University of Macau
Computer and Information Science Department
SFTW453 Digital Image Processing
Syllabus
1st Semester 2011/2012
Part A – Course Outline

Elective course in Computer Science

Catalog description:

(3-2) 4 credits. This course introduces the fundamentals of digital image processing for senior undergraduate students. It emphasizes the general principles and techniques of image processing. Topics include digital image fundamentals, intensity transformations and spatial filtering, filtering in the frequency domain, image restoration and reconstruction, color image processing, wavelets and multiresolution processing, image compression and watermarking, morphological image processing, image segmentation, representation and description.

Course type:

Theoretical with substantial laboratory/practice content

Prerequisites:

MATH103

Textbook(s) and other required material:

- R. C. Gonzalez and R. E. Woods, *Digital Image Processing*, 3rd edition, Prentice Hall , 2008.
- R. C. Gonzalez, R. E. Woods and Steven L. Eddins , *Digital Image Processing Using MATLAB* , 2rd edition, Prentice Hall, 2009.

Major prerequisites by topic:

1. Basic knowledge in Calculus and Engineering Mathematics.
2. Basic knowledge in Linear system and linear convolution.
3. Programming knowledge of MATLAB or C++.

Course objectives:

1. Learn the fundamental concepts and applications of digital image processing. [a, e, j]
2. Learn the concepts of and how to perform Intensity transformations and spatial filtering. [a, b, e, k]
3. Understand the relationship between Filtering in the spatial and frequency domains. [a, b, e, k]
4. Understand the concepts of and how to perform Image restoration and reconstruction, Color image processing, Wavelets and multiresolution processing, Image compression and watermarking, Morphological image processing, Image segmentation, Representation and description. [a, b, e, k]

Topics covered:

1. **Digital image fundamentals (5 hours)** - Fundamental Steps in Digital Image Processing; Image Sampling and Quantization.
2. **Intensity transformations and spatial filtering (5 hours)**- Basic Intensity Transformation Functions and Histrogram Processing; Fundamentals of Spatial Filtering.
3. **Filtering in the frequency domain (10 hours)** - The Discrete Fourier Transform (DFT) and the Basics of Filtering in the Frequency Domain; Image Smoothing and Sharpening Using Frequency Domain Filters.
4. **Image restoration and reconstruction (5 hours)** - Model of the Image Degradation/Restoration Process and Noise Models; Noise reduction by spatial and frequency domain filtering.

5. **Color image processing (5 hours)** - Color Fundamentals and Models; Color Transformations and Image Processing Techniques.
6. **Wavelets and multiresolution processing (5 hours)**- Multiresolution Expansions and Wavelet Transforms.
7. **Image compression and watermarking (10 hours)** - Fundamentals of data redundancy; Basic Compression Methods; Digital Image Watermarking.
8. **Morphological image processing (10 hours)**- Erosion and Dilation, Opening and Closing; Basic Morphological Algorithms.
9. **Image segmentation (10 hours)**- Point, Line, and Edge Detection; Thresholding and Region-Based Segmentation; Segmentation Using Morphological Watersheds.
10. **Representation and description (5 hours)** - Image Representation; Boundary and Regional Descriptors.

Class/laboratory schedule:

Timetabled work in hours per week			No of teaching weeks	Total hours	Total credits	No/Duration of exam papers
Lecture	**Tutorial**	**Practice**				
3	Nil	2	14	70	4	1 / 3 hours

Student study effort required:

Class contact:	
Lecture	42 hours
Tutorial	28 hours
Other study effort	
Self-study	42 hours
Homework assignment	9 hours
Project	15 hours
Total student study effort	136 hours

Student assessment:

Final assessment will be determined on the basis of:

- Homework 20%
- Project 30%
- Final Exam 50%

Course assessment:

The assessment of course objectives will be determined on the basis of:

1. Homework, project and exams
2. Course evaluation

Course Outline:

Weeks	Topics	Course work
1	**Digital image fundamentals**	

	- Fundamental Steps in Digital Image Processing; - Image Sampling and Quantization.	
2	**Intensity transformations and spatial filtering** - Basic Intensity Transformation Functions and Histrogram Processing; - Fundamentals of Spatial Filtering.	Assignment#1
3,4	**Filtering in the frequency domain** - The Discrete Fourier Transform (DFT) and the Basics of Filtering in the Frequency Domain; - Image Smoothing and Sharpening Using Frequency Domain Filters	Assignment#2
5	**Image restoration and reconstruction** - Model of the Image Degradation/Restoration Process and Noise Models; - Noise reduction by spatial and frequency domain filtering.	
6	**Color image processing** - Color Fundamentals and Models; - Color Transformations and Image Processing Techniques.	Assignment#3
7	**Wavelets and multiresolution processing** - Multiresolution Expansions and Wavelet Transforms.	Course Project
8,9	**Image compression and watermarking** - Fundamentals of data redundancy; - Basic Compression Methods; - Digital Image Watermarking.	Assignment#4
10,11	**Morphological image processing** - Erosion and Dilation, Opening and Closing; - Basic Morphological Algorithms.	Assignment#5
12,13	**Image segmentation** - Point, Line, and Edge Detection; - Thresholding and Region-Based Segmentation; - Segmentation Using Morphological Watersheds.	
14	**Representation and description** - Image Representation; - Boundary and Regional Descriptors.	

Contribution of course to meet the professional component:

This course prepares students to work professionally in the area of digital image processing.

Relationship to CS program objectives and outcomes:

This course primarily contributes to Computer Science program outcomes that develop student abilities to:
(a) an ability to apply knowledge of mathematics, science, and engineering.
(b) an ability to design and conduct experiments, as well as to analyze and interpret data.
(e) an ability to identify, formulate, and solve engineering problems.
(k) an ability to use the techniques, skills, and modern engineering tools necessary for computer engineering practice.

The course secondarily contributes to Computer Science program outcomes that develop student abilities to:
(j) a knowledge of contemporary issues.

Relationship to CS program criteria:

Criterion	DS	PF	AL	AR	OS	NC	PL	HC	GV	IS	IM	SP	SE	CN
Scale: 1 (highest) to 4 (lowest)								2	3	1	3			

Discrete Structures (DS), Programming Fundamentals (PF), Algorithms and Complexity (AL), Architecture and Organization (AR), Operating Systems (OS), Net-Centric Computing (NC), Programming Languages (PL), Human-Computer Interaction (HC), Graphics and Visual Computing (GV), Intelligent Systems (IS), Information Management (IM), Social and Professional Issues (SP), Software Engineering (SE), Computational Science (CN).

Course content distribution:

Percentage content for			
Mathematics	Science and engineering subjects	Complementary electives	**Total**
40%	60%	0%	100%

Coordinator:

Chi Man Pun, Associate Professor of Computer Science and Engineering

Persons who prepared this description:

Chi Man Pun, August 23, 2012.

Part B General Course Information and Policies

1st Semester 2010/2011

Instructor: Prof. Chi Man Pun Office: N319
Office Hour: Monday 15:00-16:00, Thursday 15:00-17:00, or by appointment
Phone: 8397-4369
Email: cmpun@umac.mo

Time/Venue:

Lecture	Monday	10:30 - 12:30	U101
	Thursday	10:30 - 11:30	U101
Practice	Saturday	10:30 - 12:30	T103

Time/Venue:

Grading Distribution:

Percentage Grade	Final Grade	Percentage Grade	Final Grade	Percentage 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-		

Comment:
The objectives of the lectures are to explain and to supplement the textbook. Students who wish to succeed in this course should read the correspondence chapters of the textbook prior to the lecture and should work all homework assignments by themselves. You are encouraged to look at other sources (other references, etc.) to complement the lectures and textbook.

Homework Policy:
The completion and correction of homework is a powerful learning experience; therefore:

- There will be approximately 5 homework assignments.
- Homework is due two weeks after assignment unless otherwise noted, no late homework is accepted.
- Possible revision of homework grades may be discussed with the grader within one week from the return of the marked homework
- The course grade will be based on the average of the HW grades.

Course Project:
One course project will be assigned at about the middle of the semester.

Note

- Attendance is strongly recommended.
- Check course web pages for announcement, homework and lectures. Report any mistake on your grades within one week after posting.
- No make-up exam is given except for medical proof.
- Cheating is absolutely prohibited by the university.

Appendix:

Rubric for Program Outcomes

Rubric for (a)	5 (Excellent)	3 (Average)	1 (Poor)
Understand the theoretic background	Students understand theoretic background and the limitations of the respective applications.	Students have some confusion on some background or do not understand theoretic background completely.	Students do not understand the background or do not study at all.
Use a correct model and formulation correctly	Students choose a model correctly and properly apply correct techniques.	Students choose a wrong model sometime, use a wrong formula, or a different technique.	Students use a wrong model and wrong formula, or do not know how to model.
Compute the problem correctly	Students use correct techniques, analyze the problems, and compute them correctly.	Students sometime solve problem mistakenly using wrong techniques.	Students do not know how to solve problems or use wrong techniques completely.

Rubric for (b)	5 (Excellent)	3 (Average)	1 (Poor)
Conduct experiments	Student successfully completes the experiment, records the data, analyzes the experiment's main topics, and explains the experiment concisely and well.	Student successfully completes the experiment, records the data, and analyzes the experiment's main topics.	Student either does not complete the experiment successfully, or completes it successfully but does not record the correct data.
Design experiments	Student understands what needs to be tested and designs an appropriate experiment that takes into account the limitations of the equipment and measurement accuracy.	Student understands what needs to be tested and designs an appropriate experiment, but may not fully understand the limitations of the measurements.	Student does not understand what needs to be tested and/or does not design an appropriate experiment.

Rubric for (e)	5 (Excellent)	3 (Average)	1 (Poor)
Identify applications in engineering	Students understand problem and can identify fundamental formulation.	Students understand problem but cannot apply formulation, or cannot understand problem.	Students cannot identify correct terms for engineering applications.

systems			
Modeling, problem formulation and problem solving	Students choose and properly apply the correct techniques.	Students model correctly but cannot select proper technique or model incorrectly but solve correctly accordingly.	Students at loss as to how to solve a problem.
Rubric for (j)	5 (Excellent)	3 (Average)	1 (Poor)
Relevance to the present time	Student displays an understanding of the theoretical or practical impact and an ability to correlate a subject, perception, communication, association and reasoning from a global and societal perspective.	Student is able to display an understanding of current topics and issues with some knowledge regarding their impact in a bigger global and societal sense.	Student has difficulty demonstrating an awareness or familiarity with current topics and issues relevant to most current global and societal affairs.
Rubric for (k)	5 (Excellent)	3 (Average)	1 (Poor)
Use modern principles, skills, and tools in engineering practice	Student applies the principles, skills and tools to correctly model and analyze engineering problems, and understands the limitations.	Student applies the principles, skills and tools to analyze and implement engineering problems.	Student does not apply principles and tools correctly and/or does not correctly interpret the results.