B31YS Robotics Systems Science

COURSE DETAILS
Course Code: B31YS
Full Course Title: Robotics Systems Science
SCQF Level: 11
SCAF Credits: 15
Available as Elective: Yes

DELIVERY LEVEL
Undergraduate: Yes
Postgraduate Taught: Yes
Postgraduate Research: Yes

Additional Information:

COURSE AIMS
This course will be a level 11 degree level introduction to several core areas in robotics: kinematics of robots; robot control; motion planning; state estimation and signal processing; localization and mapping; computer vision for robotics; robotics architectures, tools and approaches for system integration. Lectures on these topics will be complemented by a large practical that exercises knowledge of a cross section of these techniques in the construction of an integrated robot system in the lab, motivated by a task such as robot navigation. Also, in addition to lectures on algorithms and lab sessions, we expect that there will be several lecture hours dedicated to discussion of implementation issues - how to go from the equations to code.

The aim of the course is to present a unified view of the field, culminating in a practical involving the development of an integrated robotic system that actually embodies key elements of the major algorithmic techniques.

LEARNING OUTCOMES – SUBJECT MASTERY

- model the motion of robotic systems in terms of kinematics
- analyse and evaluate a few major techniques for feedback control, motion planning and computer vision as applied to robotics
- translate a subset of standard algorithms for motion planning, localization and computer vision into practical implementations
- implement and evaluate a working, full robotic system involving elements of control, planning, localization and vision
- appreciate and apply software engineering approaches for the development of robotic software systems

Ability to critically review, evaluate and implement a range of advanced techniques in robotics

Ability to review exiting litterature and present it to an audience

Ability to write a technical report

LEARNING OUTCOMES – PERSONAL ABILITIES
The teams will be setup as a professional organisation and will be required to understand specifications from the project sheet, develop a design document, an implementation plan and a test plan, as routinely done in commercial organisations. We will also introduce the notion of risk register.

The project will develop autonomy and teamwork as groups of students will work together to develop a unique solution to solve a common problem on a set of robotics platforms. They will have a choice of sensors and algorithms to choose from and will need to work as a team (teamwork) on different aspects (Accountability) of the system.

The project will be mostly computer based developing high level engineering skills including knowledge of standard ICT frameworks for robotics such as ROS and GIT. It will also involve the development of algorithms based on scientific programming (Numeracy).

**SYLLABUS**

- Kinematics - forward and inverse
- Control
- Sensing - proprioception, etc.
- Motion planning - basics and sampling based methods
- Motion planning - planning under uncertainty, etc
- State estimation, localization and mapping
- Implementing SLAM; Multi-modal sensor fusion
- Image acquisition
- Edge detection and segmentation
- Shape description and matching
- Two-view geometry
- Interest points and regions
- Recognition of specific objects
- Visual servoing and ego-motion estimation
- Middleware and software engineering for robot systems

**Required Skills:**

This course is open to all MSc in Robotics and Beng/Meng in Robotics students. The course will require some knowledge of the following fundamental notions: Multivariate Calculus, Linear Algebra and matrix manipulations, Basic notions of Statistics and concepts including expectation and conditional probability. General programming competence is assumed. The course will use C++ / python in a Linux environment, GIT and OpenCV.
Reading list:


S. Thrun, W. Burgard and D. Fox, Probabilistic Robotics.


Efforts: 150 (Lecture Hours 30, Supervised Practical/Workshop/Studio Hours 30, Summative Assessment Hours 2, Directed Learning and Independent Learning Hours 88. You should expect to spend approximately 40 hours on the coursework for this course.

COURSE RELATIONSHIPS
N/A

LOCATION AND ASSESSMENT METHODS

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