Special Topics Courses

RBE 595 Special Topics courses are arranged by individual faculty with special expertise, these courses survey fundamentals in areas that are not covered by the regular Robotics Engineering course offerings. Courses are not always offered each semester.

RBE 595 courses offered in Spring 2022:

Artificial Intelligence for Autonomous Vehicles (Online)

Autonomous vehicles or self-driving vehicles represent one of the most significant advances in technology. Their impact will go beyond technology, beyond transportation, beyond urban planning to change our daily lives in ways we have yet to imagine.

This course is an introduction to machine learning and deep neural networks and its application in the domain of self-driving cars. Deep learning algorithms are becoming the disruptor agent that is allowing the rapid developments of autonomy in its multidimensional level. Currently we can find research of deep learning algorithms trying to improve driving performance, detecting pedestrians, detecting traffic, detecting and taking actions while navigating in a highway, reading the traffic signs and evaluating in real-time the readiness of the driver while he/she is on control and more.

Students who enroll in this course will master state-of-the-art technologies that are shaping the future of the field. Students will be exposed to interactive projects in vehicle perception, vehicle cognition, vehicle controls, localization, motion planning, and more.

The course will involve the development of a project where students will be able to take relevant research problems in the field of autonomous vehicles, apply the techniques and principles learned in the course to develop an approach, and implement it to investigate how these techniques are applicable. Prerequisites: Undergraduate or graduate level course in Linear Algebra, RBE 500 Foundations of Robotics, RBE 550 Motion Planning, Proficiency in Python.

Advanced Robot Navigation (Online)

In recent years, robots have become part of our everyday lives. Leaving the research labs to be part of the common tools of a household, tools such as robotic vacuum cleaners (iRobot Roomba, Kalorik), pool cleaners (Polaris, Maytronics), Lawn mowers (Landroid, LawnBott) and more abound. For navigating safely, these robots need the ability to localize themselves autonomously using their onboard sensors. Potential applications of such systems include the automatic 3D reconstruction, 3D reconstruction of buildings, inspection and simple maintenance tasks, metric exploitation, surveillance of public places as well as in search and rescue systems. In this course, we will dive deep into the current techniques for 3D localization, mapping and navigation that are suitable for robotic applications. Required prerequisites: RBE 500 - Foundations of Robotics, RBE 501 – Robot Dynamics, RBE 502 – Robot Control

Medical Imaging and Instrumentation (In-Person)

An introduction to the physical principles behind modern medical imaging including radiography, X-ray computed tomography, nuclear medicine, ultrasound imaging, and magnetic resonance imaging and the integration with robotic instrumentation. The primary focus is on mathematical and physical foundations within each modality and understanding of interaction with biological tissue. The course will further cover advanced imaging solutions combining with robotic instrumentation to enable robotic assisted imaging and image-guided robotic intervention. The term team project would allow students to tackle real clinical challenges through medical imaging and robotic instrumentation. (Prerequisites: Linear algebra, reasonable skills in programming)

Swarm Intelligence (In-Person) *****NOTE: Swarm Intelligence is cancelled for Spring 2022*

This course will cover a wide range of topics in swarm intelligence, including mathematical, computational, and biological aspects. The course is organized in four parts. In the first part, the students will learn about complex systems and the basic concepts of self-organization, such as positive and negative feedback, symmetry breaking, and emergence. The second part concerns several types of network models, such as information cascades, epidemics and voting. The instructor will illustrate a diverse collection of self-organized systems in nature, finance, and technology that concretize these concepts. The third part is dedicated to swarm robotics, and will cover common swarm algorithms for task allocation, collective motion, and collective decision-making. The fourth and final part covers optimization algorithms inspired by swarm intelligence, namely ant colony optimization and particle swarm optimization. The course will blend theory and practice, challenging the students to learn by implementing the algorithms discussed in class. The final project will involve working on a research problem in swarm robotics, and the final deliverable will include a demo and a research paper