**Extended Syllabus**

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| **Course Title** | GKS4012 Seeing Korea: An introduction to image generation, processing & computer vision | **Semester** | 2022-2 |
| **Credit** | 3 | **Course Number** | GKS4012 |
| **Class Time** | 월,수 16:30 ~ 17:45 | **Enrollment**  **Eligibility** |  |

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| **Instructor's**  **Photo** | **Name: 서용덕 (SEO Yongduek)** | **Homepage:** |
| **E-mail:** [**yndk@sogang.ac.kr**](mailto:yndk@sogang.ac.kr) | **Telephone: 02 705 8896** |
| **Office: GA215**  **Office Hours: refer to saint.sogang.ac.kr** | |

**Ⅰ. Course Overview**

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| 1. Description |
| Images are two-dimensional data that have special characteristics. This course will investigate computer representation of image data, how to manipulate it, how to process it, and how to make computers understand the contents of images. Various image data from historical Korean artworks will be considered and students will perform several projects to develop computer programs to implement algorithms for image generation, processing, and understanding. |
| 1. Prerequisites |
| Python programming language (e.g., COR1009 or COR1010) |
| 1. Course Format (%) |
| |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Lecture | Discussion | Experiment  /Practicum | Field study | Presentations | Other | | 40% | 30% | % | % | 30% | % | |
| 1. Evaluation (%) |
| |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | Mid-term Exam | Final exam | Quizzes | Presentations | Projects | Assignments | Participation | Other | | 20% | 20% | % | 20% | 20% | 20% |  | % | |

**Ⅱ. Course Objectives**

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| Knowledge:  Image processing, image understanding algorithms, computer vision algorithms. 2D and 3D geometry  Skill:  Mathematical description of problems image processing and geometric computer vision.  Attitude: |

**Ⅲ. Course Format**

(\* In detail)

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| - The course is mostly self-contained. Details of mathematics will be introduced by student requests or by necessity of describing the related topics.  - Programming experiments are performed by students and their details will be shared through in-class presentations, discussions and Q&As. This is the most important core of this class.  - |

**Ⅳ. Course Requirements and Grading Criteria**

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| * Student projects and assignments will be presented during the course and evaluated. * Progress of the projects, assignments, and source codes will be shared. |
| Examples of curriculum-based writing homeworks/activity: all writing exercises requested by classes, including reports, discussion and presentations |

**Ⅴ. Course Policies**

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**Ⅵ. Materials and References**

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| * Digital Image Processing, Rafael Gonzalez and Richard Woods. * Augmented reality: Principle and Practice, Dieter Schmaistieg and Tobias Hollerer, 2016 * Computer Vision: Algorithms and Applications, 2nd ed., Richard Szeliski, <https://szeliski.org/Book/> * Computer Graphics Using OpenGL (2nd Ed.), Francis S. Hill * Mathematics for Machine Learning, Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong, <https://mml-book.github.io/> * [www.opencv.org](http://www.opencv.org) |

**Ⅶ. Course Schedule**

**(\* Subject to change)**

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| **Week**  **1**  **(dd/mm)** | **Learning Objectives** | Course logistics, basics of image data |
| **Topics** | * C/C++ or python ? * 1D array indexing for image data manipulation * Color representation: Gray, RGB, HIS |
| **Class Work**  **(Methods)** |  |
| **Materials**  **(Required Readings)** |  |
| **Assignments** | Drawing with opencv plotting functions |
| **Week**  **2**  **(dd/mm)** | **Learning Objectives** | 2D rigid transformations |
| **Topics** | * Rotation & translation in 2D * How to rotate a digital image * Interpolation algorithms |
| **Class Work**  **(Methods)** |  |
| **Materials**  **(Required Readings)** |  |
| **Assignments** | Visualization of 2D Primitives |
| **Week**  **3**  **(dd/mm)** | **Learning Objectives** | * How to draw a line segment? * Parametrization and sampling * Lines, traiangles, filled triangles |
| **Topics** |  |
| **Class Work**  **(Methods)** |  |
| **Materials**  **(Required Readings)** |  |
| **Assignments** |  |
| **Week**  **4**  **(dd/mm)** | **Learning Objectives** | 2D Video Tracking |
| **Topics** | * How to track a line segment? * MSE estimation of line parameters and RANSAC * How to track a rectangle/circle in a video? * Gradient operations for edge detection * MSE estimation |
| **Class Work**  **(Methods)** |  |
| **Materials**  **(Required Readings)** |  |
| **Assignments** |  |
| **Week**  **5**  **(dd/mm)** | **Learning Objectives** | 2D projective transformations |
| **Topics** | * Rigid, Similarity, Affine, and Projective transformations * Minimal parametrization and computing the transformation parameters from point correspondences |
| **Class Work**  **(Methods)** |  |
| **Materials**  **(Required Readings)** |  |
| **Assignments** |  |
| **Week**  **6**  **(dd/mm)** | **Learning Objectives** |  |
| **Topics** |  |
| **Class Work**  **(Methods)** |  |
| **Materials**  **(Required Readings)** |  |
| **Assignments** | 2D Video Augmentation |
| **Week**  **7**  **(dd/mm)** | **Learning Objectives** | * Inserting a video into a moving rectangle * Forward/backward mapping |
| **Topics** |  |
| **Class Work**  **(Methods)** |  |
| **Materials**  **(Required Readings)** |  |
| **Assignments** |  |
| **Week**  **8**  **(dd/mm)** | **Learning Objectives** | Mid-term exam |
| **Topics** |  |
| **Class Work**  **(Methods)** |  |
| **Materials**  **(Required Readings)** |  |
| **Assignments** |  |
| **Week**  **9**  **(dd/mm)** | **Learning Objectives** | 3D Rigid transformations |
| **Topics** | * Coordinate frame representation and basis change * Representation of Rotation matrices * Pin-hole camera model * Projection mechanism through a pin-hole camera * Image rendering of a 3D wireframe model |
| **Class Work**  **(Methods)** |  |
| **Materials**  **(Required Readings)** |  |
| **Assignments** |  |
| **Week**  **10**  **(dd/mm)** | **Learning Objectives** | Camera calibration |
| **Topics** | * Parametrization of a pin-hole camera * Estimation method * Lens distortion correction |
| **Class Work**  **(Methods)** |  |
| **Materials**  **(Required Readings)** |  |
| **Assignments** |  |
| **Week**  **11**  **(dd/mm)** | **Learning Objectives** | 3D Reconstruction concept |
| **Topics** | * Stereo Vision, a wll-calibrated case * Epipolar geometry * From two images to 3D: triangulation * Estimation of 3D coordinates from point correspondecs |
| **Class Work**  **(Methods)** |  |
| **Materials**  **(Required Readings)** |  |
| **Assignments** |  |
| **Week**  **12**  **(dd/mm)** | **Learning Objectives** | Image/video stitching |
| **Topics** | * Geometry of pure rotation camera. * 2D projective relationship induced by the rotation * Point corners tracking & sparse optical flow * RANSAC and 2D homography estimation |
| **Class Work**  **(Methods)** |  |
| **Materials**  **(Required Readings)** | <https://docs.opencv.org/3.4/d4/dee/tutorial_optical_flow.html> |
| **Assignments** |  |
| **Week**  **13**  **(dd/mm)** | **Learning Objectives** | Feature detectors & descriptors |
| **Topics** | * Harris corner detector * FAST corner detector * SIFT is a blob detector * ORB/BRISK as a binary descriptor * Descriptor matching for image stitching |
| **Class Work**  **(Methods)** |  |
| **Materials**  **(Required Readings)** |  |
| **Assignments** |  |
| **Week**  **14**  **(dd/mm)** | **Learning Objectives** | Camera motion estimation (Visual Odometry) |
| **Topics** | * Camera pose estimation from video sequence * BA: concept and implementation |
| **Class Work**  **(Methods)** |  |
| **Materials**  **(Required Readings)** |  |
| **Assignments** |  |
| **Week**  **15**  **(dd/mm)** | **Learning Objectives** | Project presentation |
| **Topics** |  |
| **Class Work**  **(Methods)** |  |
| **Materials**  **(Required Readings)** |  |
| **Assignments** |  |
| **Week**  **16**  **(dd/mm)** | **Learning Objectives** | Final exam |
| **Topics** |  |
| **Class Work**  **(Methods)** |  |
| **Materials**  **(Required Readings)** |  |
| **Assignments** |  |

**Ⅷ. Special Accommodations**

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**Ⅸ. Aid for the Challenged Students**

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