

## 主導課程四：實體人工智慧(Physical AI)

### 課程基本資料

開設學校：陽明交通大學

開授教師：陳奕廷

班級人數：6500人 (保留300人給開課學校, 聯盟校上限100人, 若條件式授權盟校自訂)

開課級別：研究所(大學部以上四年級修讀)

授課語言：英文

授權方式：條件式

同步遠距上課時間：星期二13:20~16:20

是否接受非同步授課：是

同步實體期末評量時間：無

遠距上課位置：使用YouTube直播

課程網頁：

建議助教學生比：每10名學生建議提供1名助教

### 課程概述

In recent years, we have witnessed remarkable breakthroughs in artificial intelligence—from ChatGPT reshaping how humans interact with language to Google Veo 3.1 expanding the frontier of video generation. As the field evolves, attention is now shifting toward Agentic AI, where systems are no longer merely reactive, but capable of goal-driven, autonomous decision-making. Yet the next major frontier extends beyond the screen. We are entering the era of Physical AI, where intelligence moves from the digital world into the physical one. Physical AI refers to AI systems that can perceive, reason, and act within real-world environments—sensing through cameras, microphones, and other sensors, and interacting with

the world via motors, robotic arms, wheels, or other actuators.

In this course, Physical AI serves as the central lens through which all projects and discussions are contextualized. Students will explore how modern AI models are integrated into real-world systems such as robots, smart homes, and autonomous vehicles, and how intelligence, embodiment, and environment jointly shape system behavior.

As AI systems increasingly operate around us in everyday life, critical questions emerge: How do these systems function in real-world settings? How do we ensure their reliability, safety, and alignment with human values? And what new challenges arise when AI is deployed in open, dynamic environments?

If these questions inspire you, this course is designed for you.

### **Intended Learning Outcomes:**

1. Explain the definition, scope, and significance of Physical AI, and distinguish it from purely digital and agentic AI systems.
2. Describe the core concepts, system architectures, and key enabling technologies underlying Physical AI, including sensing, perception, reasoning, planning, and control.
3. Analyze and apply foundational Physical AI techniques to real-world problem settings, taking into account environmental dynamics, embodiment, and system constraints.
4. Identify and evaluate major application domains and representative use cases of Physical AI, such as robotics, smart environments, and autonomous systems.
5. Design, implement, and prototype a Physical AI solution that demonstrates the integrated use of perception, decision-making, and physical action.

Note: The lectures during the week of the 12th–14th will be co-taught with Dr. Chun-yien Chang, a research scientist in the Department of Computer Science at National Yang Ming Chiao Tung University. Dr. Chang will cover ontology engineering and ontology-based evaluation.

### **參考書目：**

1. Stuart Russell and Peter Norvig (2020). *Artificial Intelligence: A Modern Approach*, 4th Global ed., Pearson College.
2. Richard Hartley and Andrew Zisserman (2003), *Multiple View Geometry in Computer Vision*.

3. Timothy D. Barfoot (2024), State Estimation for Robotics, Second Edition, Cambridge University Press.

4. Kevin Lynch and Frank Park (2017), Modern Robotics Mechanics, Planning, and Control, Cambridge University Press.

5. Keet, C. M. (2025). An introduction to ontology engineering (2nd ed.). College Publications.

6. Allemang, D. (2020). Semantic Web for the Working Ontologist : Effective Modeling for Linked Data, RDFS, and OWL / (Third Edition). Association for Computing Machinery. <https://doi.org/10.1145/3382097>

## 課程內容大綱

週次	日期	課程內容	備註
1	9/8/2026	Introduction	
2	9/15/2026	Recent Advances in Physical AI	
3	9/22/2026	Data Pyramid in Physical AI	
4	9/29/2026	Introduction to Universal Manipulation Interface (UMI) and LeRobot	
5	10/6/2026	Simultaneous Localization and Mapping	HW1 Release
6	10/13/2026	Path Planning	
7	10/20/2026	Robotic Manipulation	HW2 Release
8	10/27/2026	Introduction ICRA'26 WBCD Challenge	Link: <a href="https://wbcdcompetition.github.io/">https://wbcdcompetition.github.io/</a>

9	11/3/2026	Introduction to Issac Sim	HW3 Release and course project spec release
10	11/10/2026	Imitation Learning/Reinforcement Learning for Robotics Manipulation	
11	11/17/2026	Diffusion Models in Robotics Manipulation	HW4 Release
12	11/24/2026	Introduction to Ontology Engineering	
13	12/1/2026	Ontology-based Evaluation	HW5 Release
14	12/8/2026	Scenario-based Safety Validation and Policy Evaluation	
15	12/15/2026	Research Frontiers	
16	12/22/2026	Course Project Presentation	

## 成績評量方式

### Computer Assignment: 50%

- HW1: Coordinate Transformation
- HW2: 3D Scene Reconstruction and Mapping
- HW3: Path Planning
- HW4: Robotics Manipulation
- HW5: Ontology-based Data Quality Verification

## **Course Project : 50%**

The Course Project is designed to provide students with hands-on experience across the full lifecycle of Physical AI—from real-world data collection, to policy learning, and ultimately to evaluation. More details will be shared in the kick-off meeting.

課程要求(例如先備知識、軟硬體設備、修課規範, 若無可填無)

無

協同老師負責工作(封閉式授權免填)

衛星課程的協同老師, 需要獨立完成該盟校所有學生的評分, 包含Computer Assignment的評分、分組簡報評分、期末專題評分等等, 各盟校評分獨立作業。

【實體人工智慧】的協同老師, 不需要同步跟課, 但是需要找尋適合的助教以及協助下列評分, 也因此盟校至少要給予一半的授課學分數, 若該校學生除了主導課程老師的上課內容外, 還需要協同老師另外補充上課, 則需給予更高的學分數。

總分: 協同教師可以決定該課程是要用百分、等第、或通過/非通過的成績。