ROCHESTER INSTITUTE OF TECHNOLOGY
COURSE PROPOSAL FORM

COLLEGE OF SCIENCE

Chester F. Carlson Center for Imaging Science

REVISED COURSE: COS-IMGS-682-Image Processing and Computer Vision

1.0 Course Designations and Approvals

Required course approvals:	**Approval request date:**	**Approval granted date:**
Academic Unit Curriculum Committee	10/8/2014	10/8/2014
College Curriculum Committee		

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

2.0 Course information:

Course title:	Image Processing and Computer Vision
Credit hours:	3
Prerequisite(s):	IMGS-616 or permission of instructor
Co-requisite(s):	None
Course proposed by:	Nathan Cahill
Effective date:	October 2014

	Contact hours	**Maximum students/section**
Classroom	3	50
Lab		
Studio		
Other (specify)		

2.a 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:

2.b Student Requirements

Students required to take this course: (by program and year, as appropriate) Graduate students in Imaging Science Ph.D. program
Students who might elect to take the course: Graduate students in the Imaging Science M.S. program. Nonmatriculated students with undergraduate degrees in the physical sciences or engineering. Graduate students in the College of Science, Kate Gleason College of Engineering, or the B. Thomas Golisano College of Computing and Information Sciences.

In the sections that follow, please use sub-numbering as appropriate (eg. 3.1, 3.2, etc.)

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

This course will provide the students with a firm understanding of the basic concepts of image manipulation and analysis through a mathematical framework and computational implementation. The students will critically examine the current literature with the goal of identifying and implementing current state-of-the-art algorithms in image processing and computer vision in the core topical areas discussed. The students will become adept at documenting their efforts through written technical papers.

4.0 Course description

COS-IMGS-682 Image Processing and Computer Vision

This course will cover a wide range of current topics in modern image processing and computer vision. Topics will include linear and nonlinear systems of equations, point processing, linear and nonlinear filtering, dimensionality reduction, feature matching, image registration, image segmentation and object recognition, and geometry of cameras. Projects will involve advanced computational implementations of selected topics from the current literature in a high level language such as MATLAB or IDL and will be summarized by the students in written technical papers. (COS-IMGS-616 or permission of instructor) **Class 3, Credit 3 (S)**

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

5.1 Gonzalez, R.C. and R.E. Woods, Digital Image Processing, Prentice Hall
5.2 Hartley, R. and A. Zisserman, Multiple View Geometry in Computer Vision, Cambridge University Press
5.3 Szeliski, R., Computer Vision: Algorithms and Applications, Springer
5.4 MATLAB™ (MathWorks) or IDL™ (ITT Visual Information Solutions)
5.5 Numerous articles available in the current published literature

6.0 Topics (outline):

- 6.1 Linear Systems of Equations
    - 6.1.1 Vector spaces and subspaces
    - 6.1.2 Fundamental subspaces of a matrix
    - 6.1.3 Solving Ax = b
        - 6.1.3.1 Square, full-rank systems
        - 6.1.3.2 Overdetermined systems, least squares
    - 6.1.4 Eigenvectors and diagonalization
    - 6.1.5 Singular value decomposition
    - 6.1.6 Circulant matrices and the Discrete Fourier Transform
- 6.2 Nonlinear Systems of Equations
    - 6.2.1 Linearization
    - 6.2.2 Gauss-Newton
    - 6.2.3 Levenberg-Marquardt
- 6.3 Point Processing
    - 6.3.1 Dynamic range adjustment
    - 6.3.2 Color transformations
    - 6.3.3 Histogram equalization
- 6.4 Filtering
    - 6.4.1 Review of Linear Filtering
        - 6.4.1.1 Sampling Theory, DFT, FFT
        - 6.4.1.2 Kernel size, border effects, filter separability
        - 6.4.1.2 Image deconvolution, phase retrieval, and matched filtering
        - 6.4.2.4 Wiener filter
    - 6.4.2 Nonlinear Filtering
        - 6.4.2.1 Statistical filters
        - 6.4.2.2 Morphological filters
        - 6.4.2.3 Bilateral filter
        - 6.4.2.4 Nonlocal means filter
        - 6.4.2.5 Total variation filter
- 6.5 Dimensionality Reduction
    - 6.5.1 Principal component analysis
    - 6.5.2 Nonlinear manifold learning
    - 6.5.2 Image compression
- 6.6 Feature Matching
    - 6.6.1 Corner detectors (Harris)
    - 6.6.2 Descriptive features (SIFT, SURF, HoG)
    - 6.6.3 Robust matching (RANSAC)
- 6.7 Image Registration
    - 6.7.1 Rigid/affine registration
    - 6.7.2 Nonrigid registration
        - 6.7.2.1 BSpline free-form deformations
        - 6.7.2.2 Variational models
    - 6.7.3 Multimodality registration
- 6.8 Image Segmentation
    - 6.8.1 Parametric models and snakes
    - 6.8.2 Level sets

6.8.3 Markov random fields and graph cuts 6.8.4 Bayesian networks and image understanding 6.9 Geometry of Cameras 6.9.1 Single-view geometry, perspective projection 6.9.2 Homography 6.9.3 Multiple-view geometry 6.9.3.1 Fundamental matrix 6.9.3.2 Bundle adjustment

7.0 Intended course learning outcomes and associated assessment methods of those outcomes (please include as many Course Learning Outcomes as appropriate, one outcome and assessment method per row).

Course Learning Outcome	Assessment Method
7.1 Demonstrate a theoretical understanding of image processing and computer vision methods and how they fit into the imaging chain	Examination / In-class Attendance
7.2 Demonstrate a fluency and aptitude for implementing image processing and computer vision algorithms found in the literature	Homework and Projects
7.3 Demonstrate an ability to communicate the details of image processing and computer vision methods, implementations, results, and analysis in written media	Homework and Projects

8.0 Program outcomes and/or goals supported by this course

This course will provide a working knowledge of image processing and computer vision techniques to solve problems in the physical sciences or engineering.

9.0

	General Education Learning Outcome Supported by the Course, if appropriate	Assessment Method
Communication		
	Express oneself effectively in common college-level written forms using standard American English	
	Revise and improve written products	
	Express oneself 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		
	Demonstrate knowledge of 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 or apply statistical techniques	
	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 Classroom with in-class presentation system
10.2 Classroom with distance learning computing and audio/video system