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MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION
Federal State Autonomous Educational Institution of Higher Education
"NORTH CAUCASUS FEDERAL UNIVERSITY"

APPROVED BY
Acting Director of the Institute
Advanced Engineering
Cand. Tech. Sci., Associate Professor
A.A. Porokhnya

WORK PROGRAM OF THE DISCIPLINE **Digital Image Processing**

Field of study	11.03.02 Infocommunication Technologies and Communication Systems
Profile	Intelligent Data Processing in Infocommunication Systems and Networks
Year of start of training	2026
Form of study	Full-time
Implemented in a semester	6

Developed by
Associate Professor at the School of Digital,
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1. Purpose and objectives of mastering the discipline (module)

The purpose of mastering the discipline is to form students' professional competencies based on the development of modern computer vision systems, as well as the basics of digital image processing that meet the requirements of professional standards and employers.

Objectives of mastering the discipline:

Provide students with basic information in an easy-to-understand way about:

- Discretization and quantization of continuous images;
- Improving the visual quality of images by element-by-element transformation;
- image filtering;
- image recovery;
- geometric transformations and image referencing;
- Photogrammetry and stereovision;
- Image processing and analysis management

2. Place of the discipline (module) in the structure of the educational program

The discipline "Digital Image Processing" refers to a part of the disciplines formed by the participants of educational relations Disciplines (modules) of choice 3 (DV.3. B1.V.02.

3. List of planned learning outcomes in the discipline (module) correlated with the planned results of the development of the educational program

Code, formulation of competence	Indicator code, wording	Planned learning outcomes in the discipline (module), characterizing the stages of the formation of competencies, indicators
PC-1. Able to develop requirements and design software	ID-1PC-1 understands the principles of building software architecture and types of software architecture; understands methods and tools for software design, methods and tools for designing databases; understands methods and tools for designing program interfaces; understands methods and techniques for formalizing tasks; understands the capabilities of modern and promising tools for the development of software products and hardware.	Knows and understands the principles of building software architecture and types of software architecture; knows the basic methods and tools of software design; understands the methods and means of designing computer vision systems; understands the methods and techniques of formalizing digital image processing tasks; understands the capabilities of modern and promising tools for the development of software products and hardware.
	ID-2PK-1 Identifies the principles of operation, design, technical capabilities of radio measuring equipment in the scope of work performed	Identifies the principles of operation, design, technical capabilities of radio measuring equipment in the scope of work performed
	ID-3PK-1 Analyzes information on the quality of functioning of radio-electronic	Analyzes information on the quality of functioning of radio-electronic systems

Code, formulation of competence	Indicator code, wording	Planned learning outcomes in the discipline (module), characterizing the stages of the formation of competencies, indicators
	systems based on the results of their operation	based on the results of their operation
PC-3 Capable of conducting research work on the development of innovative radio-electronic facilities for various purposes	ID-1PK-3 collects and analyzes scientific and technical information, summarizes domestic and foreign experience in the field of radio engineering, conducts patent search	Collects and analyzes scientific and technical information, summarizes domestic and foreign experience in the field of radio engineering, conducts patent searches
	ID-2PK-3 Applies methods of theoretical and experimental research using computer modeling, performing technical calculations using computer technology	Applies methods of theoretical and experimental research using computer modeling, performing technical calculations using computer technology
	ID-3PC-3 Uses the basic logical methods and techniques of scientific research and scientific creativity	Uses the basic logical methods and techniques of scientific research and scientific creativity
	ID-4PK-3 Performs technical calculations using computer equipment	Performs technical calculations using computer technology
	ID-5PC-3 Draws up scientific and technical reports on the results of the work performed, publishes the results of research and development in the form of presentations, patents, articles, reports	Draws up scientific and technical reports on the results of the work performed, publishes the results of research and development in the form of presentations, patents, articles, reports
	ID-6PK-3 implements the principles of preparation and conduct of scientific research, experiments, technical developments, tests	Implements the principles of preparation and conduct of scientific research, experiments, technical developments, tests
	ID-7PK-3 Applies the basics of antenna theory, mechanisms of radio wave propagation, principles of construction and operation of receiving and transmitting equipment, hardware and software for digital signal processing,	Applies the basics of antenna theory, mechanisms of radio wave propagation, principles of construction and operation of receiving and transmitting equipment, hardware and

Code, formulation of competence	Indicator code, wording	Planned learning outcomes in the discipline (module), characterizing the stages of the formation of competencies, indicators
	basic principles of radar and navigation, communication facilities, methods of noise-resistant coding	software for digital signal processing, basic principles of radar and navigation, communication facilities, methods of noise-resistant coding
	ID-8PK-3 Analyzes the results of scientific research	Analyzes the results of scientific research

4. Scope of the academic discipline (module) and forms of control *

Scope of classes: total: 3 c.u.108 acad.h.	OFO, in acad. hours
Contact work:	24.00
Lectures/from them practical training	No
Laboratory work/from them practical training	No
Practical training/of which practical training	24.00/24.00
Independent work	84.0
Forms of control	
Exam	no
Credit	Yes
Credit with a grade	no
Computational and graphic works	no
Term papers	no

* The discipline (module) provides for the use of e-learning, distance learning technologies
(unless otherwise established by the educational standard)

5. The content of the discipline (module), structured by topics (sections) with an indication of the number of hours and types of classes

№			Full-time	I n d	Cur rent For
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	Section (topic) of the discipline and summary	Emerging competencies, indicators	Contact work of students with the teacher / of them in the form of practical training, hours				
			Lectures	Practical exercises	Laboratory work		
1	Discretization and quantization of continuous images 1.1. Discretization of continuous images 1.2. Image quantization Practice No1: Histograms, Profiles, and Projections	PC-1 ID-1PK-1 ID-2PK-1 ID-3PK-1 PC-3 ID-1PK-3 ID-2PK3 ID-3PK-3 ID-4PK-3 ID-5PK-3 ID-6PK-3 ID-7PK-3 ID-8PK-3		4.00/4.00		14,00	Practical Work Defense
2	Improve the visual quality of images by transforming them element-by-element 2.1. Linear Image Contrast 2.2. Image solarization 2.3. Preparing an image 2.4. Histogram conversion, equalization 2.5. Application of the tabular method in element-by-element image transformations Practical Work No2: Geometric Transformations of Images	PC-1 ID-1PK-1 ID-2PK-1 ID-3PK-1 PC-3 ID-1PK-3 ID-2PK3 ID-3PK-3 ID-4PK-3 ID-5PK-3 ID-6PK-3 ID-7PK-3 ID-8PK-3		4.00/4.00		14,00	Practical Work Defense
3	Image filtering 3.1. Optimal linear filtration. Wiener-Hopf equation 3.2. Mask filtering of images in the presence of additive white noise 3.3. Recurrent Causal Image Filtering 3.4. Application of the Wiener filter for non-causal two-dimensional filtration	PC-1 ID-1PK-1 ID-2PK-1 ID-3PK-1 PC-3 ID-1PK-3 ID-2PK3 ID-3PK-3 ID-4PK-3 ID-5PK-3 ID-6PK-3 ID-7PK-3 ID-8PK-3		4.00/4.00		14,00	Practical Work Defense

	3.4.1. Two-dimensional discrete Fourier transform 3.4.2. Cyclic convolution 3.4.3. Solution of the Wiener-Hopf equation in the cyclic approximation 3.5. Bayesian Image Filtering 3.5.1. The Essence of Bayesian Filtering 3.5.2. Markov filtering of one-dimensional sequences 3.5.3. Two-Step Markov Image Filtering 3.6. Median filtering Practical Work No3: Filtering and Extracting Paths						
4	Image Recovery 4.1. Image models and their linear distortions 4.1.1. Imaging 4.1.2. Motion blur (smear) 4.1.3. Defocusing 4.2. Algebraic Methods of Image Restoration 4.3. Methods of image restoration based on spatial filtering 4.3.1. Inverse filter 4.3.2. Wiener filter 4.3.3. Compensation for edge effects when restoring linearly distorted images 4.4. Iterative Methods of Image Restoration Practical Work No4: Segmentation and Imagery	PC-1 ID-1PK-1 ID-2PK-1 ID-3PK-1 PC-3 ID-1PK-3 ID-2PK3 ID-3PK-3 ID-4PK-3 ID-5PK-3 ID-6PK-3 ID-7PK-3 ID-8PK-3		4.00/4.00		14,00	Practical Work Defense
5	Geometric transformations and image snapping 5.1. Geometric transformations on the plane and in space 5.1.1. Points and Straight Lines on a Plane - Duality of Descriptions 5.1.2. Homogeneous coordinates 5.1.3. Euclidean transformations	PC-1 ID-1PK-1 ID-2PK-1 ID-3PK-1 PC-3 ID-1PK-3 ID-2PK3 ID-3PK-3 ID-4PK-3 ID-5PK-3 ID-6PK-3 ID-7PK-3		4.00/4.00		14,00	Practical Work Defense

	5.1.4. Affine transformations 5.1.5. Projective transformations 5.1.6. Polynomial transformation 5.1.7. Estimating Conversion Parameters 5.2. Restoring the Image in Converted Coordinates 5.3. Linking Images 5.3.1. Correlation criterion of similarity 5.3.2. Local Refinement of the Shift 5.3.3. Cross-spectral Measure of Similarity 5.3.4. Referencing by Local Inhomogeneities Practical Work No5: Hough Transform	ID-8PK-3					
6	Photogrammetry and stereo vision 6.1. Recording Camera Model 6.2. Relationship between different coordinate systems 6.3. Stereoscopic system 6.4. Camera Calibration 6.5. Mutual orientation 6.6. Finding Conjugate Points Practical Work No6: Morphological Analysis of Images	PC-1 ID-1PK-1 ID-2PK-1 ID-3PK-1 PC-3 ID-1PK-3 ID-2PK3 ID-3PK-3 ID-4PK-3 ID-5PK-3 ID-6PK-3 ID-7PK-3 ID-8PK-3		4.00/4.00		14,00	Practical Work Defense
	Total for the semester			24,00		84,00	

6. Fund of assessment tools for the discipline (module)

The Assessment Tools Fund (FAT) for the discipline "Digital Image Processing" is based on a list of competencies to be mastered with an indication of indicators. The FAT provides objective control over the achievement of planned learning outcomes. The FAT includes:

- description of indicators and criteria for assessing competencies at various stages of their formation, description of assessment scales;
- methodological materials that determine the procedures for assessing knowledge, skills, and (or) work experience that characterize the stages of competence formation (included in the methodological guidelines for those types of work that are provided for by the curriculum and provide for the assessment of the formation of competencies);
- standard assessment tools necessary for assessing knowledge, skills and the level of competence formation.

The FAT is an appendix to this discipline program.

7. Methodical instructions for students on the development of the discipline

Starting work, each student should take into account the following provisions.

The discipline is built on a thematic principle, each topic is a logically complete section.

The lecture material is devoted to the consideration of the key, basic provisions of the courses and the explanation of educational tasks submitted for independent work of students.

Laboratory work is aimed at gaining practical experience in the relevant subject area.

Independent work of students is aimed at independent study of additional material, preparation for laboratory and lecture classes, as well as the performance of all types of independent work.

For the successful development of the discipline, it is necessary to perform all types of independent work, using the recommended sources of information.

8. Educational, methodological and information support of the discipline

8.1. List of basic and additional literature necessary for mastering the discipline (module)

8.1.1. List of basic literature:

1. Shefer, E. A.; Digital Image Processing: Textbook / E. A. Shefer. - Digital Image Processing, 2031-02-04. - Electron. dan. (1 file). - St. Petersburg : St. Petersburg State University of Industrial Technologies and Design, 2019. - 100 p. - Electronic. - The book is in the premium version of EBS IPR BOOKS. - ISBN 2227-8397, unlimited copies

2. Pismennyy G. V., Mikhailov B. B., Korneev A. Yu. - Moscow, Mashinostroenie Publ., 1991. - 88 p. - (Industrial Robots and Flexible Production Systems). - References: p. 84. - ISBN 5-217-00995-0, copies 1

3. Selyankin, V. V.; Computer vision. Analysis and processing of images Electronic resource / Selyankin V. V. : textbook. - St. Petersburg : Lan, 2019. - 152 p. - ISBN 978-5-8114-3368-1, unlimited copies

4. Selyankin, V. V.; Solving problems of computer vision: a textbook / V.V. Selyankin ; Ministry of Education and Science of the Russian Federation ; Southern Federal University ; Engineering and Technology Academy. - Taganrog : Publishing House of the Southern Federal University, 2016. - 93 p. : schemes., tabl. - <http://biblioclub.ru/>. - Bibliogr. in the book. - ISBN 978-5-9275-2090-9, unlimited copies

8.1.2. List of additional literature:

1. Potapov, A. S.; Computer Vision Systems Elektronnyy resurs : Uchebno-metodicheskoe posobie po laboratornomu praktikumu [Computer Vision Systems] / A. S. Potapov, P. O. Malashin. - Computer Vision Systems, 2022-10-01. - St. Petersburg: ITMO University, 2012. - 41 p. - The book is in the premium version of EBS IPR BOOKS. - ISBN 2227-8397, unlimited copies

2. Rafael, Gonzalez.; Digital Image Processing Electronic resource / Gonzalez Raphael, Woods Richard ; transl.: L. I. Rubanov, P. A. Chochia; ed. by P. A. Chochia. - Moscow : Technosphere, 2012. - 1104 p. - The book is in the premium version of EBS IPR BOOKS. - ISBN 978-5-94836-331-8, unlimited copies

3. Gonzalez, R.; Digital Image Processing: Practical Advice / R. Gonzalez, R. Woods ; transl. by P. A. Chochia ; transl. by L. I. Rubanov. - 3rd ed., ispr. and add. - Moscow : Technosphere, 2012. - 1104 p. : ill., tabl., schemes. - (The World of Digital Processing). - <http://biblioclub.ru/>. - ISBN 978-5-94836-331-8, unlimited copies

8.2. List of educational and methodological support for students' independent work in the discipline (module)

Bratchenko N. Y. Systems of Technical Vision: Educational and Methodological Manual for the Organization of Students' Independent Work / FGOAU Sev.-Kav. Feder. University. – Stavropol : NCFU, 2025. – 20 p.: ill.

8.3. List of resources of the information and telecommunication network "Internet" necessary for mastering the discipline (module)

www.biblioclub.ru - Electronic Library System "University Library Online"
 www.eLibrary.ru - Scientific Electronic Library
 www.iprbookshop.ru - IPRbooks Electronic Library System

9. List of information technologies used in the implementation of the educational process in the discipline (module), including a list of software and information reference systems

When reading lectures, computer equipment is used, demonstration of presentation multimedia materials. In laboratory classes, students perform laboratory work and demonstrate the result by means of computer technology and reports in electronic form, prepared by them during the hours of independent work.

Information reference systems:

Information and reference and information and legal systems used in the study of the discipline:

1	Electronic Library System "University Library On-Line" – www.biblioclub.ru
2	IPRbooks Electronic Library System – http://iprbooks.ru
3	Electronic Library System Lan – https://e.lanbook.com/

Software:

1	Viola Workstation 10
2	Alt Workstation K
3	Viola "Server"
4	Office software package - P7-Office

10. Description of the material and technical base necessary for the implementation of the educational process in the discipline (module)

Lectures	Classroom for training sessions, equipped with multimedia equipment and technical teaching aids.
Practical exercises	Classroom for training sessions, equipped with multimedia equipment and technical teaching aids.
Independent work	Room for independent work of students, equipped with computer equipment with the ability to connect to the Internet and the ability to access the electronic information and educational environment of the university
Practical training	It is carried out in the structural divisions of the university and (or) in organizations that carry out activities in the profile of the relevant educational program, including its structural subdivision

11. Features of mastering the discipline (module) by persons with disabilities

Students with disabilities are provided with special textbooks, teaching aids and didactic materials, special technical teaching aids for collective and individual use, the services of an assistant (assistant) who provides students with the necessary technical assistance, as well as the services of sign language interpreters and typhlo-sign interpreters.

The development of a discipline (module) by students with disabilities can be organized together with other students, as well as in separate groups.

The development of a discipline (module) by students with disabilities is carried out taking into account the characteristics of psychophysical development, individual capabilities and health status.

In order to ensure the accessibility of higher education under the educational program by persons with disabilities when mastering the discipline (module), the following is ensured:

1) for visually impaired persons:

- the presence of an assistant who provides the student with the necessary technical assistance, taking into account individual characteristics (helps to take a workplace, move, read and complete the task, including by writing down by dictation),
- written tasks, as well as instructions on the procedure for their implementation, are drawn up in enlarged font,
- special textbooks, teaching aids and didactic materials (with large print or audio files),
- individual uniform lighting of at least 300 lux,
- if necessary, the student is provided with a magnifying device to complete the task;

2) for persons with hearing disabilities:

- the presence of an assistant who provides the student with the necessary technical assistance, taking into account individual characteristics (helps to take a workplace, move, read and complete the task, including by writing down by dictation),
- the availability of sound-amplifying equipment for collective use is ensured, if necessary, the student is provided with sound-amplifying equipment for individual use;
- is provided with appropriate sound means of reproducing information;

3) for persons with disabilities with musculoskeletal disorders (including those with severe disorders of the motor functions of the upper extremities or the absence of upper limbs):

- written tasks are performed on a computer with specialized software or dictated to an assistant;
- At the request of the student, tasks can be performed orally.

12. Features of the implementation of the discipline using distance educational technologies and e-learning

According to Part 1 of Article 16 of the Federal Law of December 29, 2012 No 273-FZ "On Education in the Russian Federation", *e-learning* is understood as the organization of educational activities with the use of information contained in databases and used in the implementation of educational programs and information technologies, technical means, as well as information and telecommunication networks that ensure the transmission of this information through communication lines, the interaction of students and teachers. Distance *educational technologies* are understood as educational technologies implemented mainly with the use of information and telecommunication networks with indirect (at a distance) interaction between students and teachers.

The discipline can be implemented using distance learning technologies and e-learning in whole or in part. The components of the discipline's teaching materials (the discipline's work program, assessment and methodological materials, forms of certification), implemented using distance learning technologies and e-learning, contain an indication of their use.

When organizing educational activities with the use of distance educational technologies and e-learning, asynchronous and synchronous ways of interacting with participants in educational relations through the information and telecommunication network "Internet" may be provided.

When using distance learning technologies and e-learning, the schedule for the discipline indicates: ways of interaction between participants in educational relations through the information and telecommunication network "Internet" (videoconferencing, ET - electronic testing); links to the electronic information and educational environment of NCFU, to educational platforms and resources of other organizations to which open access is provided through the information and telecommunication network "Internet"; for synchronous learning - the time of online classes and teachers; for asynchronous learning - the authors of online courses.

When organizing interim certification using distance learning technologies and e-learning, the Methodological Recommendations for the Use of Technical Means That Ensure the Objectivity of Results in the Conduct of Interim and State Final Certification in Educational Programs of Higher Education - Bachelor's Degree Programs, Specialist Programs and Master's Degree Programs with the Use of Distance Educational Technologies (Letter of the Ministry of Education

and Education of Russia dated 07.12.2020 No MN-19/1573-AN "On the Direction of Methodological Recommendations") are used.

The implementation of the discipline using e-learning and distance learning technologies is carried out using the electronic information and educational environment of NCFU, to which students have access through the information and telecommunication network "Internet", or using the resources of other organizations, including platforms that provide services for video conferences, online meetings and distance learning (MTS-Link), as well as using the capabilities of social networks for communication between students and teachers.

Educational and methodological support of the discipline implemented with the use of e-learning and distance educational technologies includes a work program, teaching aids or a course of lectures presented in electronic form, guidelines for the implementation of various types of educational activities of students provided for by the discipline, and other educational materials posted in the information and educational environment of NCFU.