School of
Engineering and Computer Science
Te Kura Mātai Pūkaha, Pūrorohiko

Prescription

This course provides a guide to advanced techniques in the field of Mechatronics. The course material studies the interaction between hardware, software and communication components as it relates to embedded systems. Robotics are frequently used to illustrate the mechatronic theory. Artificial Intelligence techniques are introduced as a practical method for addressing the complex interactions between the electronic, mechanical and software components. The course is very practically oriented and primarily uses project-based assessments. These include a robotic competition, real-world customer design, industrial design considerations (in collaboration with the School of Design) and cognitive robotics.

Course learning objectives

Students who pass this course will be able to:

1. Formulate appropriate task-solving strategies based on advanced Mechatronic techniques, such as analytical design. Much of the course is based on simulated and physical autonomous Mobile Robotics, the application will be applicable to a wide range of devices. Engineering judgement applied to mechatronic device construction and final design critique. The course considers the advanced programming and user considerations required for practical mechatronic devices. 3(b). [Examined in Assessment 1]
2. Integrate wider considerations than functionality, such as the role of customer, assembly and construction into designs. Design, demonstrate and present the above aspects of Advanced Mechatronics, including to external customers and important dignitaries 3(f). [Examined in Assessment 2 & 3]
3. Evaluate the impact of mechanical constraints in relation to operation and programming a device, i.e. investigate a robotic system. 3(e). [Examined in Assessment 1 and 3]
4. Use means like Kalman filter to handle error propagation & uncertainty; part of Simultaneous Localisation & Mapping. Define sensing, control of high-level behaviour. Categorise reactive & high-order deliberative behaviour viz localisation, mapping, path planning & goal setting. Use the capabilities in control architecture. Use high-order deliberative control, e.g. A*path planning, vector field histogram and cognitive control, i.e. affective computation 3(f). [Examined in Assessment 2]
5. Synthesise, specify, select and utilise a wide range of artificial intelligence techniques in order to solve complex control problems that would otherwise be impractical using conventional mathematical approaches. 3(f). [Examined in Assessments 3-5 if most appropriate design method]

Course content

The following is the material to be covered during the lectures. However, this is subject to change. An approximate lecture schedule is as follows:
Robotic Architectures
Robotic Operating System
Design to Customer Specification
Human Interaction
Industrial Design
Design Life Cycle
Robotic Manipulators

Sensors
Robot Kinematics
World Representation
Localisation
Control Architectures
Path Planning
Reactive Control
Why use AI?
AI Decision making
AI Learning
AI Applications
Note this schedule is subject to change, depending on progress through the material.

Withdrawal from Course

Withdrawal dates and process:
https://www.victoria.ac.nz/students/study/course-additions-withdrawals

Lecturers

Will Browne (Coordinator)

will.browne@vuw.ac.nz 04 4635233 ext 8489

418 Alan MacDiarmid Building, KelburnNick Thompson will assist in Robot Operating System expertise.

Teaching Format

During the trimester there will be two lectures and one tutorial or group meeting per week.

Student feedback

This course is assessed through assignments only, i.e. there is no final exam. As this is a 400-level course the assignments are exploratory and open-ended. **Thus, workload and time management form an important aspect of the course.** Organisation, professionalism and addressing aspects of the project correctly first time assist in not wasting time. Furthermore, communication (both written and oral) between group members working on the same project is essential to avoid time wasted debugging errors associated with the integration of component parts of the project. Knowing when to stop working on a project, i.e. the law of diminishing returns compared to other courses, is important.

Student feedback on University courses may be found at:
www.cad.vuw.ac.nz/feedback/feedback_display.php

Dates (trimester, teaching & break dates)

- Teaching: 08 July 2019 - 13 October 2019
- Break: 19 August 2019 - 01 September 2019
- Study period: 14 October 2019 - 17 October 2019
- Exam period: 18 October 2019 - 09 November 2019

Class Times and Room Numbers

08 July 2019 - 18 August 2019

- **Monday** 10:00 - 10:50 – 401, Murphy, Kelburn
- **Tuesday** 10:00 - 10:50 – 401, Murphy, Kelburn
- **Thursday** 10:00 - 10:50 – 401, Murphy, Kelburn

02 September 2019 - 13 October 2019

- **Monday** 10:00 - 10:50 – 401, Murphy, Kelburn
- **Tuesday** 10:00 - 10:50 – 401, Murphy, Kelburn
- **Thursday** 10:00 - 10:50 – 401, Murphy, Kelburn

Set Texts and Recommended Readings

Required

The textbook for ECEN 430 is *Introduction to Autonomous Mobile Robots*, where the second edition is recommended although the first still contains relevant information.

Recommended

See Also
Rob Callan, *Artificial Intelligence* (2003) Palgrave
Shigley's *Mechanical Engineering Design* (Hardcover)

- Siegwart, R., Nourbakhsh, I. D. Scaramuzza (2011) *Introduction to Autonomous Mobile Robots*. 2nd edition. A Bradford Book, The MIT Press, Cambridge, Massachusetts, London, England.

Mandatory Course Requirements

In addition to achieving an overall pass mark of at least 50%, students must:

- Submit their component of the industrial robotics project report.

If you believe that exceptional circumstances may prevent you from meeting the mandatory course requirements, contact the Course Coordinator for advice as soon as possible.

Assessment

This course will be internally assessed through assignments, design project, group project work and research presentation.

Note, there is a degree of uncertainty when using real-world customer data. Although all practical steps are taken for the industrial project to go smoothly it is possible for delays beyond the control of the course to be introduced. Thus an 'AI Racer' assignment is held in reserve if it is inappropriate for assignment 3 to carry the majority of the course marks.

Assessment Item	Due Date or Test Date	CLO(s)	Percentage
Mechatronic design evaluation.	Week 2-3	CLO: 1,3	14%
Cognitive Robotics (practical test of theory)	Week 6	CLO: 2,4	36%
Real world design, customer specification	Week 7	CLO: 1	10%
Real world design to customer investigation and implementation of an advanced mechatronic system.	Week 10	CLO: 1,2,3,4,5	30%
Real world design to customer presentation	Week 11	CLO: 2	10%

Penalties

All work is due in on the due date. Work will not be marked if more than 1 week late. Assignments and laboratory reports need to be handed in on the assigned dates - typically one week after the experiment was performed or the assignment was handed out. Work submitted after the due date will incur a penalty. Marks will be deducted at a rate of 10% of the full mark for each working day late. Any work handed in after the model solutions have been made available will not be graded at all. Extensions will be given only in exceptional circumstances, and if agreed before the due date. In the event of an aegrotat application, regular submission and performance in assignments and laboratories will contribute substantially to the outcome.

Extensions

Extensions will be given only in exceptional circumstances and require a written request submitted before the due date.
In the event of an aegrotat application regular submission of assignments and performance over the course of the project will contribute susbstantially to the outcome.

Submission & Return

The means of submission varies for different pieces of assessment. For hard copy submissions, a drop box is located in Cotton Level 2. Detailed submission instructions are included on each assessment item.

Work will be returned during regularly scheduled lecture times.

Marking Criteria

As specified in each project assignment description.

Group Work

This course is heavily team based as Mechatronics involves the integration of many different components, such that Mechatronics engineers are expected to be able to work in teams. Clear delimitation of roles within a group are required to enable individual grades to be assigned, which may be influenced by overall group performance.

Peer Assessment

Peer assessment will be used to inform grading for group projects, but will not be definitive.

Workload

In order to maintain satisfactory progress in ECEN 430, you should plan to spend an average of 10 hours per week on this paper. A plausible and approximate breakdown for these hours would be:

- Lectures and tutorials: 3
- Readings: 2
- Assignments: 5

Teaching Plan

Please see course content for the lecture schedule plan.

Communication of Additional Information

Communication will be through the class email list and Blackboard

Links to General Course Information

- Academic Integrity and Plagiarism: https://www.victoria.ac.nz/students/study/exams/integrity-plagiarism
- Academic Progress: https://www.victoria.ac.nz/students/study/progress/academic-progess (including restrictions and non-engagement)
- Dates and deadlines: https://www.victoria.ac.nz/students/study/dates
- Grades: https://www.victoria.ac.nz/students/study/progress/grades
- Special passes: Refer to the Assessment Handbook, at https://www.victoria.ac.nz/documents/policy/staff-policy/assessment-handbook.pdf
- Statutes and policies, e.g. Student Conduct Statute: https://www.victoria.ac.nz/about/governance/strategy
- Student support: https://www.victoria.ac.nz/students/support
- Students with disabilities: https://www.victoria.ac.nz/st_services/disability/
- Student Charter: https://www.victoria.ac.nz/learning-teaching/learning-partnerships/student-charter
- Terms and Conditions: https://www.victoria.ac.nz/study/apply-enrol/terms-conditions/student-contract
- Turnitin: http://www.cad.vuw.ac.nz/wiki/index.php/Turnitin
- University structure: https://www.victoria.ac.nz/about/governance/structure
- VUWSA: http://www.vuwsa.org.nz

Offering CRN: 18576

Points: 15
Prerequisites: ECEN 301 (or PHYS 340)
Duration: 08 July 2019 - 10 November 2019
Starts: Trimester 2
Campus: Kelburn