ROCHESTER INSTITUTE OF TECHNOLOGY
COURSE OUTLINE FORM

COLLEGE OF SCIENCE

Chester F. Carlson Center for Imaging Science

NEW COURSE: COS-IMGS-362 Image Processing and Computer Vision II

1.0 Course Designations and Approvals

Required course approvals:	**Approval request date:**	**Approval granted date:**
Academic Unit Curriculum Committee	9/1/10	9/15/10
College Curriculum Committee	10/19/10	12/7/2010

Optional designations:	**Is designation desired?**		***Approval request date:**	****Approval granted date:**
General Education:		No		
Writing Intensive:	Yes			
Honors		No		

2.0 Course information:

Course title:	Image Processing and Computer Vision II
Credit hours:	3
Prerequisite(s):	COS-IMGS-361
Co-requisite(s):	None
Course proposed by:	Carl Salvaggio
Effective date:	Fall 2013

	Contact hours	**Maximum students/section**
Classroom	3	30
Lab		
Studio		
Other (specify)		

2.1 Course Conversion Designation (Please check which applies to this course)

√	Semester Equivalent (SE) Please indicate which quarter course it is equivalent to: 1051-462 Digital Image Processing II
	Semester Replacement (SR) Please indicate the quarter course(s) this course is replacing:
	New

2.2 Semester(s) offered (check)

Fall	Spring √	Summer	Other

All courses must be offered at least once every 2 years. If course will be offered on a bi-annual basis, please indicate here: This elective course will be offered bi-annually

2.3 Student Requirements

Students required to take this course: (by program and year, as appropriate) Imaging Science third year, Digital Cinema third year
Students who might elect to take the course: Imaging and Photographic Technology, Computer Science, Computer Engineering, Environmental Science, Applied Mathematics, Physics

3.0 Goals of the course (including rationale for the course, when appropriate):

This course considers advanced digital image processing applications and algorithms. It further develops programming skills so that students can implement these concepts to facilitate application to real imagery. Students will also enhance their technical reading, writing, and presentation skills.

4.0 Course description (as it will appear in the RIT Catalog, including pre- and co-requisites, and quarters offered). Please use the following format:

COS-IMGS-362 Image Processing and Computer Vision II

This course is considers the more advanced concepts of digital image processing,. The topics include image reconstruction, noise sources and techniques for noise removal, information theory, image compression, video compression, wavelet transformations, frequency-domain based applications, morphological operations, and modern digital image watermarking and steganography algorithms. Emphasis is placed on applications and efficient algorithmic implementation using the student's computer programming language of choice, technical presentation, and technical writing. (COS-IMGS-361)
Class 3, Credit 3 (S)

5.0 Possible resources (texts, references, computer packages, etc.)

5.1 Gonzalez, Rafael C. and Richard E. Woods, *Digital Image Processing*, Prentice-Hall, Upper Saddle River, NJ.
5.2 Recent articles from journals and conference proceedings (updated annually)
5.3 IDL image software from ITT Visual Information Solutions, Boulder CO
5.4 MATLAB software from Mathworks, Natick MA

6.0 Topics (outline):

- 6.1 Image reconstruction
  - 6.1.1 Image degradation models
  - 6.1.2 Noise functions
    - 6.1.2.1 Gaussian
    - 6.1.2.2 Rayleigh
    - 6.1.2.3 Erlang or Gamma
    - 6.1.2.4 Exponential
    - 6.1.2.5 Uniform
    - 6.1.2.6 Impulse
  - 6.1.3 Noise removal filters
    - 6.1.3.1 Arithmetic mean
    - 6.1.3.2 Geometric mean
    - 6.1.3.3 Harmonic mean
    - 6.1.3.4 Contraharmonic mean
    - 6.1.3.5 Median
    - 6.1.3.6 Minimum
    - 6.1.3.7 Maximum
    - 6.1.3.8 Adaptive local
    - 6.1.3.9 Adaptive mean
    - 6.1.3.10 Periodic
      - 6.1.3.10.1 Bandpass
      - 6.1.3.10.2 Band reject
      - 6.1.3.10.3 Notch pass
      - 6.1.3.10.4 Notch reject
    - 6.1.3.11 Inverse Filter
    - 6.1.3.12 Wiener Filter
  - 6.1.4 Removal of noise from a real-world imaging systems
- 6.2 Edge-preserving image blurring
  - 6.2.1 Bilateral filtering
  - 6.2.2 Trilateral filtering
- 6.3 Image compression
  - 6.3.1 Basic metrics for compression effectiveness
    - 6.3.1.1 Relative data redundancy
    - 6.3.1.2 Compression ratio
  - 6.3.2 Types of redundancy
    - 6.3.2.1 Coding
    - 6.3.2.2 Interpixel
    - 6.3.2.3 Psychovisual
  - 6.3.3 Encoder/decoder models
  - 6.3.4 Basic metrics for compression/decompression performance
    - 6.3.4.1 Root-mean-square error
    - 6.3.4.2 Mean-square signal-to-noise ratio
  - 6.3.5 Information theory
    - 6.3.5.1 Information content in an event
    - 6.3.5.2 Information channel

6.3.5.3 Using information theory to reduce message size
6.3.5.4 Shannon's first theorem
6.3.6 Predictive coding
6.3.6.1 Lossless differential pulse code modulation (DPCM)
6.3.6.2 Lossy DPCM
6.3.7 Variable length coding
6.3.7.1 Shannon-Fano
6.3.7.2 Huffman
6.3.7.3 Arithmetic
6.3.7.4 Image pyramids
6.3.7.5 Kodak PhotoCD
6.3.8 Lempel-Ziv-Welch (LZW) transform coding
6.3.8.1 Discrete cosine transform (DCT)
6.3.9 Joint Photographic Experts Group (JPEG) compression
6.3.10 JPEG2000
6.3.11 Windows Bitmap format (BMP)
6.4 Video compression
6.4.1 Motion Picture Experts Group (MPEG) Level-1
6.4.2 MPEG-3
6.5 Wavelet transformations
6.5.1 Basis functions
6.5.2 Use in image compression
6.6 Digital watermarking/information hiding
6.6.1 Encryption
6.6.2 Visual cryptography
6.6.3 Phase dispersion
6.6.4 Chaotic mapping
6.6.5 Algorithm robustness
6.7 Morphological Image Processing
6.7.1 Concepts
6.7.2 Structuring elements
6.7.3 Erosion, dilation operators
6.7.4 Opening, closing operators
6.7.5 Applications
6.7.5.1 Noise removal
6.7.5.2 Boundary finding
6.7.5.3 Polygon filling

7.0 Intended course learning outcomes and associated assessment methods of those outcomes

Course Learning Outcome	Assessment 1	Assessment 2
7.1 Demonstrate ability to implement basic image processing concepts for more advanced applications, such as restoration, compression and information hiding	Homework and programming projects	Examinations
7.2 Utilize a modern computer programming environment (e.g., IDL or Matlab) to solve image processing problems	Programming Projects	

8.0 Program outcomes and/or goals supported by this course

8.1	To gain experience with an advanced set of tools for image restoration, image and video compression and digital information hiding/watermarking
8.2	To enhance their proficiency in using a modern programming environment as an image manipulation/enhancement tool and further their readiness to become active algorithm developers in industry
8.3	To apply the mathematic to which they have been exposed in earlier course work to applied image processing problems
8.4	To apply knowledge of imaging systems, physics, mathematics, and digital processing to formulate, analyze, and solve practical problems in imaging science.

9.0

	General Education Learning Outcome Supported by the Course	Assessment Method
Communication		
	Express themselves effectively in common college-level written forms using standard American English	
	Revise and improve written and visual content	
	Express themselves effectively in presentations, either in spoken standard American English or sign language (American Sign Language or English-based Signing)	
	Comprehend information accessed through reading and discussion	
Intellectual Inquiry		
	Review, assess, and draw conclusions about hypotheses and theories	
	Analyze arguments, in relation to their premises, assumptions, contexts, and conclusions	
	Construct logical and reasonable arguments that include anticipation of counterarguments	
	Use relevant evidence gathered through accepted scholarly methods and properly acknowledge sources of information	
Ethical, Social and Global Awareness		
	Analyze similarities and differences in human experiences and consequent perspectives	
	Examine connections among the world's populations	
	Identify contemporary ethical questions and relevant stakeholder positions	
Scientific, Mathematical and Technological Literacy		
	Explain basic principles and concepts of one of the natural sciences	
	Apply methods of scientific inquiry and problem solving to contemporary issues	
	Comprehend and evaluate mathematical and statistical information	
	Perform college-level mathematical operations on quantitative data	
	Describe the potential and the limitations of technology	
	Use appropriate technology to achieve desired outcomes	
Creativity, Innovation and Artistic Literacy		
	Demonstrate creative/innovative approaches to course-based assignments or projects	
	Interpret and evaluate artistic expression considering the cultural context in which it was created	

10.0 Other relevant information (such as special classroom, studio, or lab needs, special scheduling, media requirements, etc.)

10.1	Smart classroom with high-resolution projector (at least 1280×1024)
10.2	The classroom must be equipped with equipment to allow student presentations to be recorded