1SC2191 – Modelling and sizing of an upper limb exoskeleton

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Department: DOMINANTE - GRANDS SYSTÈMES EN INTERACTION
Language of instruction: FRANCAIS
Campus: CAMPUS DE PARIS - SACLAY
Workload (HEE): 40
On-site hours (HPE): 27,00

Description

Many fields, from industrial to medical, are currently looking for solutions to reduce costs and drudgery, or ensure better control of the performed operations. One of the solutions that has emerged over the last decade or so is the use of exoskeletons, which are devices placed as close to the body as possible to relieve it during physically difficult operations. The majority of exoskeletons currently available for sale are passive exoskeletons (i.e. non-motorized). The limitations of these exoskeletons have led to the development of active, motorized exoskeletons, offering much more freedom in the movements performed and on the level of assistance provided.
The upper limb exoskeleton studied here belongs to this second category. This exoskeleton possesses mechanical characteristics linked to its actuating system, allowing very high levels of transparency. Transparency corresponds to the robot's capacity to be operated by the user without exerting any or as little resistance as possible. This characteristic is particularly important for the application areas of this type of robot, an example of which is functional rehabilitation.
Functional rehabilitation is an important step towards improving the quality of life of patients with motor disabilities, whether innate or after trauma or stroke, for example. The main advantages recognised in the use of exoskeletons in the field of functional rehabilitation (especially for the upper limbs) are an extended, three-dimensional workspace, limb tracking throughout the workspace allowing work to be carried out on movements that are natural for the patient and therefore the possibility of working on movements using the synergies and dependencies between the different joints of the arm. All the possible developments and applications mentioned above can only be made possible by a fine knowledge of the characteristics of the exoskeleton under consideration, which is crucial in order to achieve a high level of transparency.

Quarter number

ST2

Prerequisites (in terms of CS courses)
None

Syllabus
Possible projects (typical topics, to be specified):

- Modeling and dynamic simulation of the exoskeleton
- Load-dependent friction modeling
- Study of human-exoskeletal coupling
- Effort transmission study

Grading
involvement in the team work during the challenge week + deliverables at the end of the week + final defense

Resources

- room for 30 students, with projector, organized in blocks by group
- 3 teachers per room
- Matlab/Simulink (network access for license) on individual students' PCs

Learning outcomes covered on the course
At the end of this challenge week, students will be able to :

1. Describe the current context of medical robotics through the main technical, application and economic challenges associated with it.
2. Identify current topics in medical robotics, and describe their technical specificities.
3. Describe the main hardware and software components of an industrial and medical robotic system.
4. Develop and simulate models of polyarticulated or mobile robots.
5. Designing, modeling and simulating a motorization chain.
6. Analyze a system in interaction with the external environment.

Description of the skills acquired at the end of the course
C1 - Analyze, design, and build complex systems with scientific, technological, human, and economic components
C4 - Have a sense of value creation for one's company and one' customers
C7 - Know how to convince
C8 - Lead a project, a team