https://courseoutline.auckland.ac.nz/dco/course/COMPSCI/373/1233

COMPSCI 373 : Computer Graphics and Image Processing

Science

2023 Semester One (1233) (15 POINTS)

Course Prescription

Basic geometric processes including transformations; viewing and projection; back projection and ray tracing. Graphics modelling concepts: primitives, surfaces, and scene graphs, lighting and shading, texture mapping, and curve and surface design. Graphics and image processing fundamentals: image definition and representation, perception and colour models, grey level and colour enhancement, neighbourhood operations and filtering. Use of the OpenGL graphics pipeline.

Course Overview

This course introduces the fundamentals of image processing and computer graphics, which are necessary for the analysis and processing of image data and for the reconstruction, modelling, animation and photo-realistic rendering of 3D scenery. You will learn about key computer graphics concepts including graphics primitives, lighting and shading, texture mapping, ray tracing, and curve and surface representation. Furthermore, image processing fundamentals are presented such as image definition and representation, perception and colour models, grey level and colour enhancement, neighbourhood operations, filtering and image segmentation. Basic geometric processes for image analysis and scene formation will be discussed including geometric transformations, viewing and projection matrices, and digital geometry.

The course aims to balance both the theoretical (mathematical) underpinnings of computer graphics and image processing as well as the practical experience with writing code in the respective areas. Lab exercises based on Coderunner and a programming assignment are components of the course to give hands-on experience.

COMPSCI 373 delivers the necessary basic understanding of computer graphics and image processing methodology, which may lead to projects or post-graduate courses in visualization, virtual and augmented reality, or computer vision. These topics are exciting research areas, e.g.:

- combined with machine learning and neural networks, image-based scene understanding has recently seen great success in applications like autonomous driving or medical image analysis
- merging graphics and image processing, virtual and augmented reality allows us to experience and explore realistically generated 3D worlds or to overlay synthetically created information onto the real world

Furthermore, these topics are also areas where specialists are sought by industry (e.g. gaming or robotics industry), both nationally as well as internationally.

Course Requirements

Prerequisite: COMPSCI 210, 230 Restriction: COMPSCI 771

Capabilities Developed in this Course

Capability 1: Disciplinary Knowledge and Practice
Capability 2: Critical Thinking
Capability 3: Solution Seeking
Capability 4: Communication and Engagement
Capability 5: Independence and Integrity

Graduate Profile: Bachelor of Science

Learning Outcomes

By the end of this course, students will be able to:

1. Explain and apply basic computer graphics concepts and mathematical (geometric) principles for creating and rendering 3D content (Capability 1 and 3)
2. Explain the OpenGL rendering pipeline and be able to write code for solving fundamental computer graphics problems using C++ and OpenGL (Capability 1)
3. Demonstrate an understanding of of image representation and manipulate digital images and objects derived from them, and be able to write basic image processing routines in Python (Capability 1)
4. Explain image filtering and basic image segmentation approaches (Capability 1)
5. Understand and analyse simple computer graphics algorithms for generating and rendering 3D scenes for different application scenarios (Capability 2)
6. Assess basic image processing methods regarding their suitability for composing specific task-oriented image processing (Capability 2)
7. Apply geometric principles to solve spatial problems (Capability 3)
8. Implement basic image processing methods regarding their suitability for composing specific task-oriented image processing (Capability 3)
9. Engage and collaborate with fellow student and discuss course material and lab problems (e.g. via the moderated Piazza online forum) (Capability 4)
10. Independently solve simple computer graphics and image processing problems and test, experiment, and apply learned concepts in novel ways (e.g. using the CodeRunner assignments and sandboxes) (Capability 5)

Assessments

Assessment Type	Percentage	Classification
Practical	40%	Individual Coursework
Mid Term Test	20%	Individual Test

Final Exam	40%	Individual Examination
3 types	100%	

Assessment Type	Learning Outcome Addressed									
	1	2	3	4	5	6	7	8	9	10
Practical	✓		✓		✓	✓	✓	✓	✓	✓
Mid Term Test	✓	✓			✓		✓			
Final Exam	✓	✓	✓	✓	✓	✓	✓	✓		

Tuākana

Tuākana Science is a multi-faceted programme for Māori and Pacific students providing topic specific tutorials, one-on-one sessions, test and exam preparation and more. Explore your options at
https://www.auckland.ac.nz/en/science/study-with-us/pacific-in-our-faculty.html
https://www.auckland.ac.nz/en/science/study-with-us/maori-in-our-faculty.html

For more information and to find contact details for the CompSci 373 Tuākana coordinator, please see https://www.auckland.ac.nz/en/science/study-with-us/maori-and-pacific-at-the-faculty/tuakana-programme.html

Key Topics

- Geometry
- Graphics & OpenGL
- Light and Illumination
- Shading and Shadows
- 3D Modelling and Transformations
- Texture Mapping
- Raytracing
- Parametric Curves and Surfaces
- Digital Images and Histograms
- Intensity Transformations and Histogram Equalization
- Filtering and Convolution
- Edge Detection
- Segmentation
- Mathematical Morphology and Morphological Image Processing

Special Requirements

To pass the course, as well as obtaining at least 50% overall, a student must also pass the Test + Exam component (60%) by obtaining at least 30 out of 60.

Workload Expectations

This course is a standard 15-point course and students are expected to spend 10 hours per week involved in each 15-point course that they are enrolled in.

For this course, you can expect:

- 3 hours of lectures
- A 1-hour tutorial
- 2 hours of reading and thinking about the content
- 4 hours of work on CodeRunner labs and/or test preparation per week

Delivery Mode

Campus Experience

Attendance is expected at scheduled activities including tutorials to receive credit for components of the course.
Lectures will be available as recordings. Other learning activities including tutorials will be available as recordings.
Attendance on campus is required for the test and exam.
The activities for the course are scheduled as a standard weekly timetable.

Learning Resources

Course materials are made available in a learning and collaboration tool called Canvas which also includes reading lists and lecture recordings (where available).

Please remember that the recording of any class on a personal device requires the permission of the instructor.

Course Material:

- Weekly lectures with lecture slides and recordings published
- Weekly tutorials with tutorial slides and recordings published
- CodeRunner: Graded weekly labs; optional weekly labs; sandboxes for practising, testing, and experimentation

Recommended Readings:

- G Gimel'farb, P. Delmas; Image Processing and Analysis: A Primer, World Scientific Europe, ISBN 978-1-78634-581-3, 2018
- F.S. Hill; Computer Graphics using OpenGL, Prentice Hall

Student Feedback

During the course Class Representatives in each class can take feedback to the staff responsible for the course and staff-student consultative committees.

At the end of the course students will be invited to give feedback on the course and teaching through a tool called SET or Qualtrics. The lecturers and course co-ordinators will consider all feedback.

Your feedback helps to improve the course and its delivery for all students.

Students found the workload in the last two weeks to high and we hence have replaced the second test with a final exam.
Students suggested to make CodeRunner assessment questions more relevant and we currently work on adding more questions with practical applications.

Academic Integrity

The University of Auckland will not tolerate cheating, or assisting others to cheat, and views cheating in coursework as a serious academic offence. The work that a student submits for grading must be the student's own work, reflecting their learning. Where work from other sources is used, it must be properly acknowledged and referenced. This requirement also applies to sources on the internet. A student's assessed work may be reviewed against online source material using computerised detection mechanisms.

Class Representatives

Class representatives are students tasked with representing student issues to departments, faculties, and the wider university. If you have a complaint about this course, please contact your class rep who will know how to raise it in the right channels. See your departmental noticeboard for contact details for your class reps.

Copyright

Inclusive Learning

All students are asked to discuss any impairment related requirements privately, face to face and/or in written form with the course coordinator, lecturer or tutor.

Student Disability Services also provides support for students with a wide range of impairments, both visible and invisible, to succeed and excel at the University. For more information and contact details, please visit the Student Disability Services' website http://disability.auckland.ac.nz

Special Circumstances

If your ability to complete assessed coursework is affected by illness or other personal circumstances outside of your control, contact a member of teaching staff as soon as possible before the assessment is due.

If your personal circumstances significantly affect your performance, or preparation, for an exam or eligible written test, refer to the University's aegrotat or compassionate consideration page https://www.auckland.ac.nz/en/students/academic-information/exams-and-final-results/during-exams/aegrotat-and-compassionate-consideration.html.

This should be done as soon as possible and no later than seven days after the affected test or exam date.

Learning Continuity

In the event of an unexpected disruption, we undertake to maintain the continuity and standard of teaching and learning in all your courses throughout the year. If there are unexpected disruptions the University has contingency plans to ensure that access to your course continues and course assessment continues to meet the principles of the University's assessment policy. Some adjustments may need to be made in emergencies. You will be kept fully informed by your course co-ordinator/director, and if disruption occurs you should refer to the university website for information about how to proceed.

The delivery mode may change depending on COVID restrictions. Any changes will be communicated through Canvas.

Student Charter and Responsibilities

The Student Charter assumes and acknowledges that students are active participants in the learning process and that they have responsibilities to the institution and the international community of scholars. The University expects that students will act at all times in a way that demonstrates respect for the rights of other students and staff so that the learning environment is both safe and productive. For further information visit Student Charter https://www.auckland.ac.nz/en/students/forms-policies-and-guidelines/student-policies-and-guidelines/student-charter.html.

Disclaimer

Elements of this outline may be subject to change. The latest information about the course will be available for enrolled students in Canvas.

In this course students may be asked to submit coursework assessments digitally. The University reserves the right to conduct scheduled tests and examinations for this course online or through the use of computers or other electronic devices. Where tests or examinations are conducted online remote invigilation arrangements may be used. In exceptional circumstances changes to elements of this course may be necessary at short notice. Students enrolled in this course will be informed of any such changes and the reasons for them, as soon as possible, through Canvas.