主導課程六：機器導航與探索（Robotic Navigation and Exploration）

課程基本資料

開設學校：國立清華大學

開授教師： 胡敏君

開課級別：學碩合開

授課語言： 中文

課程概述

本課程模組分為三個主要的部分，分別為即時追蹤與地圖建置(SLAM)、基於機器學習之場景理解(Scene Understanding)與探索導航的動作控制(Action Control)。即時追蹤與地圖建置部分包含機率模型與相機模型等理論基礎，也包含基於深度學習之 RGB-based的3DSLAM方法。場景理解的部分包含機器學習的基本概念，再帶到深度學習的技術與目前的物件偵測與語意切割技術。動作控制的部分則包含路徑規劃與導航演算法，並帶入強化學習的概念來引導行進的路徑。

參考書目

● Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction, Second Edition, MIT Press, Cambridge, MA, 2018

● Sebastian Thrun, Wolfram Burgard, and Dieter Fox , Probabilistic Robotics,2005. (Intelligent Robotics and Autonomous Agents series)

● Kevin Murphy, Machine Learning: A Probabilistic Perspective.

● Daphne Koller and Nir Friedman, Probabilistic Graphical Models: Principles and Techniques, 1st Edition, 2009.

● Ian Goodfellow, Yoshua Bengio and Aaron Courville: Deep Learning.

課程內容大綱

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| **週次** | **日期** | **課程內容** | **備註** |
| **1** | 2/17 | Introduction to Robotic Navigation and Exploration |  |
| **2** | 2/24 | Kinematic Model and Path Tracking Control   * Control System Basics * PID Control * Basic Kinematic Model * Differential Drive Vehicle * Pure Pursuit Control * Kinematic Bicycle Model | Lab 1 |
| **3** | 3/3 | Motion Planning   * Motion Planning Introduction * Path Planning * Curve Interpolation | Lab 2 |
|  |  | * Trajectory Planning * Path Planning |  |
| **4** | 3/10 | Reinforcement Learning (I)   * MDP * Value Function * Bellman Equation * Reinforcement Learning |  |
| **5** | 3/17 | Reinforcement Learning (II)   * Q-Learning / Sarsa / DQN * Policy Gradient / Actor-Critic |  |
| **6** | 3/24 | Project Environment Building (I) | Lab3 |
| **7** | 3/31 | Project Environment Building (I) | Lab4 |
| **8** | 4/7 | Project Environment Building (III) | Lab5 |
| **9** | 4/14 | SLAM Back-end (I)   * State Estimation and SLAM Problem * Probability Theory and Bayes Filter * Kalman Filter / Extended Kalman Filter |  |
| **10** | 4/21 | SLAM Back-end (II)  \* Graph based Optimization |  |
|  |  | \* Graph Optimization for 2D SLAM (Bundle Adjustment) |  | |
| **11** | 4/28 | 3D SLAM (I)   * Feature Descriptor * Multi-view Geometry * Lie Group & Lie Algebra |  | |
| **12** | 5/5 | 3D SLAM (II)   * 3D SLAM: ORB-SLAM * Direct Method * DNN-based SLAM |  | |
| **13** | 5/12 | 3D Embodied Agent |  | |
| **14** | 5/19 | Paper Presentation (I) |  | |
| **15** | 5/26 | Paper Presentation (II) |  | |
| **16** | 6/2 | Project Presentation & Demo |

成績評量方式

● 作業: 60% (15% for each HW)

● 論文閱讀報告(10%)

● 自走車期末專題(含實作、書面報告、口頭報告): 30%

課程要求

● 建議學生需已修過Python程式設計、影像處理、深度學習。

● 學生須自備具GPU顯卡之電腦。

● 本課程期末專題採分組開發，為避免影響同組修課同學之權益，本課程不接受期中退選，請謹慎評估可投入的時間再選課。