Master's Department of Engineering Sciences

MSc in Automation Engineering and Robotics

Name of the unit: Muscular system modeling

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Course code: UM5RBM21
Student workload: 8 h of lectures, 8 h of tutorials, 8 h of labs
Credits: 3 ECTS
Specialization tracks: ☐ ROBOT ☐ SI ☒ MeDH
Semester offered: ☐ S1 ☐ S2 ☒ S3 ☐ S4
Language of instruction: ☐ French ☒ English
Targeted audience: ☒ Engineering Sciences students ☒ Other (specify): ENSAM
Localization : ☐ PMC Campus ☐ Other (specify): ENSAM

Course Overview

This UE provides fundamental knowledge on modeling the human body—from an articulated rigid body chain for kinematic and dynamic motion analysis, to a complex musculoskeletal system for estimating internal muscular forces and physiological behaviors

Keywords: Motion capture, 3D kinematics, anatomical interpretation, inverse dynamics, muscle physiology, musculoskeletal modeling

Prerequisites

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

- Linear algebra : vectorial space, matrix computation, system of coordinates
- Kinematics : velocity of a point, angular velocity of a rigid body, position and orientation in space
- Dynamics of rigid bodies : fundamental principles, inertia, wrench computation

Intended Learning Outcomes

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

1. cite different technologies of motion capture and their advantages and drawback , cite sources of inaccuracy in motion analysis
2. compute anatomical frames from a given set of markers and check the orthonormality, cite the steps of computation to calculate and interpret articular angles from the mobile axis method
3. explain the principle of inverse kinematics and understand the steps of the process
4. compute the moment of a force at a given point to estimate the intersegmental moment at different joint levels
5. perform basic programming in Matlab
6. Understand muscle physiology and model its behavior.
7. Estimate muscle forces from joint moments calculated via inverse dynamics.

Indicative Teaching Sequence and Methods

Week	C/TD/TP*	Content	Preparation	Learn. outc.
S1	C/TP	Matlab intro / Kinematics		
S2	C/TP	Inverse Dynamics		
S3	C	motion capture devices and inverse kinematics		
S4	C	Muscle physio		
S5	C	Muscle modelisation		
S6	C/TP	Muscle force estimation		

* 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 %
S2	Individual	In-person	TP	AAV 1-5	20 %
S6	Individual	In-person	TP	AAV 5-7	20 %
S6	Individual	In-person	Written exam	AAV 1-7	60 %

2nde session of exam

Session	Individ./group	In-person/remote	Type of exam	Evaluated outcomes	Scale %
1	Individuel	In-person	TP	AAV 1-5	20 %
1	Individuel	In-person	TP	AAV 5-7	20 %
2	Individuel	In-person	Written exam	AAV 1-7	60 %

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