Extended Syllabus

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**	

Instructor's Photo	**Name: 서용덕 (SEO Yongduek)**	**Homepage:**
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Ⅰ. Course Overview

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.

2. Prerequisites

Python programming language (e.g., COR1009 or COR1010)

3. Course Format (%)

Lecture	Discussion	Experiment /Practicum	Field study	Presentations	Other
40%	30%	%	%	30%	%

4. Evaluation (%)

Mid-term Exam	Final exam	Quizzes	Presentations	Projects	Assignments	Participation	Other
20%	20%	%	20%	20%	20%		%

Ⅱ. Course Objectives

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)

- 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.
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Ⅳ. Course Requirements and Grading Criteria

- 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

VI. Materials and References

- 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

Ⅶ. Course Schedule

(* Subject to change)

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

IX. Aid for the Challenged Students