Computer Vision Systems

Course: Computer Vision Systems

Faculty: Computer Systems and Networks	Amount of student effort (hours): 116
Department: Computer Science	Class contact time (hours): 54
Level: MA, Year 1	Term period(s): Sem. 1
Language of instruction: English	Course status: Mandatory core
Course leader: Igor Frolov	Entry requirements: At least 20 ECTS of the first degree's studies in the fields of Object Oriented Programming, Digital Signal Processing, Digital Image Processing, Computer Architecture.
ECTS: 3	Contact: frolov@bsuir.by

- ECTS and Amount of student efforts are in accordance with the educational standard of the Republic of Belarus
- the course was changed from Intellectual Image Processing in Detailed Description of the MaCICT Project (p. 61)

Objectives:

- acquisition of knowledge in the field of machine learning and pattern recognition, computer vision, biometric personality recognition systems;
- developing skills in applying methods and tools to create intelligent systems of technical vision;
- studying the principles of building intelligent systems of technical vision;
- mastering the methods of designing vision systems.

Learning Outcomes:

- knows basic definitions and basic concepts in the field of color and light physics, principles of camera operation;
- knows basic concepts in the field of stereovision and 3D images;
- basics of working with a video stream;
- methods and algorithms for detecting objects in images;
- methods of constructing a reduced set of features to represent initial images;
- basic methods for classifying and recognizing images;

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- methods of applying the studied methods for solving applied problems;
- analyze requirements for technical vision systems;
- evaluate the parameters of technical vision systems based on their intended purpose;
- mechanisms for preparing data for machine learning algorithms;
- machine learning algorithms;
- image processing mechanisms for technical vision systems;
- techniques for data compression and recovery in technical vision systems.

Curriculum Outline:

This course is intended for students of the second stage of higher education specializing in Computer Engineering at BSUIR.
The discipline creates the basis for fundamental and applied training within the framework of the creation of intelligent systems of technical vision, aimed at solving urgent national economic problems.
The main goal of teaching the discipline is to prepare masters in the following relevant areas: object identification systems and pattern recognition, hardware and software for scene analysis, and computer vision systems.
In our tutorials, we put academic knowledge and skills into practice, working on case studies from "real life" professional practice.

Contents:

When studying the discipline Computer Vision Systems you will know such topics as object identification systems and pattern recognition, hardware and software for scene analysis, and computer vision systems.

Course content

No	Sections and topics	Content of topics
1	Image representation and processing	The subject of the course, its objectives, structure. Creating and displaying images. Creating and displaying images. Image types and formats . Analysis of binary, halftone, and color images. Cameras, camera models. Digital image formats. File formats for storing video data. Color, light, and illumination.
2	Search and extract informative features of the image	Harris angle Detector. Invariant recognition extraction algorithms SIFT, SURF, FAST, and BRIEF. Algorithms for

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		matching attributes (metrics, estimates). Principal component method (PCM), singular matrix decomposition (SMD).
3	Introduction to machine learning and image recognition	Regression. Classification. Clustering. Support vector machines, neural networks, deep learning, k-nearest neighbor method, decision tree, metric algorithms, static algorithms, AdaBoost.
4	Stereo vision and 3d images	Perception of three-dimensional space by a person. Sources of information about the depth of the scene. Stereo image. Parallax. Depth margin. Monocular stereo effect. Serial-time stereo effect. Binocular stereo effect. Multi -camera methods for evaluating a person's posture, using three-dimensional reconstruction.
5	Concepts of virtual and augmented reality	Virtual reality. Augmented reality. 3D reconstruction based on images. Tracking and frame-by-frame evaluation. Illustrated models and methods based on them.
6	Processing the video stream	The concept of optical flow. The Lucas-Canada Method. Subtracting the background. Methods for subtracting the background. Methods for tracking objects. Combinations of methods.
7	Biometric data system of recognition of personality	Test collections. Recognition of the attributes of the face. Biometric access control systems based on facial recognition. Identification and identity verification. Methods for recognizing a person by the iris of the eye. Fingerprint identification systems.

Course Methodology:

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Classes in the first week are devoted to familiarization with the theoretical foundations of the course, sufficient to determine the topics of an individual assignment, and plan the distribution of work for the entire semester.
During the third week, students are divided into teams, and receive assignments for laboratory and individual work. Each team, when performing laboratory work under the supervision of the teacher, learns to interact with each other as a team. To finalize individual work students are responsible for time planning themselves and must interact between teams. In the penultimate week, all students present their work in classrooms, receiving feedback from teacher and fellow students.
Students take an exam in the last week

Assessment Strategies:

A. Formative assessment:
1. End term individual work on a self-defined topic relevant to the field of study (15%)
2. Defence of the laboratory work (50%)
3. End term exam (35%)

B. Summative assessment:
Presentation of the project and essay takes place in practical classes.

Assessment Criteria:

Detailed assessment criteria are presented in the University's Regulation "On the procedure for organizing and conducting the current certification" (Appendix 1 of the Regulation).

Indicative Student Learning Resources:

BSUIR Learning Management System for Computer Vision Systems page:
https://lms2.bsuir.by/course/view.php?id=2245

Literature:

1. Rafael C. Gonzalez. Digital Image Processing. 4th edition.
2. Reinhard Klette. Concise Computer Vision: An Introduction into Theory and Algorithms

2020/2021 Calendar for Computer Vision Systems MA course Sem.1

Month	September				October					November				December				
Week number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Type of activity	IL	IL	IL	IL	IL	IL	IL	IL	IL	IL	IL							E
		L	L	L	L	L	L	L	L	L	L	L	L	L	L		IWP	

IL – Lecture/Interactive lecture (2 hours)

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L – Laboratory Work (2 hours)
IWP – Presentation of individual work results (4 hours)
E - End term exam

Summative and formative assessments

Formative assessments are used within each module and are awarded for the quality of laboratory work, presentation and justification of the result obtained. These estimates can be confirmed by demonstrating the project, the ability to form and present a presentation. The use of such formative assessments provides feedback to maximize the student's learning potential. The set of study guides will also provide formative assessments to validate understanding of the learning process and provide individualized support.
Final assessments are an integral part of each section of the program. They represent the evidence of achievement of the module results and the corresponding academic credits.

Student workload, form of student activity:

Average number of hours for the activity: 116 hours
Lecture: 22 hours
Laboratory: 28 hours
Presentation of individual work results: 4 hours
Student's own work (62 hours):
Preparation for classes: 16 hours
Elaboration of results: 8 hours
Reading literature: 18 hours
Report writing: 20 hours

Completely new course

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