國 立 成 功 大 學 模 組 化 課 程

開課學年度/學期：115 學年度第 1 學期　　領域：科際整合

數位影像處理導論
Introduction to Digital Image Processing

授課教師	任職單位	畢業學校
朱書賢 **jusushan@gmail.com**	**EDA Software Engineer, Intel corp.**	**College of Science and Engineering, University of Minnesota-Twin Cities, Minneapolis, MN**

課程類別	學分數	選必修	開課人數	其他注意事項
Lecture + Recitation	**1.5**	**選修**	**20**	**請見其他備註**

先修課程或先備能力

以修完大二上學期課程學生程度估計

課程難易度

□難 □中偏難 ■中偏易 □易

建議修課學生背景

理學院、工學院、生科院、電資學院、管理學院、醫學院、規劃設計學院

教學方法

講授 70%，實作 30%

補充說明：

The course follows a structured daily format featuring theoretical lectures in the morning and hands-on laboratory sessions in the afternoon. While prior Python experience is not required, a basic understanding of general programming logic is recommended to help you get up to speed.

To ensure a smooth learning curve, lab sessions are divided into two parts:

- **Guided Technical Workshop: We will walk through practical examples and review Python homework assignments. Full source code will be provided, allowing you to follow along during the session and continue practicing independently afterward.**
- **Open Lab & TA Consultation: The second half of the lab serves as dedicated "TA Hours." This is an ideal time to troubleshoot homework, brainstorm project ideas, or collaborate with peers on development tasks with direct support from the teaching staff.**

評量方式

問題考試 28%：

四次隨堂測驗，第二天至第五天 9:00-9:30，範圍為前幾日所教的課程內容.

作業 50%：

四次作業分別針對第一天至第四天課程內容，第二到第五天下課前上傳繳交至課程平台

報告 22%：

課程結束後的 2 天內須繳交一份完整的專案報告。報告可以使用中文或英文撰寫。報告必須包含以下章節：

- **標題與作者資訊 (Title & Author Information)**

國 立 成 功 大 學 模 組 化 課 程

開課學年度/學期：115 學年度第 1 學期　　領域：科際整合

- **摘要與前言 (Abstract & Introduction)**
- **問題陳述與研究方法 (Problem Statement & Methodology)**
- **結果、討論與結論 (Results, Discussion, & Conclusion)**
- **個人貢獻聲明 (Individual Contribution Statement)：需詳細說明每位成員的具體分工。**
- **參考文獻 (References)**

Grading Policy & Assessment

Your final grade is based on three core components designed to ensure consistent engagement and practical mastery of Digital Image Processing (DIP) concepts.

1. **Daily Quizzes (28%)**
   - **Timing**: Administered from **Day 2 to Day 5** during the first 30 minutes of class **(09:00–09:30)**.
   - **Scope**: These assessments focus on the material covered in the **previous days'** lecture to ensure foundational concepts are reinforced.
2. **Homework Assignments (50%)**
   - **Distribution**: Assignments are posted prior to each lecture.
   - **Deadline**: Submissions are due by **midnight the following day**, providing a fast-paced feedback loop for your technical skills.
3. **Final Project (22%)**
   - **Collaboration**: Students will work in teams of **up to 4 members** to tackle a DIP challenge and develop effective computational solutions.
   - **Submission**: A comprehensive project report is due **two days after the course concludes**.
   - **Language**: Reports may be submitted in either **English or Chinese**.
   - **Report Structure**: To receive full credit, the report must include the following sections:
     - Title & Author Information
     - Abstract & Introduction
     - Problem Statement & Methodology
     - Results, Discussion, & Conclusion
     - **Individual Contribution Statement** (detailing each member's specific role)
     - References

學習規範

按時上課、按時交作業(報告)

課程概述

數位影像處理已深入現代社會的各個角落，應用範疇極其廣泛。從工業自動化的精準檢測，到科學探索中透過各類感測器拓展人類視距之外的疆界，再到近年來結合人工智慧（AI）**所引領的生活變革，其影響力無處不在。具體應用案例包括醫療領域的 X 光、超音波、核磁共振（MRI），以及尖端技術如太空遙測與自動駕駛。**

本課程旨在帶領學生探索數位影像的奧秘，內容涵蓋影像構成、採樣原理、影像增強處理與關鍵資訊擷取。此外，我們將透過實作演習課，指導學生如何運用 Python 強大的工具庫進行影像處理實務。

關鍵字：數位影像處理，影像分析，影像增強，訊息擷取

國 立 成 功 大 學 模 組 化 課 程

開課學年度/學期：115 學年度第 1 學期 領域：科際整合

課程概述(英文)

Digital Image Processing (DIP) has evolved into a cornerstone of modern technology, transcending simple entertainment to become vital in fields as diverse as medicine, industry, and artificial intelligence. Its reach spans from manufacturing inspections and robotic navigation to advanced scientific research in biology, astronomy, and physics. Whether it is analyzing aerial imagery or optimizing traffic control systems, DIP provides the tools to interpret the visual world.

This course offers a comprehensive introduction to the core techniques and algorithms required to acquire, process, and derive meaningful insights from digital images. We will place a specific focus on **spatial-domain operations**, including sampling, quantization, image transformation, and enhancement.

Keywords：Digital Image Processing, Image Analysis, Image Enhancement, Information Extraction

課程進度

日期	時間	進度說明
7/6(一)	09:00-12:00 13:00-15:30	**Day 1: Foundations & Mathematical Framework** **Morning (09:00–12:00): Theory & Introduction** • **Course Launch: Logistics, syllabus overview, and the diverse applications of DIP in modern industry.** • **DIP Fundamentals: Exploring human visual perception, image acquisition sensors, and the core concepts of resolution, intensity, and contrast.** • **Mathematical Toolbox: Essential linear algebra and matrix operations required for digital image manipulation.** **Afternoon (13:00–15:30): Practical Lab** • **Environment Setup: Python installation and essential library configuration (NumPy, OpenCV/Pillow).** • **Initial Practice: Hands-on exercises in image creation, array-based representation, and basic pixel manipulations.**
7/7(二)	09:00-12:00 13:00-15:30	**Day 2: Intensity & Color Space Dynamics** **Morning (09:00–12:00): Theory** • **Intensity Transformations: Mastering histogram processing, including equalization and histogram matching for contrast enhancement.** • **Color Science: Understanding color models (RGB, HSV, CMYK), pseudocolor processing, and full-color transformations.** **Afternoon (13:00–15:30): Practical Lab** • **Implementation: Applying intensity mapping and color space conversions to enhance real-world datasets.**
7/8(三)	09:00-12:00 13:00-15:30	**Day 3: Spatial Filtering & Image Enhancement** **Morning (09:00–12:00): Theory**

國 立 成 功 大 學 模 組 化 課 程

開課學年度/學期：115 學年度第 1 學期　　領域：科際整合

		• **Spatial Operations: Deep dive into neighborhood processing, including correlation and convolution.** • **Filters: Implementing smoothing kernels for noise reduction and sharpening filters for edge enhancement.** **Afternoon (13:00–15:30): Practical Lab** • **Filtering Workshop: Applying linear and non-linear spatial filters to both morphological and multi-channel color images.**
7/9(四)	**09:00-12:00 13:00-15:30**	**Day 4: Morphological Analysis** **Morning (09:00–12:00): Theory** • **Morphological Foundations: Exploring set theory-based operations, including erosion, dilation, opening, and closing.** • **Structural Extraction: Using morphology for noise removal, boundary extraction, and skeletonization.** **Afternoon (13:00–15:30): Practical Lab** • **Shape Processing: Implementing morphological algorithms to clean binary images and extract structural components.**
7/10(五)	**09:00-12:00 13:00-15:00**	**Day 5: Segmentation & Feature Detection** **Morning (09:00–12:00): Theory** • **Image Segmentation: Techniques for partitioning images into meaningful parts via thresholding and region-based growth.** • **Feature Detection: Identifying primitives using line/edge detectors and the Hough Transform for geometric shape recognition.** **Afternoon (13:00–15:00): Project Showcase**

課程學習目標

1. **Deconstruct how images are built**, mastering the differences between binary shapes, grayscale gradients, and color spaces.
2. **Master pixel-level enhancement** tools to sharpen, filter, and optimize images directly in the spatial domain.
3. **Isolate and identify key data** by learning the algorithms behind component detection and image segmentation.
4. **Build a professional intuition** for selecting and applying the right image processing tools to solve practical industry problems.

課程的重要性、跨域性與時代性

Driven by the rapid evolution of computing power and machine learning, **Digital Image Processing (DIP)** has become an indispensable technology across nearly every modern industry. Its successful integration is visible in diverse applications, including high-precision medical imaging, robotic vision, and sophisticated pattern recognition systems, such as autonomous traffic monitoring and computer-aided diagnostic tools. Even the everyday convenience of smartphone photography relies on these complex underlying algorithms.

國 立 成 功 大 學 模 組 化 課 程

開課學年度/學期：115 學年度第 1 學期 領域：科際整合

Upon completion of this course, students will possess a deep understanding of the mechanisms behind digital imagery. More importantly, they will gain the technical proficiency to implement image processing solutions within their own academic research, professional projects, and daily technological interactions.

其他備註

- **參考書目：**
  R.C. Gonzales and R.E Woods, Digital Image Processing 4th ed.
- **Course Prerequisites**
  There are **no formal requirements** to enroll in this course. However, to ensure a smoother learning experience during the technical labs, a foundational grasp of the following is recommended:

(1) Mathematics: Basic Linear Algebra (matrix operations and arrays).

(2) **Programming:** Familiarity with **Python** syntax and logic.

- **Software & Essential Tools**
  We might utilize several industry-standard libraries to process and manipulate digital imagery.

1. **The Core Language**
   - Python: The primary environment for all computational tasks.
2. **Computational & Image Libraries**
   - NumPy: The fundamental package for scientific computing, used here for high-performance matrix and array manipulations.
   - Pillow (PIL): A user-friendly library for opening, manipulating, and saving many different image file formats.
   - OpenCV-Python**:** A powerful real-time computer vision library designed for advanced image processing and analysis.

本課程若因天災等不可抗力之因素或中央、地方政府公告停課，授課教師需依情況依建議補課方式調整課程進度與補課；若需使用假日、國定假日補課，則需與所有修課學生達成共識方能用例假日補課。

建議補課方式：

1. **線上授課方式補課；**
2. **當預期可能會因天災(颱風、超大豪雨…等)宣佈停課時，建議老師先行調整加快課程進度或預先增加可能天氣預警之前幾次課程時數；**
3. **停課後隔天起延後下課，補足停課延誤的進度；若停課超過 1 天，則在開始上課後延後下課補課，或當週星期六、日補課；**
4. **更改課程授課方式，例如：DEMO 改以考試、報告、作業取代。**