RTU Course "Robot systems modeling basics"

33000 Faculty of Computer Science, Information Technology and Energy

General data

Code	DSP716
Course title	Robot systems modeling basics
Course status in the programme	Compulsory/Courses of Limited Choice
Responsible instructor	Agris Ņikitenko
Academic staff	Mārtiņš Ekmanis
Volume of the course: parts and credits points	1 part, 4.5 credits
Language of instruction	LV
Annotation	Robotic systems are modelled with different tools and using different development environments. The user can use the graphical environment of mentioned tools, but to understand what happens in the background, he needs to know the mathematics. The study course is designed to teach robot modelling basics and the dominant topic is rigid body kinematics (movement and rotations). The study course also will look at several linked element kinematics, where one element affects another element's speed and movement direction. The study course practical part is organized as classroom courses where students will develop computer programmes to solve problems covered in theoretical lectures.
Goals and objectives of the course in terms of competences and skills	The aim of the study course is to provide basic knowledge for performing homogeneous kinematic transformations. Tasks of the study course are to provide knowledge and skills: - to create a physics engine and to be able to realize mathematical transformations of kinematics. - to be able to use kinematic transformations in visual representation in Xna Game Studio or a similar framework; - to use quaternions in defining rotations; - to work with kinematic systems of several related elements.
Structure and tasks of independent studies	Students must independently write or complete partially written relatively simple programs on the topics covered in the theoretical lessons in a computer class. Within the study course, students must write a course paper, the content of which is a deepening of practical work.
Recommended literature	Obligātā/Obligatory: 1.Jack B. Kuipers. Quaternions and rotation sequences. – Princeton University Press. 2002, - 371 p. 2.Mark W. Spong, Seth Hutchinson, M. Vidyasagar. Robot Modeling and control. – John Wiley & Sons. 2006, - 478 p. 3.Geoffrey M. Dixon. Division Algebras: Octanions, Quaternions, Complex Numbers and the Algebraic Design of Physics. – Kluwer Academic Publishers. 2002, - 236 p. 4.Ian Millington. Game Physics Engine Development. - Elsevier Science & Technology Books. 2007, - 480 p. Papildu/Additional: 5.Д Конгер. Физика для разработчиков компьютерных игр. – Бином. 2007, – 530 с.
Course prerequisites	Mathematics (vectors and matrices), physics (kinematics) and programming basics.

Course contents

Content	Full- and part-time intramural studies		Part time extramural studies	
	Contact Hours	Indep. work	Contact Hours	Indep. work
Introduction.	2	0	0	0
The application of mathematics.	4	4	0	0
Kinematics, homogenous transformations.	2	4	0	0
Introduction in game physics engine development.	2	4	0	0
2D rendering.	2	4	0	0
3D transformations.	2	0	0	0
3D rendering.	2	0	0	0
Advanced technique of defining rotations.	4	4	0	0
Mesh objects.	2	0	0	0
Xna Game Studio basics.	2	0	0	0
Introduction to robot mechanics modelling.	4	4	0	0
Kinematics for several linked elements.	8	12	0	0
Acceleration and angular velocity.	4	0	0	0
Path and trajectory planning.	6	8	0	0
Physical fore modeling.	6	8	0	0
Connecting previously covered topics.	8	8	0	0

Total:	60	60	0	0

Learning outcomes and assessment

Learning outcomes	Assessment methods
Is able to solve the homogeneous kinematic transforms in 2D space and be able to use these transformations in 2D computer graphics.	Practical works 2., 3., 4. Exam questions on appropriate topics.
Is able to solve the homogeneous kinematic transforms in 3D space and be able to use these transformations in 3D computer graphics.	Practical works 5. un 6. Exam questions on appropriate topics.
Is able to use algebra quaternion algebra to describe rotations.	Practical works 7. un 8. Exam questions on appropriate topics.
Knows the physics engine development principles and be able to use XNA Game Studio for mesh object visualization and to perform homogeneous kinematic transformations in 3D space.	Practical works 1., 9., 10. Exam questions on appropriate topics.
Knows the kinematics for several linked elements.	Practical works 11., 12., 13. Exam questions on appropriate topics.
Is able to simulate the acceleration and angular velocity of rigid bodies.	Practical works 14. un 15. Exam questions on appropriate topics.
Is able to plan the path and trajectory of moving rigid bodies.	Practical works 16. un 17. Exam questions on appropriate topics.
Knows the force modeling methods.	Practical works 18. un 19. Exam questions on appropriate topics.

Evaluation criteria of study results

Criterion	%
Practical work	75
Exam	25
Total:	100

Study subject structure

Part	CP	Hours			Tests		
		Lectures	Practical	Lab.	Test	Exam	Work
1.	4.5	1.5	1.5	0.0		*	