UNIVERSITY OF MACAU

FACULTY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF COMPUTER AND INFORMATION SCIENCE

CISB466– Special Topics in Computer and Information Science II

Subtitle: Computer Vision

Syllabus

2nd semester 2014/2015

Part A – Course Outline

Elective course in Computer Science

Catalog description:

(2-2) 3 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.

Course type

Theoretical with substantial laboratory/practice content

Prerequisites:

None

Textbook(s) and other required material:

- Richard Szeliski, *Computer Vision Algorithms and Applications*, Springer, 2011.

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.

Major prerequisites by topic:

None

Course objectives:

- Introduce to students the basic concepts in computer vision and its major applications in practice. [a]
- 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, c]
- Introduce to students the basic filtering knowledge in frequency domain. [a]
- Learning to apply course material to improve thinking, and problem solving. [a, c]

Topics covered:

- **Introduction to computer vision and digital image representation (4 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 (6 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 (6 hours):** Histogram and different thresholding algorithms, histogram equalization, image enhancement, and high-pass and low-pass filtering.
- **Fourier transform and its applications (2 hour):** Discrete Fourier transform and its applications in computer vision, FFT algorithm.
- **Edge detection (4 hours):** Edge models and different edge detection techniques; including Sobel edge detector, Laplace edge detector, and Canny edge detector, etc.
- **Color image processing fundamentals (2 hours):** Color models in computer vision, including RGB and HSI models, color image histogram processing, histogram equalization in color image and color edge detection.
- **Introduction to Open CV (2 hours):** The characteristics of Open CV, Open CV structure and content, develop programs in Open CV
- **Final project presentation (2 hours).**

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				
2	2	Nil	14	56	3	3

Student study effort required

Class contact	
Lecture	28 hours
Tutorial	28 hours
Other study effort	
Self-study	28 hours
Assignments and projects	12 hours
Projects	12 hours
Total student study effort	108 hours

Student assessment

Final assessment will be determined on the basis of

Assignments: 20%
Lab exercises and reports: 10%
Project: 20%
Mid-term exam: 20%
Final exam: 30%

Course assessment

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

- Assignments, project, and exams
- 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.	Lab Practice
3,4	**Binary image processing fundamentals** Concepts, and algorithms and applications of Image morphology, including dilation, erosion, closing, and opening**.**	Lab exercise1-3
5	**Binary image processing fundamentals (continued)** Contour tracing algorithms, connected components labeling algorithms, and algorithm of counting the objects in the binary Image.	1. Lab exercise 4-6 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	Lab exercise 7
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 and high pass filter.	1. Lab exercise 8 2.Project
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.	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.	Assignment 2-part 1
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.	Assignment 2-part 2
13	**Introduction to Open CV** The characteristics of Open CV, Open CV structure and content, develop programs in Open CV	Lab practice
14	**Project Presentation**	

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 Computer Science program outcomes that develop student abilities to:
(a) An ability to apply knowledge of computing and mathematics to solve complex computing problems in computer science discipline.
(c) An ability to analyse a problem, and identify and define the computing requirements appropriate to its solution;

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**
20%	80%	0%	100%

Coordinator:

Prof. Yiping Li

Persons who prepared this description:

Dr. Liming Zhang

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Part B General Course Information and Policies

2nd Semester 2014/2015

Instructor: Dr. Liming Zhang Office: E11-4016
Office hour: Wed 2:30 pm – 5:30 pm, or by appointment Phone: 8822 8467
Email: lmzhang@umac.mo

Time/Venue: Fri 3.:30 pm – 5:30 pm, (lectures)
Wed 9:00 am – 10:45 am, (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 assignments, lab exercises and project. 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 2 homework assignments, 3 lab exercises, and 1 project.
- Assignments and project are due four weeks, the lab exercises are due one week unless otherwise noted, late homework will be deducted 10% marks for each delayed day.
- Possible revision of homework grades may be discussed with the grader within one week from the return of the marked homework.

Exams:
One 2-hour mid-term exam will be held during the semester. One 3-hour final exam will be held at the end of semester. Both the mid-term and final exams are close booked examinations.

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.
- No make-up exam is given except for CLEAR medical proof.
- Cheating is absolutely prohibited by the university.

Appendix:

Rubric for Program Outcomes

(a) An ability to apply knowledge of computing and mathematics appropriate to the programme outcomes and to the discipline

(c) An ability to analyse a problem, and identify and define the computing requirements appropriate to its solution

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.
Rubric for (c)	**5 (Excellent)**	**3 (Average)**	**1 (Poor)**
Identify applications in engineering systems	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.