UNIVERSITÀ DI PISA

Human and animal models in biorobotics

MATTEO CIANCHETTI

Anno accademico	2020/21
CdS	BIONICS ENGINEERING
Codice	848II
CFU	6

Moduli	Settore/i	Tipo	Ore	Docente/i
HUMAN AND ANIMAL MODELS IN BIOROBOTICS	ING-IND/34	LEZIONI	60	MARCELLO CALISTI MATTEO CIANCHETTI

Learning outcomes

Knowledge
The course introduces the basics of robotics and non-linear system analysis, and upon them the principles of biorobotics are illustrated by presenting case-studies where human and animal models are applied in robotics.
The objective is to provide the students with knowledge on robotics, on the tools and software to study non-linear dynamical systems, and on bioinspired methodologies which are applied in robotics at morphological, functional and behavioural level.

Assessment criteria of knowledge
The knowledge gained by the students is assessed through questions at the oral exam sessions.

Skills
The course provides the students with the theoretical tools for designing and building robots which possible exploit principles derived from living beings. Moreover, the course features practical sessions in Matlab which will give the students generic tools to handle mathematical models and differential equations.

Assessment criteria of skills
The skills are evaluated through hand-on programming sessions in Matlab, oriented toward real-case scenario introduced during the lectures.

Behaviors
The students develop a novel view of robotics, and reinforce the basics of traditional robotics with up to date approach.

Assessment criteria of behaviors
The behaviours developed by the students result evident during the hand-on sessions.

Prerequisites
Basic knowledge of physics, linear algebra, ordinary differential equations

Teaching methods
The course consists of 2 main activities:

- about half of the course consists of frontal lectures on robotics, non-linear dynamical systems and bioinspired approaches
- the remaining part consists of hand-on sessions in Matlab, with exercises focussed on the comprehension of the theoretical concepts

The professor provides the materials to study, which include slides and paper presented during the lectures, through the class web site.
Communications are based on emails and on-line personal meetings on request.

Syllabus
Robotics part: Configuration Space; Rigid-Body Motions; Forward Kinematics; Velocity Kinematics and Statics; Inverse Kinematics; Dynamics of Open Chains; Trajectory Generation; Robot Control
Nonlinear dynamic part: monodimensional flow; bifurcation; bidimensional flow; phase space; limit cycles and Poincarè maps

Bio-inspired part: embodied intelligence and soft robotics; fundamental models of animal gaits; from fundamental to multi-body models; exploitation of compliant components; selected research papers
Matlab hands-on: linear algebra with matrix laboratory; basic programming commands; visualization tools; numerical solution of differential equations; hybrid systems

Bibliography

The materials provided by the professor will be sufficient. The lectures are based upon:

- Lynch, K. M., & Park, F. C. (2017). *Modern Robotics*. Cambridge University Press.
- Strogatz, S. H. (2018). *Nonlinear dynamics and chaos: With applications to physics, biology, chemistry, and engineering*. CRC press.
- Pfeifer, R., & Bongard, J. (2006). *How the body shapes the way we think: a new view of intelligence*. MIT press.

And on selected research papers.

Assessment methods

Oral exam

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