ROCHESTER INSTITUTE OF TECHNOLOGY
Rochester, New York

COLLEGE of SCIENCE
Department of IMAGING SCIENCE

REVISED COURSE: 1051-462

1.0 TITLE: DIGITAL IMAGE PROCESSING II
DATE: 12 June 2003
CREDIT HOURS: 4
PREREQUISITE(S): 1051-461
COREQUISITE(S): none
COURSE PROPOSED BY: Carl Salvaggio

2.0 COURSE INFORMATION:

	Contact Hours	Maximum Students / Section
Classroom	4	20
Lab	n/a	n/a
Studio	n/a	n/a
Other	n/a	n/a

QUARTER(S) OFFERED: (every other year)
_x_Fall ___Winter ___Spring ___Summer

STUDENTS REQUIRED TO TAKE THIS COURSE:
Imaging Science, 3rd/4th year

STUDENTS WHO MIGHT ELECT TO TAKE THE COURSE:
Imaging and Photographic Technology, Computer Science, Environmental Science, Applied Mathematics, Physics

3.0 GOALS OF THE COURSE:

The goal of this course is to provide the student with an understanding of basic digital image processing concepts and to develop their programming skills so that they can implement these concepts to facilitate application to real imagery.

4.0 COURSE DESCRIPTION:

This course is an introduction to the more advanced concepts of digital image processing. The student will be exposed to image reconstruction, noise sources and techniques for noise removal, information theory, image compression, video compression, wavelet transformations and the basics of digital image watermarking. Emphasis is placed on applications and efficient

algorithmic implementation using the IDL programming language. (1051-461) Class 4, Credit 4 (F)

5.0 POSSIBLE RESOURCES:

5.1 Gonzalez, Rafael C. and Richard E. Woods, *Digital Image Processing*, 2nd Edition, Prentice Hall, New Jersey, 2002, ISBN: 0-201-18075-8

5.2 Cox, Ingemar, Jeffrey Bloom and Matthew Miller, *Digital Watermarking: Principles & Practices*, Morgan Kaufmann Publishers, New York, 2001, ISBN: 1-558-60714-5

5.3 Wayner, Peter, *Disappearing Cryptography – Information Hiding: Steganography and Watermarking*, Second Edition, Morgan Kaufmann Publishers, New York, 2002, ISBN: 1-558-60769-2

5.4 Student version of IDL 5.6 for Windows

6.0 TOPICS:

6.1 Image reconstruction

6.1.1 Image degradation model

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 Band pass

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

6.1.3.12 Weiner

6.1.4 Removal of noise from a real-world imaging system

6.2 Image compression

6.2.1 Basic metrics for compression effectiveness

6.2.1.1 Relative data redundancy

6.2.1.2 Compression ratio

- 6.2.2 Types of redundancy
  - 6.2.2.1 Coding
  - 6.2.2.2 Interpixel
  - 6.2.2.3 Psychovisual
- 6.2.3 Encoder/decoder models
- 6.2.4 Basic metrics for compression/decompression performance
  - 6.2.4.1 Root-mean-square error
  - 6.2.4.2 Mean-square signal-to-noise ratio
- 6.2.5 Information theory
  - 6.2.5.1 Information content in an event
  - 6.2.5.2 The information channel
  - 6.2.5.3 Using information theory to reduce message size
  - 6.2.5.4 Shannon's first theorem
- 6.2.6 Predictive coding
  - 6.2.6.1 Lossless DPCM
  - 6.2.6.2 Lossy DPCM
- 6.2.7 Variable length coding
  - 6.2.7.1 Shannon-Fano
  - 6.2.7.2 Huffman
  - 6.2.7.3 Arithmetic
  - 6.2.7.4 Image pyramids
  - 6.2.7.5 Kodak PhotoCD
  - 6.2.7.6 LZW
- 6.2.8 Transform coding
  - 6.2.8.1 Discrete cosine transform (DCT)
- 6.2.9 JPEG
- 6.2.10 Windows BMP

- 6.3 Video compression
  - 6.3.1 MPEG
- 6.4 Wavelet transformations
- 6.5 Digital watermarking/information hiding

7.0 INTENDED LEARNING OUTCOMES AND ASSOCIATED ASSESSMENT METHODS OF THOSE OUTCOMES:

- 7.1 Ability to put into practice the basic image processing concepts of the first course in this series to perform more advance image processing techniques such as restoration, compression and information hiding (HOMEWORK/PROGRAMMING ASSIGNMENTS / EXAMS)
- 7.2 Ability to use the IDL environment as an interactive problem solving tool and visualization system (HOMEWORK/PROGRAMMING ASSIGNMENTS)

8.0 PROGRAM OR GENERAL EDUCATION GOALS SUPPORTED BY THIS COURSE:

8.1 The student will have an advanced set of tools with which they can perform image restoration, image and video compression and digital information hiding/watermarking
8.2 The student will enhance their proficiency in using IDL as an image processing environment and further their readiness to become active algorithm developers in industry
8.3 The student will apply the mathematic to which they have been exposed in earlier course work to applied image processing problems

9.0 OTHER RELEVANT INFORMATION:
9.1 Course needs to be conducted in a classroom equipped with a high-resolution projector (1280x1024) for classroom instruction

10.0 SUPPLEMENTAL INFORMATION:
none