**KAZAKH-BRITISH TECHNICAL UNIVERSITY SCHOOL OF APPLIED MATHEMATICS**

**Approved**

**Head of School of Applied Mathematics**

**A.A. Issakhov**

**Syllabus**

**Basics of Computer Vision and Deep Learning MAT 1410**

Semester: Spring 2023 2022/2023 Academic Year 3 credits (2/1/0)

**Instructor:** Kuanysh Sh. Abeshev, professor

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| --- | --- | --- | --- | --- |
| **Personal Information**  **about the Instructor** | **Time and place of classes** | | **Contact information** | |
| **Lessons** | **Office Hours** | **Tel.:** | **e-mail** |
| Professor, PhD | According to the schedule | TBA |  |  |
|  |  | TBA |  |  |

**COURSE DURATION:** 3 credits, 15 weeks, 45 class hours.

**COURSE PRE-REQUISITES**: Mathematical foundations of the theory of machine learning and forecasting

**COURSE DESCRIPTION**

**Course Objectives:**

This course is for learning how to use the Python programming for Computer Vision.

In this course, we will look at how to use Python and the OpenCV (Open Computer Vision) library to analyze images and video data.

The world's most popular platforms generate unprecedented amounts of image and video data. Every 10 seconds, users upload over 50 hours of video to YouTube, Netflix subscribers stream over 10,000 hours of video, and Instagram users love over 1 million photos! Developers now need the skills needed to work with images and videos using computer vision more than ever.

Computer vision allows us to analyze, use image and video data with applications in a variety of fields, including self-driving cars, social media applications, medical diagnostics, and more.

At the beginning of the course, we will explore the numerical processing tools with the NumPy library and how to open and work with images with NumPy. Next, we will learn to use the OpenCV library to open and work with image basics. After that, we will begin to understand how to manipulate images and apply various effects, including color matching, blending, thresholds, gradients, and more. Understand video basics with OpenCV, including working with streaming video from a webcam. Afterwards we'll learn about optical flow and object detection. Also face detection, object tracking. At the end of the course, we will learn the deep learning topics, including image recognition and custom image classifications. Course also will cover the latest deep learning networks, including the YOLO (you only look once) deep learning network.

**Competition (learning outcomes):** After completing the course, the students will: Be able to

* Manage and open images with NumPy
* Use OpenCV to work with image files.
* Use Python and OpenCV to Draw Shapes on Images and Videos
* Perform image manipulations with OpenCV, including anti-aliasing, blurring, threshold setting, and morphological operations.
* Create color histograms with OpenCV.
* Open and stream videos with Python and OpenCV
* Object detection including corner, edge and mesh detection techniques with OpenCV and Python
* Create facial recognition software.
* Segment images with the watershed algorithm
* Tracking objects in video
* Work with Tensorflow, Keras, and Python to learn from your own custom images Be qualified in
* Creation/manipulation application.
* gain skills of computational thinking and modeling acquired to date; Know:
* The basics of NumPy
* How to use OpenCV to work with image files style
* How to use Python and Deep Learning to Create Image Classifiers

**Prerequisites:** Basic knowledge of Linear Algebra, Mathematical Statistics.

**In evaluating the performance of the student during the semester to consider the following:**

* Attendance
* Active and productive participation in practical exercises
* Study of basic and additional literature
* Homework
* Implementation of the CDS
* Timely delivery of all jobs **(for the late delivery of a rating of three CDS AW)**

**REFERENCES**

**Main:**

**Basic Literature:**

1. Aurélien Géron. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition. 2019.
2. Joseph Howse, Joe Minichino. Learning OpenCV 4 Computer Vision with Python 3: Get to grips with tools, techniques, and algorithms for computer vision and machine learning, 3rd Edition 2020.

**Supplementary literature:**

1. François Chollet. Deep Learning with Python, Second Edition. 2021.

**COURSE CALENDAR**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Week** | **Class work** | | | | **SIW (student’s individual work)** |
| **Topic** | **Lectures** | **Seminars** | **Chapters for read- ing** |
| 1 | NumPy basics. Images with NumPy  *Seminar #1.* | 2 | 1 | according to the lecture notes |  |
| 2 | Image and Video Basics with NumPy  *Seminar #2.* | 2 | 1 | according to the lecture notes |  |
| 3 | Color Mappings Blending and Pasting Images  *Seminar #3.* | 2 | 1 | according to the lecture notes | *SIW 3* |
| 4 | Image Thresholding  *Seminar #4.* | 2 | 1 | according to the lecture notes |  |
| 5 | Blurring and Smoothing Morphological Operators  *Seminar #5.* | 2 | 1 | according to the lecture notes | *SIW 5* |
| 6 | Gradients Histograms  *Seminar #6.* | 2 | 1 | according to the lecture notes | *SIW 6* |
| 7 | Project defense  *Seminar #7.* | 2 | 1 | according to the lecture notes | *SIW 7* |
| 8 | Streaming video with OpenCV  Object Detection  *Seminar #8.* | 2 | 1 | according to the lecture notes | *SIW 8* |
| 9 | Template Matching Corner, Edge, and Grid Detection  *Seminar #9.* | 2 | 1 | according to the lecture notes | *SIW 9* |
| 10 | Contour Detection. Feature Matching  *Seminar #10.* | 2 | 1 | according to the lecture notes |  |

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| 11 | WaterShed Algorithm. Face Detection  *Seminar #11.* | 2 | 1 | according to the lecture notes | *SIW 11* |
| 12 | Object Tracking. Optical Flow  *Seminar #12.* | 2 | 1 | according to the lecture notes |  |
| 13 | Deep Learning with Keras Keras and Convolutional Networks  *Seminar #13.* | 2 | 1 | according to the lecture notes |  |
| 14 | Customized Deep Learning Networks  *Seminar #14.* | 2 | 1 | according to the lecture notes | *SIW 14* |
| 15 | State of the Art YOLO Networks  *Seminar #15.* | 2 | 1 | according to the lecture notes |  |

**COURSE ASSESSMENT PARAMETERS**

|  |  |
| --- | --- |
| Attendance and activity on lessons | 7% |
| Seminars | 34.5% |
| SIW | 18.5% |
| Final exam | 40% |
| **Total** | **100%** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No** | **Assessment** | **Weeks** | | | | | | | | | | | | | | | | **Total** |
|  | **criteria** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **-** |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **17** |  |
| 1. | Attendance and | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |  |  | 7 |
|  | activity on les- | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |  |
|  | sons |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. | Seminars | 0.  5 | 0.  5 | 1 | 1 | 2 | 1 | 10 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 10 |  | 34.5 |
| 3. | SIW |  |  | 1 |  | 3 | 3.  5 | 3 | 2 |  | 1 | 1 | 1 | 1 | 1 |  |  | 18.5 |
| 6. | Final  examination |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 40 | 40 |
|  | Total |  |  |  |  |  |  |  | 30 |  |  |  |  |  |  | 30 | 40 | 100 |

**Lectures** are conducted in the form of explaining the theory given in the course that is why students supplied with handouts uploaded into the intranet. Activity and attendance on lessons is mandatory. Mandatory requirement is preparation for each lesson.

**Grading policy:** 5

Intermediate attestations (on 7th and 15th week) join topics of all lectures, laboratories, homework, quiz and materi- als for reading discussed to the time of attestation. Maximum number of points within attendance, activity, home- work, quiz and laboratories for each attestation is 30 points.

Final exam joins and generalizes all course materials, as project defense. Final exam duration is 120 min. Maximum number of points is 40. At the end of the semester you receive overall total grade (summarized index of your work during semester) according to conventional KBTU grade scale.

**ACADEMIC POLICY**

**Students are required:**

 to be respectful to the teacher and other students;

 to switch off mobile phones during classes;

 DO NOT cheat. Plagiarized papers shall be graded with zero points!

 to come to classes prepared and actively participate in classroom work; to meet the deadlines.

 to enter the room before the teacher starts the lesson.

 to attend all classes. No make-up tests or quiz are allowed unless there is a valid reason for missing it;

 to follow KBTU academic policy regarding **W, AW, I, F** grades.

 When students are absent for 20% of the lessons or more (without Spravka), then their grade is F.

 When students have a score of 29 or less for attestation 1 added to attestation 2, then their grade is F.

 When students have a score of 19 or less (less than 50%) for their final exam, then their grade is F.

 When students do not come for their final exam, then their grade is F.

**Students are encouraged to**

 consult the teacher on any issues related to the course.

 make up within a week’s time for the works undone for a valid reason without any grade deductions.

K. Abeshev

Professor of School of Applied Mathematics

« » , 2022

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