(2022-2nd)Course Syllabus

Course Title	Advanced Computer Vision	CRN (Course Reference Number)	EE7107
Subtitle	-	Credit hour (Lecture hours - Lab hours - Credit hours)	3-0-3
Course Format	Lecture ■ Discussion ☐ Labotory ☐ Practicum ☐ Blended ☐ Online ☐ (Add)		
Course Description	This course provides advanced theories and applications of computer vision and deep learning. We cover diverse studies from traditional computer vision methodologies (e.g., camera theory, feature extraction, segmentation, multiple view geometry, etc.) to recent learning-based approaches (e.g., image classification, semantic segmentation, correspondence problem, 3D vision, etc.). At the end of the semester, recent advances in these studies will be dealt with in group discussion sessions organized by the enrolled students for final presentation.		

P1. Course Information

Instructor	Seokju Lee	Office	
Office Hours	TBD	Office Telephone	
		E-mail	slee@kentech.ac.kr
Discipline	Energy AI	Prerequisite	- Python Programming - Linear Algebra
Target Audience	Graduate Students		
Course Reading & Resources			
Required Materials	Required Materials Lecture Notes will be provided.		
Other Recommended Materials (optional)	- “Multiple View Geometry in Computer Vision”, by Richard Hartley and Andrew Zisserman, Cambridge University Press, 2004 - “CS231n: Deep Learning for Computer Vision”, Stanford University		
Course Access	This is an offline course. However, it may be changed to an on-line course if the situation due to COVID-19 does not allow off-line meeting.		
Technical & Academic Support	- Instructor: Prof. Seokju Lee - Course Teaching Assistant: TBD		

P2. Course Objectives

Course Learning Objectives	- Understand basic theories of computer vision from traditional methods to recent learning-based algorithms. - Understand how to build neural networks and optimize them. - Explore extensive theories and applications of computer vision and deep learning.
Course Learning Activities	- Read required reading materials every week. - Check your progresses with Intermittent programming assignments. - Design your own neural networks with Python programming for various applications. - Make intermittent presentations reviewing recent studies published in CVPR, ICCV, ECCV, NeurIPS, ICLR, ICML, AAAI, ICRA, etc.

P3. Topic Outline / Schedule

Important note : Refer to the course calendar for specific dates and times. Activity and assignment details will be explained in detail within each week's corresponding learning module. If you have any questions, please contact your instructor.

MODULE01 Week (01~05)	Fundamentals of Computer Vision		
	Week01	Overview & Camera Theory	- Course overview – two-stream learning for computer vision study: past & present - Basic camera theory & image processing – pinhole camera model, transformation, calibration, etc.
			Lecture note 01a & 01b
	Week02	Image Filtering	- Image transformations, point image processing, linear shift-invariant image filtering, convolution, image gradients, image pyramids, sampling
			Lecture note 02a & 02b
	Week03	Feature Extraction	- Designing feature descriptors, HOG descriptor, SIFT, detecting corners, multi-scale features, learning-based feature extractors
			Lecture note 03a & 03b Group presentation – group making, topic scheduling
	Week04	Geometry (1)	- Image homography, 2D transformations, projective geometry, two-view geometry, triangulation, epipolar geometry, essential matrix, fundamental matrix, 8-point algorithm
			Lecture note 04a & 04b
	Week05	Geometry (2)	- Structure-from-Motion, stereo matching, multi-view stereo, radiance field, rendering
			Lecture note 05a & 05b
MODULE02 Week (06~16)	Advanced Topics of Computer Vision & Deep Learning		
	Week06	Image Classification with MLP & DNN	- Linear/nonlinear classifiers, feature representations, convolution and pooling, activation functions, normalization, data processing, visualization
			Lecture note 06a & 06b Group presentation – neural networks

MODULE02 Week (06~16)	Week07	Backpropagation	- Regularization, stochastic gradient descent, momentum, AdaGrad, Adam, learning rate schedules, hyperparameter tuning, data augmentation
			Lecture note 07a & 07b Group presentation – regularization and optimization
MODULE02 Week (06~16)	Week08	Object Detection & Segmentation	- Single-stage detectors, two-stage detectors - Semantic/instance/panoptic segmentation
			Lecture note 08a & 08b Group presentation – object detection & segmentation
	Week09	Generative Models	- Supervised vs. Unsupervised learning, Pixel CNN, variational autoencoders, image-to-image, generative adversarial networks
			Lecture note 09a & 09b Group presentation – generative models
	Week10	Self-supervised Learning & Attention	- Pretext tasks, contrastive learning, multisensory supervision - Self-attention, transformers
			Lecture note 10a & 10b Group presentation – self-supervised learning & attention
	Week11	Video Processing	- Video understanding, video classification, video enhancement, 3D CNNs, two-stream networks
			Lecture note 11a & 11b Group presentation – video processing
	Week12	3D Vision	- Optical flow, depth estimation, Structure-from-Motion, stereo matching, multi-view-stereo, neural radiance field, neural implicit representations
			Lecture note 12a & 12b Group presentation – 3D vision
	Week13	Multimodal Learning	- Learning different modalities – thermal & event camera, LiDAR, motion, audio, text, language
			Lecture note 13a & 13b Group presentation – multimodal learning
	Week14	Vision for Robotics	- Various visual perception applications for robotics, SLAM, visual odometry, reinforcement learning, visual question and answering, vision-language navigation
			Lecture note 14a & 14b Group presentation – vision for robotics
	Week15	Guest Lectures	- Seminars by special guests
			Guest lectures
	Week16	Final Projects	- Final projects on modern computer vision and deep neural networks, re-implementation of recent study
			Final group presentation and paper writing

P4. Grading Policy

Graded Course Activities

Activity	Percentage
Attendance	10
Quizzes	10
Assignments (CNN implementation with Python)	20
Presentations (group discussions for paper review)	30
Projects (re-implementation of recent study)	30
Total	**100%**