University of Macau
Faculty of Science and Technology
Department of Computer and Information Science
SFTW373 Special Topics in Computer and Information Science I
Subtitle: Computer Vision
Syllabus
2nd Semester 2011/2012
Part A – Course Outline

Elective course in Computer Science

Catalog description:
(3-2) 4 credits. Digital Image Representation, Binary Image Analysis, Gray Level Image Segmentation, Filtering in the Frequency Domain, Edge detection Techniques, Digital Morphology and Color Image Processing Fundamentals.

Textbook(s) and other required material:
None

References:
- Linda G. Shapiro, George C. Stockman. *Computer Vision*, Prentice-Hall, Inc., 2001
- J.R. Parker. *Algorithms for Image Processing and Computer Vision*, Wiley Computer Publishing, 2010.
- E.R.Davies, *Machine Vision*, 3rd Edition, Elsevier, 2005.
- Richard Szeliski, Computer Vision Algorithms and Applications, Springer, 2011.

Course objectives:
- Introduce to students the basic concepts in computer vision and its major applications in practice. [a, e]
- Introduce to students the fundamental principles and algorithms in binary, grey level, and color image processing, and how to use the algorithms in practice. [a, e, k]
- Introduce to students the basic filtering knowledge in frequency domain. [a]
- Learning to apply course material to improve thinking, and problem solving. [k]

Topics covered:
- **Introduction to computer vision and digital image representation (6 hours):** Introduce the basic concepts of computer vision, the difference disciplines among Computer Vision, Image Processing, Pattern Recognition and Computer Graphics, the applications in computer vision, and digital image representation and processing.
- **Binary image processing fundamentals (9 hours):** Binary image morphology and applications, contour tracing algorithms, connected components labeling algorithms, and algorithm of counting the objects in the binary Image.
- **Gray level image processing fundamentals (9 hours):** Histogram and different thresholding algorithms, histogram equalization, image enhancement, and high-pass and low-pass filtering.
- **Fourier transform and its applications (3 hour):** Discrete Fourier transform and its applications in computer vision, FFT algorithm.
- **Edge detection (6 hours):** Edge models and different edge detection techniques; including Sobel edge detector, Laplace edge detector, and Canny edge detector, etc.
- **Color image processing fundamentals (3 hours):** Color models in computer vision, including RGB and HSI models, color image histogram processing, histogram equalization in color image and color edge detection.
- **Image segmentation and applications (6 hours):** Texture and texture segmentation, region segmentation, edge connection. The applications of different segmentation approaches.

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	1	1	14	70	4	Nil

4 hour lectures, including three hours tutorials every three weeks. (14 weeks)

Student study effort required:

Class contact:	
Lecture	42 hours
Tutorial	14 hours
Practice	14 hours
Other study effort	
Self-study	14 hours
Assignment and projects	28 hours
Total student study effort	112 hours

Student assessment:

Final assessment will be determined on the basis of:

Assignment	20%	Lab exercises and reports	30%
Project	30%	Seminar report: 10%	
Algorithm presentation	10% (Each student has different algorithm topic for presentation).		

Course assessment:

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

- Assignments, lab exercises and reports, project, algorithm presentation, and seminar report.
- Course evaluation

Course outline:

Weeks	Topic	Course work
1	**Introduction to computer vision** Basic concepts of computer vision and the applications.	
2	**Introduction to digital image representation** Digital image representation and processing in computer program and MATLAB.	
3-4	**Binary image processing fundamentals** Concepts, and algorithms and applications of Image morphology, including dilation, erosion, closing, and opening**.**	1. Algorithm presentation 1 2. Lab exercise 1.1-1.3
5	**Binary image processing fundamentals (continued)** Contour tracing algorithms, connected components labeling algorithms, and algorithm of counting the objects in the binary Image.	1. Algorithm presentation 2 2. Assignment 1
6	**Gray level image processing fundamentals** Thresholding techniques, including basic global threshold algorithm, histogram-based threshold algorithms—single valued and multimodal, basic adaptive thresholding algorithm	1. Algorithm presentation 3 2. Lab exercise 1.4-1.6
7-8	**Gray level image processing fundamentals (continued)** Image enhancement, including spatial domain techniques and frequency domain techniques. Topics cover: Point operations, histogram equalization, ideal low pass and high pass filter, Butterworth low pass and high pass filter, and Gaussian low pass	1. Lab exercise 2.1-2.3

Weeks	Topic	Course work
	and high pass filter.	
9	**Fourier transform and its applications** Fourier series, Fourier transform, inverse Fourier transform, discrete Fourier transform pair, and fast Fourier transform and its applications in computer vision.	1. Lab practice
10-11	**Edge detection** Edge types and models, noise types, edge detection categories – Gradient and Laplacian. Derivative Operator Algorithm, principle and operator of Sobel edge detection and its algorithm, Roberts' operator, Prewitt operator, Laplace Edge Detector algorithm, zero-crossing detection, principle and algorithm of Canny edge detector.	1. Algorithm presentation 4,5 2. Project 3. Lab exercise 2.4
12	**Color image processing fundamentals** Fundamentals of color, color models in computer vision, including RGB and HSI models, the transform from RGB to HSI and inverse, color image histogram processing, histogram equalization in color image and color edge detection algorithms.	1. Algorithm presentation 6-9 2. Lab exercise 3.1-3.3
13-14	**Image segmentation and applications** Intensity-based segmentation, Edge-based segmentation, Region-based segmentation	1. Assignment 2 2. Seminar report 3. Lab Exercise 3.4

Contribution of course to meet the professional component:

This course prepares students to work professionally in the area of computer vision software development.

Relationship to CS program objectives and outcomes:

This course primarily contributes to the Computer Science program outcomes that develop student abilities to:

(a) an ability to apply knowledge of computing, mathematics, science, and engineering.

(e) an ability to analyze a problem, and identify, formulate and use the appropriate application requirements for obtaining its computing solution.

The course secondarily contributes to the Computer Science program outcomes that develop student abilities to:

(k) an ability to use the techniques, skills, and modern computer tools necessary for engineering practice.

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)	1	2	4											4

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**
10%	40%	50%	100%

Coordinator:
Prof. Yi Ping Li

Persons who prepared this description:
Dr. Li Ming Zhang

Part B – General Course Information and Policies

2nd Semester 2011/2012

Instructor: Dr. Liming Zhang Office: B1-B703
Office hour: Wed 2:30 pm – 5:30 pm, or by appointment Phone: 8397 8467
Email: lmzhang@umac.mo

Time/Venue: Mon 2:30 pm – 5:30 pm, WLG305 (lectures)
Thu 1:30 pm – 3:30 pm, WLG305 (laboratory)

Grading distribution:

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

Comment:
The objectives of the lectures are to explain and to supplement the text material. Students are responsible for the assigned material whether or not it is covered in the lecture. Students who wish to succeed in this course should work all homework and class exercises. Students are encouraged to look at other sources (other texts, etc.) to complement the lectures and text.

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 homework grades.

Note:
- Lab exercise sessions are important part of this course and attendance is strongly recommended.
- Check UMMoodle for announcement, homework and lectures. Report any mistake on your grades within one week after posting.
- Cheating is absolutely prohibited by the university.