CENTRALE NANTES

ENGINEERING PROGRAMME

2024-2025

Year 2 / Year 3

Specialisation option

Robotics

OD ROBOTIQUE

PROGRAMME SUPERVISOR
Abdelhamid CHRIETTE

Autumn Semester

Course unit	ECTS Credits	Track	Course code	Title
UE 73	12	Core course	COBSS MOROB PROAV VIROB	Non-linear control and observation Manipulator Robot Modelling Advanced Programming Vision for Robotics
UE 74	13	Core course	COROB MIDWA P1ROBOTIQUE RASOM VETIN	Robot Design Middleware Robotic Project 1 Modeling and Control of Unmanned Systems (Aerial/Submarine) Intelligent vehicle and transport

Spring Semester

Course unit	ECTS Credits	Track	Course code	Title
UE 83	14	Core course	COMRO INTEG P2ROBOTIQUE PASME PLANI	Robot Control Integration Robotic Project 2 Parallel, social and medical robotics Planification

Non-linear control and observation [COBSS]

LEAD PROFESSOR(S): Franck PLESTAN

Requirements

Objectives

This course's main objective is to introduce the basic tools for the analysis and control of linear and nonlinear systems in the state approach.

Course contents

Linear systems
Part 1: systems analysis (controllability, observability)
Part 2: Synthesis controllers (state feedback, observers, reconstructed state feedback)
Part 3: Robust stability.

Nonlinear systems
Part 4: systems analysis (accessibility, observability)
Part 5: synthesis regulators (input-output linearization, robust control-sliding mode).

Labs:
LAB1: inverted pendulum (linear version)
LAB2: inverted pendulum (nonlinear version)

Course material

- Phlippe de Larminat, commande des systèmes linéaires, Hermès science, 2002, 288 p.
- Hassan K. Khalil, Nonlinear Systems, Prentice Hall PTR, 2002 - 750 pages
- Y. Shtessel, C. Edwards, L. Fridman, A. Levant, Sliding mode control and observation, Springer, New York, 2016.

Assessment

Collective assessment: EVC 1 (coefficient 0.5)

Individual assessment: EVI 1 (coefficient 0.5)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	14 hrs	8 hrs	8 hrs	0 hrs	2 hrs

ENGINEERING - OD ROBOTIQUE

Year 2 / Year 3 - Autumn Semester - Course Unit 73 / 93

Manipulator Robot Modelling [MOROB]

LEAD PROFESSOR(S): Abdelhamid CHRIETTE

Requirements

Objectives

The main aim of this course is to study and apply the mathematical tools needed to develop models (geometric, kinematic and dynamic) dedicated to manipulator robots, and to study their kinematic redundancy.

Course contents

Part1: Introduction to robotics
Part2: Background on geometry, kinematics and dynamics of solids
Part3: direct and inverse geometrical modeling of manipulator arms
Part4: direct and inverse kinematics modeling of manipulator arms
Part5: direct and inverse dynamic modeling of manipulator arms

Labs:
LAB1: Introduction to tools and methods for modeling
LAB2: Complete modeling of a robot manipulator with 6 degrees of freedom
LAB3: Exploiting kinematic redundancy in an anthropomorphic robot.

Course material

- W. Khalil, and E. Dombre, Modelling, identification and control of robots, Hermes Penton, London, 2002.
- J. Angeles, Fundamentals of Robotic Mechanical Systems, Springer-Verlag, New York, 2002.
- Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, and Giuseppe Oriolo, Robotics: Modelling, planning and control, 1st ed., Springer

Assessment

Collective assessment: EVC 1 (coefficient 0.5)

Individual assessment: EVI 1 (coefficient 0.5)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	10 hrs	8 hrs	12 hrs	0 hrs	2 hrs

ENGINEERING - OD ROBOTIQUE

Year 2 / Year 3 - Autumn Semester - Course Unit 73 / 93

Advanced Programming [PROAV]

LEAD PROFESSOR(S): Olivier KERMORGANT

Requirements

Objectives

To provide students with the fundamentals of modern programming (with C++) and industrial robot manipulator programming with specialized robot languages.

After completing the course, students will be able to:

- Write a C++ program from scratch or expand an existing project, using external libraries
- Create their own classes and know how to understand a class interface documentation
- Use tools such as Cmake, Qt Creator, a debugger and a profiler
- Use the STL when needed

Course contents

C++
- Basic types, STL useful classes (string, vector, pair, map), struct
- Control blocks: if/then/else, for, while, switch
- Functions: argument passing, overloading
- Classes: attributes and methods, inheritance
- Templates, lambda-functions and STL algorithms
- Code organization
- Compilation with Cmake, using external libraries
- Debugger and profiler

Course material

Christine EBERHARDT, Tout sur le C++, éditions Dunod, 2009, 224 pages, EAN13: 9782100531899.

Scott Meyer, Effective C++: 55 Specific Ways to Improve Your Programs and Designs (3rd Edition), Addison-Wesley

Assessment

Collective assessment: EVC 1 (coefficient 0.5)

Individual assessment: EVI 1 (coefficient 0.5)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	10 hrs	12 hrs	8 hrs	0 hrs	2 hrs

Vision for Robotics [VIROB]

LEAD PROFESSOR(S): Elwan HERY

Requirements

Objectives

This course's main objective is to present the basic principles of vision (image formation, image processing, visual geometry and Deep Learning). The topics covered include the formation of images, vision sensors, 2D image processing, feature detectors and descriptors, camera calibration, pose estimation, multi-view geometry and semantic segmentation using Deep Learning.

Course contents

Lectures:

- Introduction
- Image Formation 1: perspective projection and camera models
- Image Formation 2: camera calibration algorithms
- Filtering and Edge detection
- Feature Point Detection
- Multiple-view Geometry and Robust Estimation
- Deep Learning and Semantic Segmentation

Tutorials:
- Projective Geometry and camera models

Practical Sessions :
LAB1: Camera calibration
LAB2: Feature point detection

Course material

- Multiple view Geometry, by R. Hartley and A. Zisserman, 2003.
- Robotics, Vision and Control: Fundamental Algorithms, by Peter Corke, 2011.
- Digital Image Processing, by R. C. Gonzalez and R. E. Woods, 2002.
- Computer Vision: Algorithms and Applications, by Richard Szeliski, 2009.
- An Invitation to 3D Vision, by Y. Ma, S. Soatto, J. Kosecka, S.S. Sastry, 2004.
- Course from Davide Scaramuzza: http://rpg.ifi.uzh.ch/teaching.html
- OpenCV: https://opencv.org/

Assessment

Collective assessment:	EVC 1 (coefficient 0.5)
Individual assessment:	EVI 1 (coefficient 0.5)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	12 hrs	10 hrs	8 hrs	0 hrs	2 hrs

ENGINEERING - OD ROBOTIQUE

Year 2 / Year 3 - Autumn Semester - Course Unit 74 / 94

Robot Design [COROB]

LEAD PROFESSOR(S): Stéphane CARO

Requirements

Objectives

This course is about the optimum design of serial and parallel robots. Some performance indices will be provided and the design problems will be formulated as optimization problems. Those optimization problems may be mono- or multi-objective and subject to constraints. The geometric, kinematic, kinetostatic, elastostatic and dynamic performance of the robots will be considered in those design problems. Moreover, some optimization routines will be taught to solve the optimization problems at hand.

Course contents

Part 1: Geometric, kinematic, kinetostatic, elastostatic and dynamic modeling of robots
Part 2: Performance indices: maximal regular workspace, dexterity indices, transmission factors for velocities and wrenches, elastostatic and elastodynamic indices (considering actuator stiffness only), accuracy / resolution, maximal torque value, energy, etc.
Part 3: Problem of the non-homogeneity of Jacobian matrices
Pare 4: Sensitivity analysis of serial and parallel manipulators to geometric errors and joint clearances.
Part 5: Static Balancing: use of counterweights or springs
Part 6: Trajectory planning
Part 7: Optimal task placement
Part 8: Optimal and robust design

Course material

- W. Khalil, E. Dombre, Modelling, identification and control of robots, Hermes Penton, London, 2002.
- C. Germain, S. Caro, S. Briot and P. Wenger &guil;Optimal Design of the IRSBot-2 Based on an Optimized Test Trajectory, &guil; Proceedings of the ASME 2011 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference IDETC/CIE 2013, August 4-7, 2013, Portland, Oregon, USA.
- S. Briot, A. Pashkevich and D. Chablat, &guil;Optimal Technology-Oriented Design of Parallel Robots for High-Speed Machining Applications, &guil;Proceedings of the 2010 IEEE International Conference on Robotics and Automation (ICRA 2010), 3-8 mai, 2010, Anchorage, Alaska, USA
- Caro, S., Bennis, F. and Wenger, P., 2005, Tolerance Synthesis of Mechanisms : A Robust Design Approach, ASME Journal of Mechanical Design, Vol.127, pp. 86-94, January 2005. hal-00463707
- Wu, G., Bai, S., Kepler, J.A., and Caro, S., 2012, Error Modeling and Experimental Validation of a Planar 3-PPR Parallel Manipulator With Joint Clearances, ASME Journal of Mechanisms and Robotics, Vol. 4(4), pp. 041008-1-041008-12. hal-00832640
- Binaud, N., Cardou, P., Caro, S. and Wenger, P., The Kinematic Sensitivity of Robotic Manipulators to Joint Clearances, Proceedings of ASME Design Engineering Technical Conferences, August 15-18, 2010, Montreal, QC., Canada.

Assessment

Collective assessment: EVC 1 (coefficient 0.5)

Individual assessment: EVI 1 (coefficient 0.5)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	14 hrs	8 hrs	8 hrs	0 hrs	2 hrs

Middleware [MIDWA]

LEAD PROFESSOR(S): Olivier KERMORGANT

Requirements

Objectives

The goal of this course is to discover Robot Operating System, especially the version 2.
This framework allows for the design of a whole robotic architecture with several elementary programs that communicate together, which is a common situation in robotics.

Course contents

Contents
1: General architecture: nodes, topics and services
2: Low-level tools for assisted development
3: Higher-level tools

Labs: The labs will be using the Baxter robot from Rethink Robotics
LAB1: Using nodes and topics, writing launch files to run several nodes
LAB2: Message reading an writing
LAB3: Using the TF topic (frame transformation) and services
LAB4: Mobile robotics

Course material

- Quigley, M., Conley, K., Gerkey, B., Faust, J., Foote, T., Leibs, J., ... & Ng, A. Y. (2009, May). ROS: an open-source Robot Operating System. In ICRA workshop on open source software (Vol. 3, No. 3.2, p. 5).
- http://wiki.ros.org/ROS/Tutorials
- https://docs.ros.org/en/foxy/index.html

Assessment

Collective assessment: EVC 1 (coefficient 0.5)

Individual assessment: EVI 1 (coefficient 0.5)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	6 hrs	8 hrs	16 hrs	0 hrs	2 hrs

ENGINEERING - OD ROBOTIQUE

Year 2 / Year 3 - Autumn Semester - Course Unit 74 / 94

Robotic Project 1 [P1ROBOTIQUE]

LEAD PROFESSOR(S): Abdelhamid CHRIETTE

Requirements

Objectives

Introduce students to robotics engineering tools (modeling, identification and control) through the projects proposed by teachers of the specialisation.

Course contents

Continuous project.

Course material

Depending on the project.

Assessment

Collective assessment: EVC 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	1	0 hrs	0 hrs	0 hrs	32 hrs	0 hrs

ENGINEERING - OD ROBOTIQUE

Year 2 / Year 3 - Autumn Semester - Course Unit 74 / 94

Modeling and Control of Unmanned Systems (Aerial/Submarine) [RASOM]

LEAD PROFESSOR(S): Abdelhamid CHRIETTE

Requirements

Objectives

This course's main objective is to inform engineering students on the problems associated with modeling, perception, navigation and control stand-alone systems like aerial drones and submarines.

Course contents

Part 1A: Unmanned Aerial Systems (UAS)
Part 1B: Fixed Wing (General Introduction & Basics of Aerodynamics, Stability and Derivation of a Dynamic Model, Control, Aspects of Flight Dynamics & Autopilot Design)
Rotary Wing (Introduction to Rotorcraft, Dynamic Modeling of Rotorcraft, Control of Rotorcraft).
Part 2: Unmanned Submarine Vehicles (USV)
Introduction to Submarine Systems, Dynamic Modeling of Submarine Systems, Control of Submarine Systems

Lab Work:
LAB1: Fixed Wing UAS Model and Control
LAB2: Modeling and control of a Quadrotors
LAB3: State Estimation & Control

Course material

- Unmanned Aerial Vehicles: Embedded Control, Rogelio Lozano (Editor), February 2013, Wiley-ISTE.
- Advances in Unmanned Aerial Vehicles State of the Art and the Road to Autonomy. Series: Intelligent Systems, Control and Automation: Science and Engineering, Vol. 33
Valavanis, Kimon P. (Ed.), 2007, XXIV, 543 p.
- Autonomous Underwater Vehicles: Modeling, Control Design, and Simulation, Pushkin Kachroo, Sabiha Wadoo. CRC Press Inc, 14 décembre 2010.

Assessment

Collective assessment: EVC 1 (coefficient 0.5)

Individual assessment: EVI 1 (coefficient 0.5)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	14 hrs	8 hrs	8 hrs	0 hrs	2 hrs

ENGINEERING - OD ROBOTIQUE

Year 2 / Year 3 - Autumn Semester - Course Unit 74 / 94

Intelligent vehicle and transport [VETIN]

LEAD PROFESSOR(S): Abdelhamid CHRIETTE / Gaëtan GARCIA

Requirements

Objectives

The first part of the course aims to give students an overview of the applications of mobile robots. This part also covers the basics of their kinematic modelling, together with the mathematical tools used in vehicle localization algorithms.
The second part of the course addresses some of the issues related to human-machine interactions in the field of automotive transportation. The emphasis is on a multidisciplinary approach to system design, at the interface between cognitive ergonomics and engineering. The illustrations are mainly from the field of driver assistance and autonomous vehicles.

Course contents

- Constraint equations of wheeled mobile robots.
- Mobile robot mobility depending on the types of wheels.
- Kinematic modelling of wheeled mobile robots.
- The localization function in mobile robotics, with a focus on odometry and Kalman filtering tools.
- Psychology and ergonomics applied to human-machine systems.
- Perception for the control of vehicular motion.
- Human-machine cooperation in driving.
- The autonomous vehicle.

Course material

- C.Canudas, B. Siciliano, G.Bastin (editors), Theory of Robot Control, Springer-Verlag, second edition 1999, Chapters 7,8 & 9.
- B.Siciliano, O.Khatib, (editors), Robots Handbook, Springer-Verlag 2008, Chapters 17, 34, 35.
- Pierre Dauchez (editor), Applications non manufacturières de la robotique, traité I2S, Hermès Science Publications 2000, ISBN 2-7462-0165-8.
- Berthoz, A. (1997) Le sens du mouvement, Odile Jacob
- Cacciabue, PC (2007) Modelling Driver Behaviour in Automotive Environments: Critical Issues in Driver Interactions with Intelligent Transport Systems, Springer
- Jagacinski & Flach (2002). Control Theory for Humans, Quantitative Approaches to Modeling Performance. Lawrence Erlbaum Associates.

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	18 hrs	0 hrs	12 hrs	0 hrs	2 hrs

Robot Control [COMRO]

LEAD PROFESSOR(S): Abdelhamid CHRIETTE

Requirements

Objectives

This course's main objective is to apply the control techniques of nonlinear systems in particular cases of robot manipulators and mobile robots.

Course contents

Part 1: Introduction to classical robot control
Part 2: Computed torque of manipulator arms
Part 3: Position control / force
Part 4: Introduction to parametric identification of robots
Part 5: Control of mobile robots back by static, dynamic return and Lyapunov
Part 6: Follow path and trajectory

Labs:
LAB1: Control by torque calculated from a manipulator arm
LAB2: Control of mobile robots
LAB3: Parametric identification (geometric parameters, dynamic)

Course material

- W. Khalil, and E. Dombre, Modelling, identification and control of robots, Hermes Penton, London, 2002.
- C.Canudas, B. Siciliano, G.Bastin (editors), Theory of Robot Control, Springer-Verlag, 1996.
- R.Siegwart I.R. Nourbakhsh, Intrduction to Autonomous Mobile Robots, MIT Press second edition 2010.
- B.Siciliano, O.Khatib,edt , Robots Handbook, Springer-Verlag 2008, Chapters 17, 34, 35.

Assessment

Collective assessment: EVC 1 (coefficient 0.3)

Individual assessment: EVI 1 (coefficient 0.7)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	6 hrs	12 hrs	12 hrs	0 hrs	2 hrs

ENGINEERING - OD ROBOTIQUE

Year 2 / Year 3 - Spring Semester - Course Unit 103 / 83

Integration [INTEG]

LEAD PROFESSOR(S): Gaëtan GARCIA / Olivier KERMORGANT / Vincent FRÉMONT

Requirements

Objectives

Allow the students to realize a group work that integrates the knowledge from various modules of the curriculum.

Course contents

This module aims at coverinv the entire perception chain in terms of force, vision, calibration and control of a robot manipulator.
It is based on simulation work using Gazebo and ROS, followed by validation on a real robot (Franka Panda).
The tasks to be carried out are as follows:
- development of a comanipulation strategy with sight centering constraints
- validation of the strategy on the real robot, in order to acquire photos of the calibration checkboard
- off-line calibration of the homogeneous end-effector/camera matrix using the photos
- development of a visual servoing method in simulation
- development of a hybrid vision-force control in simulation
- validation of the hybrid vision-force control on the real robot

Course material

As provided in each of the relevant curriculum module.

Assessment

Collective assessment: EVC 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	0 hrs	32 hrs	0 hrs	0 hrs	0 hrs

Robotic Project 2 [P2ROBOTIQUE]

LEAD PROFESSOR(S): Abdelhamid CHRIETTE

Requirements

Objectives

Introduce students to robotics engineering tools (modeling, identification and control) through the projects proposed by teachers of the specialisation.

Course contents

Continuous project.

Course material

Depending on the project.

Assessment

Collective assessment: EVC 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	2	0 hrs	0 hrs	0 hrs	48 hrs	0 hrs

Parallel, social and medical robotics [PASME]

LEAD PROFESSOR(S): Juan SANDOVAL AREVALO

Requirements

Objectives

To familiarize students with parallel robots, social robotics and medical robotics.

Part A: Parallel robots
A parallel robot comprises a movable platform with n degrees of freedom and a fixed base connected together by at least two kinematic chains. The movements of the movable platform are generally controlled by n motorized kinematic connections. The most common parallel robot is the Gough-Stewart platform. This platform is used in flight simulators, among other things, and is controlled via six motorized prismatic joints. However, many other parallel manipulators with six degrees of freedom or less have been developed over the past three decades. In this course, several parallel robots, including parallel cable robots, will be presented and analyzed.

Part B: Social robotics
Social robotics is the broad field of robotics that provides interaction (in the broadest sense of the term) with humans. These robots can take many forms, from the most abstract object to the humanoid robot that reproduces the appearance of the human body, as well as some of its sensory and cognitive capabilities. The goal of the course is to make students aware of the many social promises of these technologies, as well as the scientific and human issues they raise, especially from an ethical perspective.

Part C: Medical robotics
The goal of this course is to give students a general overview of the various advances in medical robotics. Emblematic cases of medical robots currently on the market will be presented in detail, as well as new applications in the research phase. Teleoperated and comanipulated robotic assistance systems will be studied and case studies will be proposed to understand the robotic issues related to medical constraints.

Course contents

Course contents

Part A: Parallel robots (4 hours of lectures, 4 hours of tutorials)
Part 1: Enumeration and classification of existing parallel robots
Part 2: Geometric modeling of parallel robots
Part 3: Workspace Analysis of parallel robots
Part 4: Kinematic Modeling of parallel robots
Part 5: Analysis of singularities of parallel robots
Part 6: Presentation of parallel manipulators with several modes of motion
Tuto1: Plotting the workspace of parallel planar robots
Tuto2: Search singular configurations of parallel manipulators

Part B: Social robotics (4 hours of lectures)
Part 1: State of the art and definitions
Part 2: Social acceptability
Part 3: Human-Robot Interaction
Part 4: Robotics and social intelligence
Part 5: Influence of robot appearance

Part 6: Social robotics and ethics

Part C: Medical robotics (4 hours of lectures, 2 hours of tutorials, 12 hours of labs)
Part 1: Introduction to medical robotics
Part 2: Surgical robotics
Part 3: Non-invasive medical robotics
Part 4: Teleoperated systems
Part 5: Comanipulated systems
Lab1: Simulation of a robotic surgical assistant

Course material

- J. Angeles, Fundamentals of Robotic Mechanical Systems, Springer-Verlag, New York, 3rd edition, 2007
- Merlet, J. P., 2006, Parallel Robots (Solid Mechanics and Its Applications), Springer, New York, Vol. 128.
- Amine, S., Tale-Masouleh, M., Caro, S., Wenger, P., and Gosselin, C., 2012, "Singularity Analysis of 3T2R Parallel Mechanisms using Grassmann-Cayley Algebra and Grassmann Line Geometry", Mechanism and Machine Theory, Vol. 52, pp. 326--340. hal-00833520
- Amine, S., Caro, S., Wenger, P. and Kanaan, D., 2012, Singularity Analysis of the H4 Robot using Grassmann-Cayley Algebra", Robotica, Vol. 30(7), pp. 1109-1118, hal-00642230 - Amine, S., Tale-Masouleh, M., Caro, S., Wenger, P., and Gosselin, C., 2012, Singularity Conditions of 3T1R Parallel Manipulators with Identical Limb Structures", ASME Journal of Mechanisms and Robotics, Vol. 4(1), pp. 011011-1{011011-11, doi:10.1115/1.4005336. hal-00642238
- Baddoura, R. & Venture, G. (2013). Social vs. Useful HRI: Experiencing the familiar, perceiving the robot as a sociable partner and responding to its actions. International Journal of Social Robotics, 5(4), 529-547.
- Guay, F., Cardou, P., Cruz Ruiz, A. L. and Caro, S., 2013, Measuring How Well a Structure Supports Varying External Wrenches", The Second Conference on Mechanisms, Transmissions and Applications (MeTrApp 2013), Bilbao, Spain, October 2-4, 2013.
- Wisama Khalil, Etienne Dombre. Modeling, identification and control of robots. Butterworth-Heinemann 2004.
- Shuuji Kajita, Hirohisa Hirukawa, Kensuke Harada, Kazuhito Yokoi: Introduction à la commande des robots humanoïdes: De la modélisation à la génération du mouvement. Springer 2009.
- Troccaz, J. (Ed.). (2013). Medical robotics. John Wiley & Sons.

Assessment

Collective assessment: EVC 1 (coefficient 0.3)

Individual assessment: EVI 1 (coefficient 0.7)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	12 hrs	6 hrs	12 hrs	0 hrs	2 hrs

Year 2 / Year 3 - Spring Semester - Course Unit 103 / 83

Planification [PLANI]

LEAD PROFESSOR(S): Abdelhamid CHRIETTE / Gaëtan GARCIA

Requirements

Objectives

The objective of this course is to get the students acquainted with the main notions and methods in collision free trajectory planning in robotics.

Course contents

- Overview of various classes of problems in trajectory planning.
- Useful concepts: path, trajectory, configuration space, topology and dimension of configuration space, task space, obstacles, obstacles in configuration space.
- Algorithm properties: optimality, complexity, completeness.
- Trajectory generation for robot manipulators: joint synchronization, interpolators.
- Planning in finite state spaces, trees, graphs, the A alorithm, optimality conditions of A.
- Algorithms "Bug1" and "Bug2".
- Potential field methods.
- Planning using road maps, visibility graph, Voronoi diagram, generalized Voronoi diagram, sensor based building of the generalized Voronoi diagram.
- Random sampling based planning: PRM (Probabilistic Road Map), basic PRM implementation.
- Single query planners: EST (Expansive Search Tree), RRT (Rapidly exploring Random Trees).
- Case studies.

Course material

- “Principles of Robot Motion – Theory, Algorithms and Implementation” by H. Choset, K. Lynch, S. Hutchinson, G. Kantor, W. Burgard,
L. Kavraki and S. Thrun, Bradford Book, MIT Press.
- “Planning Algorithms”, S. M. LaVallen, Cambridge University Press.
- “Modeling, Identification and Control of Robots”, W. Khalil and E. Dombre. Kogan Page Science.

Assessment

Collective assessment: EVC 1 (coefficient 0.3)

Individual assessment: EVI 1 (coefficient 0.7)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
French	3	12 hrs	18 hrs	0 hrs	0 hrs	2 hrs