UNIVERSITY OF MACAU
FACULTY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF COMPUTER AND INFORMATION SCIENCE
2025-1-CISC3011 DIGITAL IMAGE PROCESSING
Syllabus
1st Semester 2025/2026
Part A – Course Outline

Course Description

Digital Image Processing (DIP) is a basic and important component in numerous real-world applications, spanning business, industry, medical imaging, digital photography, computer games, robotics, etc. Its widespread use also enables effective and efficient communication through visual results, e.g., tele-presence and tele-communication for AR/VR. This 3-credit, 14-week course prepares students with the fundamentals of DIP and illustrates the various effects one can achieve with digital images and how to develop appropriate DIP methods to solve real-world problems.

Course Type

Theoretical

Prerequisites

- Python programming
- Linear algebra
- Statistics and probability
- Multivariate calculus
- Algorithms
- Preferably access to GPUs (e.g., Public Lab in E11, Google Colab).

Recommended Background

- **Python**. All class assignments will be in Python. For those who aren't as familiar with Python, please follow this tutorial. In the tutorial, go over all topics under "Python Tutorial", "Python NumPy". It will also be beneficial to go over all topics under "Machine Learning".
- **Familiar with Jupyter Notebook**. We will use Jupyter Notebook (https://jupyter.org) to implement algorithms, demonstrate experiment qualitative and quantitative results, and write up assignment report. There is an online lab of Jupyter (https://jupyter.org/try-jupyter/lab). Converting a Jupyter Notebook file to pdf script is trivial (https://nbconvert.readthedocs.io/en/latest/usage.html).
- **PyTorch**. Some coding assignments can be done in a more convenient way by using deep learning. PyTorch is an excellent python-based toolbox for machine learning and deep learning. For those who haven't used it before, please refer to its official tutorial and navigate specific topics therein such as "Image and Video".
- **Linear Algebra**. You should be comfortable taking derivatives and understanding matrix vector operations and notation. Go over the "Essence of linear algebra" playlists by "3Blue1Brown" at https://www.youtube.com/c/3blue1brown/playlists
- **Statistics and Probability.** You should be familiar with basics of probabilities, Gaussian distributions, mean, standard deviation, etc. Go over the "Probabilities of probabilities" playlist by "3Blue1Brown" at https://www.youtube.com/c/3blue1brown/playlists

Popular Textbook(s) and Reading Material

- Steven W. Smith, The Scientist and Engineer's Guide to Digital Signal Processing (Online)
- R. C. Gonzalez, R. E. Woods, Digital Image Processing, 4th edition, Pearson, 2018
- William K. Pratt, Introduction to Digital Image Processing, CRC Press, 2013
- A. Kaehler, G. Bradski, Learning OpenCV 3, OReilly Media, 2017.
- IEEE Transactions on Image Processing (TIP)
- IEEE International Conference on Image Processing (ICIP)
- IEEE Computer Vision and Pattern Recognition (CVPR)
- scikit-image: Image processing in Python

Course Objectives

The objective of this course is to teach fundamental concepts, methods and problems related to Digital Image Processing. The course will also train students with respect to implementing classic digital image processing algorithms. Upon completion of the course, students will:

1. Have a good understanding of fundamental concepts and classic algorithms in DIP.
2. Know useful toolboxes for DIP.
3. Be able to develop methods to solve real-world problems related to DIP.
4. Build interests in other topics like computer vision, machine learning, deep learning, etc.

The learning outcomes will be assessed based on homework, course projects, and exams.

Topics

1. Point operations/combining images/histograms
2. Image filtering, correlation, convolution
3. Edge, contour, corner
4. Morphological image processing
5. Color space
6. Image thresholding, segmentation
7. Scale-space image processing
8. Image matching, image registration
9. Applications: deblur, denoise, super-resolution, etc.

Class / Laboratory Schedule

Timetabled work in hours per week			**No of teaching weeks**	**Total hours**	**Total credits**	**No of exam papers**
Lecture	**Tutorial**	**Practice**				
1.5	**0**	**1.5**	**14**	**52**	**3**	**2**

Student Study Effort Required

Class:	
Lecture	21 hours
Tutorial	0 hours
Other study Effort:	
Self-study	25 hours
Course project	25 hours
Total student study effort	50 hours

Student Assessment
Final assessment will be determined on the basis of

- Five homework assignments: 72%=9*8%
- Final / midterm exam: 28%=2*14%

Course Outline

Weeks	Topics	Homework / exam / project
1	Introduction, logistics	Homework 1: Basic python
2	Point Operations, Combining Images	Homework 2: Brightness and blending
3	Histograms	Homework 3: Histogram equalization
4	Filtering, Convolution	Homework 4: Filter, blur, denoising
5	Edges	Homework 5: edge detection, sharpening
6	Lines and Corners	
7	Morphological Processing	Homework 6: Morphological operations
8	Scale Space	Midterm Exam
9	Color Science, Color Spaces	Homework 7: Color balancing
10	EigenImages, FisherFace	Homework 8: Face recognition
11	Template matching, Feature-based Matching	Homework 9: Object detection
12	Spectral methods, Discrete Fourier Transform	
13	Image restoration: deblur, inpainting, etc.	
14	Deep Learning in DIP	

Student Disabilities Support Service:
The University of Macau is committed to providing an equal opportunity in education to persons with disabilities. If you are a student with a physical, visual, hearing, speech, learning or psychological impairment(s) which substantially limit your learning and/or activities of daily living, you are encouraged to communicate with your instructors about your impairment(s) and the accommodations you need in your studies. You are also encouraged to contact the Student Disability Support Service of the Student Counselling and Development Section (SCD), which provides appropriate resources and accommodations to allow each student with a disability to have an equal opportunity in education, university life activities and services at the University of Macau. To learn more about the service, please contact SCD at scd.disability@umac.mo, or 8397 4901 or visit the following website: https://sao.um.edu.mo/

Instructor
Shu Kong, Assistant Professor of CIS
https://aimerykong.github.io

Persons Who Prepared This Description
Shu Kong, June 7th, 2025

Part B General Course Information and Policies

1st Semester 2025/2026
Instructor: Prof. Shu Kong
Office: E11-4025
Office hour: Tuesday and Wednesday at 14:00-15:00, or by appointment
Email: skong@um.edu.mo

Time/Venue

Lecture	TBD	TBD

Grading Distribution

Percent. Grade	Final Grade	Percent. Grade	Final Grade	Percent. Grade	Final Grade
100 – 93	A	77 – 73	B-	57 – 53	D+
92 – 88	A-	72 – 68	C+	52 – 50	D
87 – 83	B+	67 – 63	C	below 50	F
82 – 78	B	62 – 58	C-		

Homework Policy
The completion and correction of homework are helpful for learning. As a result,

- There are five homework assignments.
- Homework is due two weeks after assignment unless otherwise noted.
- No late penalty but is a reward (+5 points) if submitting >24 hours earlier by the due date.
- Revisions submitted after the deadline will not be rewarded for +5 points.
- Possible revision of grades may be discussed with the instructor.
- The course grade will be based on the weighted average of the homework, midterm/final exam, and the course project.

Other Important Notes

- Check the ummoodle web pages for announcements, and lectures.
- Cheating is absolutely prohibited by the university.
- UM students can 'use ChatGPT or other generative-AI systems to ***enhance*** their learning' and that they 'should be aware that they ***must be authors of their own work***' (email 'Notes on the use of generative-AI systems', 11 April 2023). See details in FAQs for Students: Using Generative AI Tools in Graded Assignments (https://ctle.um.edu.mo/resource/faqs-for-students-using-generative-ai-tools-in-graded-assignments/).