exploratory analysis; confirmatory analysis. 6. **Challenges and Advancements** Graphical realism; motion capture and animation realism; challenges in making generic haptic interface; nausea and simulation sickness; socialisation of extended reality; artificial intelligence and extended reality.

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 theoretical foundations and practical knowhows. Guest lectures from the industry or practitioners will be invited to introduce the application of extended reality in solving real-world problems. Tutorials and labs will provide students guidance and opportunities in applying what they have learned during the lectures in the design, development and evaluation of extended reality applications using de-facto standards and platforms.

Group Project and Individual Assignments

Group project 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
Continuous Assessment	70%						
1. Individual Assignments and Group Project		✓	✓	✓	✓	✓	✓
Final Examination	30%	✓	✓	✓	✓		
Total	100%						

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

The individual assignments are designed to reinforce the theoretical foundations 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 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.

Reference Books:
1. Akcayir, G., & Demmans Epp, C. (Eds.). (2020). Designing, Deploying, and Evaluating Virtual and Augmented Reality in Education. IGI Global.
2. Akenine-Möller, T., Haines, E., & Hoffman, N. (2018). Real-Time Rendering, Fourth Edition, A K Peters/CRC Press.
3. Aron, A., & Aron, E. N. (2012). Statistics for Psychology 6th Edition. Pearson.
4. Valve Software. (2020). OpenVR API Documentation. Retrieved from https://github.com/ValveSoftware/openvr/wiki/API-Documentation

Reading List:
1. Azmandian, M., Hancock, M., Benko, H., Ofek, E., & Wilson, A. D. (2016). Haptic retargeting: Dynamic repurposing of passive haptics for enhanced virtual reality experiences. In Proceedings of the 2016 chi conference on human factors in computing systems (pp. 1968-1979).
2. Brooks, F. P. (1999). What's real about virtual reality?. IEEE Computer graphics and applications, 19(6), 16-27.
3. Kilteni, K., Groten, R., & Slater, M. (2012). The sense of embodiment in virtual reality. Presence: Teleoperators and Virtual Environments, 21(4), 373-387.
4. Mori, M., MacDorman, K. F., & Kageki, N. (2012). The uncanny valley [from the field]. IEEE Robotics & Automation Magazine, 19(2), 98-100.
5. 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.
6. 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.
7. 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.</td></tr>
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