UCLouvain

lmeca2335

2018

Biorobotics

5 credits	30.0 h + 30.0 h	Q2

Teacher(s)	Ronsse Renaud ;
Language :	English
Place of the course	Louvain-la-Neuve
Main themes	Robots are progressively leaving the factories to penetrate inside more uncontrolled environments. This includes our own environment, where they have to interact with us, humans. Biorobotics investigates the applications where robots cross the boundaries with life sciences, either because of their intrinsic design (in which case robots are said to be 'bio-inspired'), or due to the physical and/or cognitive proximity they have with humans. This includes medical applications: nowadays, robots are routinely used in surgical theatres and rehab facilities. This course covers some of the most recent developments in biorobotics. The first part focusses on bio-inspired robots, both regarding their design and the way they are controlled. We particularly pay attention to highlight the bidirectional influence between robotics and biology: biology/nature inspiration helps in making better robots (e.g. regarding skills and agility), while robotics offers test benches to make new hypotheses about the functioning of the corresponding biological agent. The performances being achieved by these robots are compared to those of their human or animal counterpart. The second part will focus on robots displaying a physical interaction with humans, with a specific attention to robots being used for the rehabilitation and assistance of disabled users.
Aims	In consideration of the reference table AA of the program "Masters degree in Mechanical Engineering", this course contributes to the development, to the acquisition and to the evaluation of the following experiences of learning: · AA1.1, AA1.2, AA1.3 · AA3.1, AA3.2, AA3.3 · AA4.1, AA4.2, AA4.3, AA4.4 · AA5.2, AA5.3, AA5.5, AA5.6 · AA6.1, AA6.2, AA6.3 At the end of this course, students will be able to: a. Disciplinary Learning Outcomes 1 · Describe several applications of biorobotics, both regarding bio-inspired robots and robots having the capacity to interact with humans. · Illustrate ' through several examples ' the bilateral relationship between robotics and biology, i.e. how both disciplines influence each other. · Analyze the working principle of a bio-inspired robot and model its interactions with the environment. · Design the controller of a typical haptic interface, and adapt it to the field of rehab and assistive robotics. · Reproduce and evaluate the results of a scientific paper dealing with biorobotics. b. Transversal Learning Outcomes · Search and read a book chapter or a scientific paper dealing with biorobotics, and reproduce its main results, either in a simulated or is a physical environment. - Report the main results of this paper as a short oral presentation, and provide a critical opinion about them. - - - - *The contribution of this Teaching Unit to the development and command of the skills and learning outcomes of the programme(s) can be accessed at the end of this sheet, in the section entitled "Programmes/courses offering this Teaching Unit".*
Evaluation methods	The evaluation combines the group project and a final exam (oral), dealing with the materials covered during the lectures. Questions could also be connected to the debates taking place at the end of each lecture (see the "Teaching methods" section). If the final exam is failled with 30% (6/20) or less, the final mark is equal to the exam mark. Otherwise, the final mark is obtained as following: • 50% based on the group project (see the "Teaching methods" section). Students from the same group receive the same mark, except if it appears that the workload was not fairly distributed. • 50% based on the performance during theoral exam.

Teaching methods	The course combines a series of ex cathedra lectures and group projects conducted by the students. Groups are made of 2 to 3 students. Lectures give a strong emphasis on developing a critical vision about the maturity level of the biorobotics technology. They highlight the successes of biorobotics projects, but also their failures. Each lecture ends with a short debate session (about 10 minutes). Starting from a question raised by the lecturer - for instance about a possible limitation of a given application - students are requested to perform a quick search on the internet; and draft together some investigations that could be performed to answer it. The project outline is the following: • First part of the semester: students select a recent scientific paper dealing with biorobotics. They have to present this paper and its most significant results in front of the classroom. • Second part of the semester: using a simulation environment or a physical setup, students have to try reproducing the results described in the paper (at least partly). They come again in front of the classroom and present their own results, comparing them to the original paper. A critical discussion is expected.
Content	The lectures will deal about the following topics: 1. Introduction Part 1: bio-inspired robots 2. Robots that swim and fly 3. Robots that crawl and climb 4. Humanoid 5. Legged locomotion 6. Grasping 7. Neurorobotics 8. Soft robotics Part 2: robots interacting with humans 9. Cooperative robots - coworking 10. Haptic interfaces 11. Rehabilitation robots 12. Artificial limbs 13. Conclusion and course wrap-up
Bibliography	• Various scientific papers dealing with biorobotics • Chapters from the "Springer Handbook of Robotics" • Lecture slides
Faculty or entity in charge	MECA

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Aims
Master [120] in Electro-mechanical Engineering	ELME2M	5		
Master [120] in Mechanical Engineering	MECA2M	5		
Master [120] in Biomedical Engineering	GBIO2M	5		