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ФИО: Ястребов Олег Александрович
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Federal State Autonomous Educational Institution of Higher Education
"Peoples' Friendship University of Russia named after Patrice Lumumba"

Academy of Engineering
(name of the main educational unit (MEU) that developed the educational program of higher education)

WORKING PROGRAM OF THE DISCIPLINE

VIRTUAL REALITY AND COMPUTER VISION
(name of discipline/module)

Recommended for the field of study/specialty:

27.04.04 CONTROL IN TECHNICAL SYSTEMS
(code and name of the training area/specialty)

The discipline is mastered within the framework of the implementation of the main professional educational program of higher education (EP HE):

AIML and Space Sciences / Artificial Intelligence, Machine Learning and Space Sciences
(name (profile/specialization) of the educational institution of higher education)

2025

1. THE GOAL OF MASTERING THE DISCIPLINE

The course "Virtual Reality and Computer Vision" is part of the Master's program "Artificial Intelligence, Machine Learning and Space Sciences" in the direction 27.04.04 "Control in Technical Systems" and is studied in the 1st semester of the 1st year. The course is implemented by the Department of Mechanics and Control Processes. The course consists of 8 sections and 20 topics and is aimed at studying modern technologies for image processing and analysis, the possibilities of use, applications of computer vision systems and approaches to creating systems with virtual reality support.

The goal of mastering the discipline is to master the basic concepts of image processing and analysis, the principles of creating computer vision and virtual reality systems.

2. REQUIREMENTS TO THE RESULTS OF MASTERING THE DISCIPLINE

Mastering the discipline "Virtual reality and computer vision" is aimed at developing the following competencies (parts of competencies) in students:

Table 2.1. List of competencies developed in students while mastering the discipline (results of mastering the discipline)

Cipher	**Competence**	**Indicators of Competence Achievement** (within the framework of this discipline)
GPC-1	Able to analyze and identify the natural scientific essence of control problems in technical systems based on provisions, laws and methods in the field of natural sciences and mathematics	GPC-1.1 Knows the basic laws, provisions and methods in the field of natural sciences and mathematics; GPC-1.2 Able to identify the natural scientific essence of control problems in technical systems, guided by the laws and methods of natural sciences and mathematics; GPC-1.3 Has command of tools for analyzing control problems in technical systems.
GPC-2	Able to formulate control problems in technical systems and justify methods for solving them	GPC-2.1 Knows the basic methods of solving control problems in technical systems; GPC-2.2 Able to justify methods for solving control problems in technical systems; GPC-2.3 Proficient in methods of setting control problems in technical systems.
GPC-3	Capable of independently solving control problems in technical systems based on the latest achievements of science and technology	GPC-3.1 Knows the basic approaches to solving control problems in technical systems; GPC-3.2 Able to apply basic approaches based on the latest achievements of science and technology to solving control problems in technical systems; GPC-3.3 Has mastered methods for solving control problems in technical systems based on the latest achievements of science and technology.
GPC-9	Capable of developing methods and performing experiments on existing facilities with processing of results based on information technologies and technical means	GPC-9.1 Possesses modern information technologies and technical means for conducting experiments at operating facilities; GPC-9.2 Has skills in developing methods and conducting experiments at existing facilities; GPC-9.3 Has the skills to develop methods and perform experiments at existing facilities with processing of results using information technology.;
PC-2	Able to apply modern theoretical and experimental methods for developing mathematical models of objects and processes under study in the field of aerospace systems management	PC-2.1 Knows modern theoretical and experimental methods used to develop mathematical models of the objects under study and processes of professional activity; PC-2.2 Able to determine the effectiveness of the methods used to develop mathematical models of the objects and processes under study; PC-2.3 Has mastered modern theoretical and experimental methods for developing mathematical models of objects and processes of professional activity in the field of study.;

Cipher	Competence	Indicators of Competence Achievement (within the framework of this discipline)
PC-3	Capable of carrying out work and research on the processing and analysis of scientific and technical information obtained using geographic information systems and technologies	PC-3.1 Able to analyze the results of theoretical and experimental research; PC-3.2 Able to formulate recommendations for improving devices and systems, prepare scientific research results for publication and generate documents for filing an application for an invention; PC-3.3 Participates in the analysis of research results, has the skills to formulate recommendations for improving devices and systems, as well as writing articles and submitting documents for registration of inventions.;

3. PLACE OF THE DISCIPLINE IN THE STRUCTURE OF THE EDUCATIONAL EDUCATIONAL EDUCATION

Discipline "Virtual Reality and Computer Vision" refers to the mandatory part of block 1 “Disciplines (modules)” of the educational program of higher education.

As part of the higher education program, students also master other disciplines and/or practices that contribute to the achievement of the planned results of mastering the discipline "Virtual Reality and Computer Vision".

Table 3.1. List of components of the educational program of higher education that contribute to the achievement of the planned results of mastering the discipline

Cipher	Name of competence	Previous courses/modules, practices*	Subsequent disciplines/modules, practices*
GPC-1	Able to analyze and identify the natural scientific essence of control problems in technical systems based on provisions, laws and methods in the field of natural sciences and mathematics		Advanced Methods of Space Flight Mechanics; Advanced Methods of Earth Remote Sensing; Geoinformation Systems and Applications; Undergraduate Training;
GPC-2	Able to formulate control problems in technical systems and justify methods for solving them		Undergraduate Training; Dynamics and Control of Space Systems;
GPC-3	Capable of independently solving control problems in technical systems based on the latest achievements of science and technology		Dynamics and Control of Space Systems; Advanced Methods of Space Flight Mechanics; Undergraduate Training; Research work / Scientific research work;
GPC-9	Capable of developing methods and performing experiments on existing facilities with processing of results based on information technologies and technical means		Undergraduate Training; Dynamics and Control of Space Systems; Geoinformation Systems and Applications;
PC-2	Able to apply modern theoretical and experimental methods for developing mathematical models of objects and processes under		Research work / Scientific research work; Undergraduate Training; Dynamics and Control of Space Systems;

Cipher	Name of competence	Previous courses/modules, practices*	Subsequent disciplines/modules, practices*
	study in the field of aerospace systems management		*Artificial Neural Networks (Deep Learning)***; *Artificial Neural Networks (Deep Learning)***; Advanced Methods of Space Flight Mechanics; *Artificial Neural Networks (Reinforcement Learning)***; Geoinformation Systems and Applications;
PC-3	Capable of carrying out work and research on the processing and analysis of scientific and technical information obtained using geographic information systems and technologies		Advanced Methods of Earth Remote Sensing; Research work / Scientific research work; Undergraduate Training;

* - filled in in accordance with the competency matrix and the SUP EP HE

** - elective disciplines/practices

4. SCOPE OF THE DISCIPLINE AND TYPES OF STUDY WORK

The total workload of the discipline “Virtual Reality and Computer Vision” is “5” credit units.

Table 4.1. Types of educational work by periods of mastering the educational program of higher education for full-time education.

Type of academic work	**TOTAL,**ac.h.		**Semester(s)**
			1
Contact work, academic hours	*34*		*34*
Lectures (LC)	17		17
Laboratory work (LW)	17		17
Practical/seminar classes (SC)	0		0
Independent work of students, academic hours	*119*		*119*
Control (exam/test with assessment), academic hours	*27*		*27*
General complexity of the discipline	**ac.h.**	***180***	*180*
	credit.ed.	***5***	*5*

5. CONTENT OF THE DISCIPLINE

Table 5.1. Contents of the discipline (module) by types of academic work

Section number	Name of the discipline section	Section Contents (Topics)		Type of academic work*
Section 1	Formation and presentation of images	1.1	Devices for image formation. Types of images.	LC, LR
		1.2	Types of ¶images.	LC, LR
		1.3	Digital Image Formats	LC, LR
Section 2	Basic concepts of pattern recognition	2.1	Pattern recognition tasks. ¶Features used to ¶describe objects.	LC, LR
		2.2	¶Representation of objects as ¶feature vectors.	LC, LR
		2.3	Methods of ¶recognition¶	LC, LR
Section 3	Filtering and ¶enhancing ¶images ¶	3.1	Histogram equalization. ¶Noise removal. Image smoothing.	LC, LR
		3.2	Image ¶filtering. Edge ¶detection.	LC, LR
		3.3	Convolution Function. ¶Spatial Frequency Analysis Using Harmonic Functions	LC, LR
Section 4	Search ¶images ¶based ¶on ¶content	4.1	Image databases. ¶Querying image databases. Indexing in image search engines.¶	LC, LR
Section 5	Movement in ¶2D ¶images	5.1	Image subtraction. ¶Calculating displacement vectors.	LC, LR
		5.2	Calculating ¶trajectories of moving points.¶	LC, LR
Section 6	Segmentation of ¶images	6.1	Region detection. ¶Edge detection.	LC, LR
		6.2	High-level structure detection. Segmentation based on coordinated motion.	LC, LR
Section 7	Comparison in two-dimensional space	7.1	Affine geometric transformations. Recognition of two-dimensional objects using affine transformations.	LC, LR
		7.2	Recognition of ¶two-dimensional objects using ¶relational ¶models. Nonlinear methods of ¶image deformation	LC, LR
Section 8	Perception of ¶three-dimensional ¶scenes from two-dimensional images	8.1	Three-dimensional features on two-dimensional images.	LC, LR
		8.2	Determining the shape of objects by one feature	LC, LR
		8.3	Vanishing Points. Signs Associated with Movement	LC, LR
		8.4	Contours and ¶virtual lines. ¶Determining depth using a stereoscopic ¶system.	LC, LR

* - filled in only for FULL-TIME education: LC – lectures; LR – laboratory work; SC – practical/seminar classes.

6. LOGISTIC AND TECHNICAL SUPPORT OF DISCIPLINE

Table 6.1. Material and technical support of the discipline

Audience type	Equipping the auditorium	Specialized educational/laboratory equipment, software and materials for mastering the discipline (if necessary)
Lecture	An auditorium for conducting lecture-type classes, equipped with a set of specialized furniture; a board (screen) and technical means for multimedia presentations.	
Computer class	A computer room for conducting classes, group and individual consultations, ongoing	

Audience type	Equipping the auditorium	Specialized educational/laboratory equipment, software and materials for mastering the discipline (if necessary)
	monitoring and midterm assessment, equipped with personal computers (in the amount of [Parameter] pcs.), a board (screen) and technical means for multimedia presentations.	
For independent work	A classroom for independent work of students (can be used for conducting seminars and consultations), equipped with a set of specialized furniture and computers with access to the Electronic Information System.	

* - the audience for independent work of students MUST be indicated!

7. EDUCATIONAL, METHODOLOGICAL AND INFORMATIONAL SUPPORT OF THE DISCIPLINE

Main literature:

1. Shapiro L. Computer vision / L. Shapiro, J. Stockman; trans. from English. – M.: ¶BINOM. Laboratory of knowledge, 2006. – 752 p.: ill., [8] p. color incl. – (Best foreign ¶textbook)

2. Donald Hearn, M. Pauline Baker. Computer Graphics and the StandardOpenGL, 3rd edition. : Trans. from English. — M. : Williams Publishing House, 2005. — 1168 p. (+48 p. color ill.): ill. Access mode: https://yadi.sk/i/J54teYDc3Pnc4s

3. Forsyth, David A., Pons, Jean. Computer vision. A modern approach. : Trans. from English. – M. : Williams Publishing House, 2004. – 928 p.: ill.

Further reading:

1. Potapov A. Computer vision systems: modern tasks and methods. – 2014.¶– №1 (49). –CONTROL ENGINEERING RUSSIA, pp. 20-26. Access mode: ¶https://controleng.ru/wp-content/uploads/CE_149_sistemy_kompyuternogo_zreniya.pdf

2. Fisenko, V. T. Computer processing and recognition of images: a manual / V. T. Fisenko, T. Yu. Fisenko. - St. Petersburg: St. Petersburg State University of Information Technologies, Mechanics and Optics, 2008 - 192 p. Access mode: ¶http://pzs.dstu.dp.ua/ComputerGraphics/bibl/fisenko.pdf

Resources of the information and telecommunications network "Internet":

1. RUDN University EBS and third-party EBSs to which university students have access on the basis of concluded agreements
   - Electronic library system of RUDN - ELS RUDN https://mega.rudn.ru/MegaPro/Web
   - Electronic library system "University library online"http://www.biblioclub.ru
   - EBS Yuraithttp://www.biblio-online.ru
   - Electronic Library System "Student Consultant" www.studentlibrary.ru
   - EBS "Znanium"https://znanium.ru/
2. Databases and search engines
   - Sage https://journals.sagepub.com/
   - Springer Nature Link https://link.springer.com/
   - Wiley Journal Database https://onlinelibrary.wiley.com/
   - Scientometric database Lens.org https://www.lens.org

Educational and methodological materials for independent work of students in mastering a discipline/module:*

1. Lecture course on the subject "Virtual reality and computer vision".

* - all educational and methodological materials for independent work of students are posted in accordance with the current procedure on the discipline page in TUIS!

DEVELOPER:

Associate Professor		Kruglova Larisa Vladimirovna
Position, Department	*Signature*	*Surname I.O.*

HEAD OF THE DEPARTMENT:

Head of Department		Razumny Yuri Nikolaevich
Position of the Department	*Signature*	*Surname I.O.*

HEAD OF THE EP HE:

Head of Department		Razumny Yuri Nikolaevich
Position, Department	*Signature*	*Surname I.O.*