Master's Department of Engineering Sciences

MSc in Automation Engineering and Robotics

Name of the unit: Teleoperation and haptic interfaces

Lecturer: Sinan Haliyo ()
Course code:
Student workload: 12 h of lectures, 12 h of labs
Credits: 3 ECTS
Specialization tracks: ☒ ROBOT (elective) ☒ SI (elective) ☒ MeDH (elective)
Semester offered: ☐ S1 ☐ S2 ☒ S3 ☐ S4
Language of instruction: ☐ French ☐ English
Targeted audience: ☐ Engineering Sciences students ☐ Other (specify): ENSAM
Localization : ☒ PMC Campus ☐ Other (specify):

Course Overview

This course unit covers the principles of robot teleoperation in a bilateral-coupling scenario with force feedback. The operator controls the motion of a robot in a remote environment and receives mechanical information through a handheld haptic interface. The teleoperation chain comprises three elements: the haptic interface manipulated by the operator (the master), the teleoperated robot (the slave), and the bilateral coupling scheme that transmits information in both directions. The course focuses both on designing this coupling scheme to achieve stable, transparent control and on designing haptic interfaces that capture the operator's movements and stimulate the sense of touch. Particular attention is given to haptic perception, which is necessary for understanding the sensorimotor mechanisms involved.
Keywords: Teleoperation, bilateral coupling, haptic perception, transparency, stability, passivity, admittance, impedance

Prerequisites

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

- Automatic control, control theory
- Mechanics, vibrations of discrete systems
- Python/C, linear algebra

Intended Learning Outcomes

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

1. Design a bilateral-coupling scheme
2. Design a haptic interface
3. Analyze the haptic perception of an individual or population.

Indicative Teaching Sequence and Methods

Week	C/TD/TP*	Content	Preparation	Learn. outc.
S1	C1	General concepts of teleoperation, transparency and stability. Direct and indirect coupling		AAV1
S2	C2	Bilateral-coupling schemes, impedance and admittance		AAV1
S3	C3	Haptic perception: biological foundations		AAV3
S4	C4	Psychophysics of touch		AAV3
S5	C5	Design of kinesthetic haptic interfaces		AAV2
S6	C6	Design of tactile haptic interfaces		AAV3
S7	CC1			
S8	TP1	Introduction to a haptic interface		TOUT
S9	TP2	Design of haptic feedback in simulation		TOUT
S10	TP3	Design of a bilateral coupling		TOUT
S11	PR1	Supervised project		TOUT
S12	PR2	Independent project		TOUT
S13	PR3	Independent project		TOUT

* 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 %
S7	Individual	In-person	Written exam		25 %
S10	Individual	Remote	Other		25 %
S15	Individual	Remote	TP		50 %

2nde session of exam

Session	Individ./group	In-person/remote	Type of exam	Evaluated outcomes	Scale %
2	Group	In-person	Written exam	AAV 1-10	50 %
1	Group	In-person	Quiz	AAV1-8	50 %

Bibliographic references

- PF Hokajem, MW Spong, « Bilatéral Teleoperation: An historic Survey », Automatica 42, pp 2025 – 2057 2006
- COIFFET Philippe, KHEDDAR Abderrahman, « Téléopération et Télérobotique », Lavoisier, 2022
- Vincent Hayward, Karon MacLean, « DIY Haptics, Part I II », IEEE Robotics Automation Magazine 14(4):88 – 104, 2008

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