COURSE DESCRIPTION CARD - SYLLABUS

Course name
Applications of robotics in medicine [N2AiR1-SSiR>PO2-ZRwM]

Course

Field of study
Automatic Control and Robotics

Year/Semester
2/3

Area of study (specialization)
Control and Robotic Systems

Profile of study
general academic

Level of study
second-cycle

Course offered in
polish

Form of study
part-time

Requirements
elective

Number of hours

Lecture
10

Laboratory classes
0

Other (e.g. online)
0

Tutorials
0

Projects/seminars
20

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

The student starting this subject should have a basic knowledge of automation, kinematics and dynamics of manipulators and mechanics. Should also have basic knowledge of the basics of programming. He should have the ability to think logically, to use information obtained from the library and the Internet and solving simple programming tasks. He should also understand the need to broaden his competences and be ready to cooperate within a team. In addition, in the field of social competence, students must present attitudes such as honesty, responsibility, perseverance, cognitive curiosity, creativity, personal culture, and respect for other people.

Course objective

Providing students with basic knowledge of robotics in the field of modern constructions of robotic systems used in medicine as well as modern solutions of electric and pneumatic drives. Developing students' skills to solve design problems related to robotic systems used in medicine. Developing students' skills in interdisciplinary teams to solve simple research tasks on the border of technology and medicine.

Course-related learning outcomes

Knowledge

1. has knowledge of the use of advanced measuring systems used in medicine - [K2_W6]
2. Has a structured and in-depth knowledge of adaptive systems - [K2_W9]
3. has extensive knowledge of the use of robotics in medicine (surgery, neurosurgery, cardiac surgery, rehabilitation) - [K2_W10]
4. has the knowledge necessary to understand the social aspects of engineering activities and the possibilities of their application in medicine - [K2_W14]

Skills

1. is able to simulate and analyze the operation of complex control systems of robotic medical systems and plan and carry out experimental verification - [K2_U9]
2. can, when formulating and solving tasks involving the design of robotics systems, see their non-technical aspects - [K2_U14]
3. is able to assess the usefulness and possibility of using new achievements (technologies) in the field of medical robotics - [K2_U16]
4. is able to design and implement a complex control system for medical systems including non-technical aspects - [K2_U23]

Social competences

1. is aware of the importance and understands the non-technical aspects and effects of engineering activities, including its impact on human beings and the related responsibility for decisions taken - [K2_K2]
2. is aware of the responsibility for own work and readiness to comply with the principles of teamwork and taking responsibility for jointly implemented tasks - [K2_K3]
3. is aware of the need for a professional approach to technical issues, meticulous familiarization with the documentation and environmental conditions in which the devices and their components can function - [K2_K4]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
Knowledge acquired during the lecture is verified by the colloquium carried out at the last lecture. The test consists of 10 differently scored questions. Counting threshold: 50% points. Final issues will be sent to students by email.
Skills acquired as part of the project classes are verified on the basis of the completed project implemented in a 2-person group. The effectiveness of applying the acquired knowledge when solving a given problem will be assessed.

Programme content

The lecture program includes the following issues: classification of medical robots due to their use in surgery, diagnostics and rehabilitation, and due to the size and impact on the human body, directions and perspectives for the development of robotics in medicine, discussion of the structure, kinematics, workspace of manipulators supporting surgeons e.g. for laparoscope control, construction, kinematics and control as well as interface of robotic systems used in surgical procedures (laparoscopic and LESS / NOTES type procedures and inside the human body). Presentation of examples of robotic medical systems such as the robot Zeus, daVinci and RobinHeart. Presentation of own research at the Institute.
Construction of modern tools used in surgical robots. Discussion of modern electric and / or pneumatic drives used in surgical and rehabilitation robots. The use of gears containing flexible elements. The use of robotic systems in rehabilitation as devices supporting disabled people and used in rehabilitation. Modeling of biomechanical properties of tissues, conducting experimental and simulation studies. The use of tissue models in virtual surgery. Analysis and modeling of the human musculoskeletal system with particular emphasis on the kinematic model of the knee joint. Human gait analysis, muscle structure and role. Vision systems for gait analysis. Rehabilitation systems, discussion of isometric, isokinetic and isotonic tests.
Safety procedures in medical robots. Discussion of advanced measuring systems used in medicine, with particular emphasis on measuring position, acceleration and forces and moments of forces. Control algorithms for medical manipulators including force feedback.
Design classes take place in the laboratory and consist of solving simple research tasks. Project tasks are carried out by teams of 2 students. The projects cover the following issues:

1. Modeling and simulation of the musculoskeletal system.

2. Use of acceleration and pressure sensors to analyze human gait.
3. Use of an industrial robot to control the laparoscope.
4. Designing in the CAD environment of simple medical manipulators.
5. Modeling and simulation of kinematics and dynamics of sample simple medical robots.
6. Analysis of knee x-ray images and its modeling.
7. Use of a vision location system in the study of human motion
8. The use of mobile devices in medicine (for controlling medical robots or analyzing human gait)
9. The use of haptic console in medicine

Teaching methods

Teaching methods:
1. lecture: multimedia presentation, illustrated with films presenting existing solutions of medical robots
2. project classes: solving research tasks, presentation of research results, discussion, teamwork.

Bibliography

Basic
1. Leszek Podsędkowski, Roboty Medyczne: Budowa i zastosowanie, Wydawnictwa Naukowo-techniczne, Warszawa 2010
2. J. Troccaz, Medical Robotics, John Wiley & Sons, Ltd 2012
3. M. Nałęcz, Biocybernetyka i Inżynieria biomedyczna 2000, Tom 5, Biomechanika i Inżynieria rehabilitacyjna, Akademicka Oficyna Wydawnicza EXIT, Warszawa 2004,
4. J. L. Pons, Wearable Robots: Biomechatronic Exoskeletons, John Wiley & Sons, Ltd 2008
Additional
1. M. Nałecz, Biocybernetyka i Inżynieria biomedyczna 2000, Tom 3, Sztuczne Narządy, Akademicka Oficyna Wydawnicza EXIT, Warszawa 2004
2. J. Rosen, B. Hannaford, R. M. Satava, Surgical Robotics, Systems Applications and Visions, Springer, 2011,
3. Medical Robotics Reports Journal, International Society for Medical Robotics (www.medicalroboticsreports.com)
4. W. Kostewicz, Chirurgia laparoskopowa, Wydawnictwo Lekarskie PZWL, Warszawa 2002.

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,00
Classes requiring direct contact with the teacher	30	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	45	1,00