Master's Department of Engineering Sciences

Name of the unit: Introduction to Robotics

Lecturer: Faiz BEN AMAR (faiz.ben$_a$*mar@sorbonne − universite.fr*)
Course code: UM4RBR13
Student workload: 12h of lectures, 8h of tutorial sessions, 8h of lab sessions@
Credits: 3 ECTS

Specialization tracks:	- **E3A** :	☐ CIMES	☐ Syscom	☐ IPS
	- **AR** :	☒ ROBOT	☐ SI	☒ MeDH
	- **MECA** :	☐ MS2	☐ MF2A	☐ CompMech
		☐ ACOU	☐ EE	☐ EE APP

Semester offered: ☒ S1 ☐ S2 ☐ S3 ☐ S4
Language of instruction: ☒ French ☐ English
Targeted audience: ☒ Engineering Sciences students ☐ Other (specify):
Localization : ☒ PMC Campus ☐ Other (specify):

Course Overview

This course aims to train students in the geometric and kinematic modeling of serial manipulator robots. Based on examples of simple manipulation tasks such as taking down or following a trajectory, it introduces the basic concepts of robotics, such as the space of operational parameters, the space of joint parameters, forward and inverse models.
Keywords: Serial manipulator robot, operational space, joint space, rotation matrix, homogeneous transformation matrix, DH convention, direct and inverse geometric models, direct and inverse kinematic model, Jacobian, singularities, manipulability ellipsoid, redundancy and optimization

Prerequisites

Students should have previously acquired the following prerequisites to follow this course:

- Know the following mathematical tools: trigonometric functions, vector calculus, linear algebra, matrix calculus
- Knowing how to parameterize a solid in space

Intended Learning Outcomes

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

1. parameterize a robot in the operational space with Cartesian parameters
2. parameterize a manipulator robot in the joint space with the DH convention
3. use homogeneous transformation matrices in displacement composition
4. write the direct geometric model of a manipulator robot
5. calculate the inverse geometric model of a non-redundant analytical manipulator robot
6. describe the space accessible by the end-effector of a non-redundant manipulator robot
7. analyze the kinematics of a serial robot: mobility, model, Jacobian, singularity, internal mobility, gear transmission

Indicative Teaching Sequence and Methods

Week	C/TD/TP*	Content	Preparation	Learn. outc.
S1	Cours	Rotation and transformation		AAV1
S2	Cours	Geometric modeling of serial robots: DH parameterization		AAV2
S3	TD	Rotation and transformation		AAV1
S4	Cours	Geometric modeling of serial robots: direct model		AAV2-AAV3-AAV4
S5	Cours	Geometric modeling of serial robots: inverse model		AAV4-AAV5
S6	TD	Geometric modeling of serial robots: DH parameterization		AAV4-AAV5
S7	TD	Geometric modeling of serial robots: direct and inverse model		AAV4-AAV5
S9	TP	Handling the equipment (4 ddl robot)		AAV4-AAV5
S10	Cours	Kinematic modeling of series robots		AAV7
S11	Cours	Kinematic modeling of serial robots: Jacobienne		AAV7
S12	Cours	Kinematic modeling of serial robots: Singularities, Redundancy, Optimization		AAV7
S13	TD	Kinematic modeling of series robots		AAV7
S14	TP	Programming an inverse geometric model of a robot		AAV5-AAV6

* C/TD/TP respectively corresponds to lectures, tutorials and lab sessions.

Indicative Assessment of Intended Learning Outcomes (1st session)

Week	Individ./group	In-person/remote	Type of exam	Evaluated outcomes	Scale %
S8	Individual	In-person	Quiz	AAV1-4	15 %
S16	Individual	In-person	Written	AAV1-7	60 %
S14	Individual	In-person	Practical	AAV1-7	25 %

2nde session of exam

Session	Individ./group	In-person/remote	Type of exam	Evaluated outcomes	Scale %
2	Individual	In-person	Written	AAV1-7	75 %
1	Individual	In-person	Practical	AAV1-7	25 %

Bibliographic references

- W. Khalil et E. Dombre, Modélisation, identification et commande des robots

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