CSIE 2019 Fall: Introduction to Image Processing, Computer Vision and Deep Learning (初階影像處理、電腦視覺及深度學習)

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Website: http://robotics.csie.ncku.edu.tw/course.html **Prerequisites:** C, C++ or Python

Class Time/Location: 09:10 ~ 12:00 Friday / room A1302/ for undergraduate and master students

Syllabus: (W: Week - Ch: Bradski's book chapter)

	01-01	Introduction to **industry 4.0** - Intelligent robotics and automation: Sensors, machine vision, deep learning, big data and IoT (Internet of Things).
Image Processing	01-06, 05	Image processing 1 - **Convolution**: High-Pass (edge) and low-pass (smooth) filters, and morphology operation with CCLabeling (connected-component labeling– 09).
	02-05, 06	Image processing 2 - **Image transforms**: Hough transformation, geometric trans., FT (Fourier transform), II (integral image) and histogram equalization.
	03-06	Image processing 2 - **Image transforms:** Hough transformation, geometric trans., FT (Fourier transform), II (integral image) and histogram equalization.
	04-07	Image proc. 3 – **(Texture) Histograms and matching:** Stochastic and probability.
	05-08	Image Processing 4 – **(Shape) Contours:** Data structure - **Linked list**. **Assignment 1.**
Computer Vision	06-11	Sensor - **Camera models and calibration**: Optimization process and **AR** (Augmented reality).
	07-12	Sensor - Projection and **3D vision**: Geometric transformations between 2D and 3D; and 1) **Stereo**, 2) ToF (Time-Of-Flight, Kinect 2, SoftKinetic), and 3) Structured light (Kinect 1, DLP projector).
	08-09	Image parts and segmentation: **Background subtraction/modeling** - Real-time motion detection using **GMM**.
	09-	**Midterm exam.** (from W01~07)
	10-10	Tracking and motion: **Optical flow** (feature tracking), mean-shift, **Camshift** tracking, and condensation algorithm (particle filter).
Machine Learning	11-13	1) **SIFT** (and brief HOG): Feature extraction, 2) **AdaBoost**: Face detection,
	12-13	3) **PCA**, LDA: Face recognition.
Deep Learning	13-	From **AI** (artificial intelligence) to **ML** (machine learning), to **DP** (deep learning): -From **Bayes' Rule** (posterior probability) to Gaussian model, to similarity measure (likelihood probability: Mahalanobis distance, SSD (sum of squared differences) and correlation (or **pattern matching**)), to PCA (linear combination). **Assignment 2.**
	14-	Deep learning: From BPNN (back propagation neural networks) to deep learning.
	15-	Deep learning: LeNet and AlexNet
	16-	Deep learning: VGG-16
	17-	Deep learning: GoogLeNet and ResNet
	18-	**Final exam.** (from W01~17)

Grading: Assignment x 2: 25% x 2 = 50%, Exam x 2: 25% x 2 = 50%.

Textbooks/Reference Books:

1. Textbook1: Class lecture notes.
2. Textbook2: Learning OpenCV, Computer Vision with the OpenCV Library by Gary Bradski and Adrian Kaebler, O'Reilly, 2008.
3. Ref1. OpenCV (V.2.4.7 or above) documents including 1) tutorials, 2) reference manual, and 3) user guide.

4. Ref2. Digital Image Processing by Rafael C. Gonzalez and Richard E. Woods, 3rd, Pearson, 2007.
5. Ref3. Computer Vision: Algorithms and Applications by Richard Szeliski, Springer, 2010.
6. Ref4. Deep Learning by Ian Goodfellow, Yoshua Bengio, and Aaron Courville, MIT Press, 2016.

課程概述：

這門課將教授工業界常會用到的影像處理、電腦視覺及人工智慧-深度學習的理論基礎及技術，並學習及實作 OpenCV 的功能與實務應用。為了讓學生了解深度學習的原理是如何結合人工智慧及電腦視覺發展而來的相互關係，課程中會傳授影像處理中最重要的 convolution 的基本原理與實際應用，並會讓學生了解如何用神經網路來實現並強化 convolution 的功能以完善 Convolutional Neural Networks (CNN) 的架構（topology)。 課程將以工業界實際的例子來解釋基礎原理，透過這些理論來解決實際的問題，技術內容包括影像處理、即時偵測、追蹤及辨識系統的設計、3D 立體視覺、增擬實境及深度學習等等。本課程期待培養學生於影像處理、電腦視覺及深度學習領域設計、驗證及整合實作的能力，透過作業實作，可把所學的理論基礎應用到工業界的實務面。

教學目標:

培養學生具備以下的基本知識及實作能力：

1）具備基本的影像處理、電腦視覺及深度學習理論基礎；

2）融匯貫通深度學習的原理是如何結合人工智慧、電腦視覺及影像處理- convolution 發展而來的；

3）具備以電腦視覺及深度學習的技術來解決即時偵測、追蹤、辨識及增擬實境生活上的實際問題；

4）學習 OpenCV 的功能原理及實務應用。