ROCHESTER INSTITUTE OF TECHNOLOGY
Rochester, New York

COLLEGE of SCIENCE
Department of IMAGING SCIENCE

REVISED COURSE: 1051-463

1.0 TITLE: DIGITAL IMAGE PROCESSING III
DATE: 04 May 2005
CREDIT HOURS: 4
PREREQUISITE(S): 1016-314, programming language (*e.g.* 1051-211)
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:
___Fall _x_Winter ___Spring ___Summer

STUDENTS REQUIRED TO TAKE THIS COURSE:
Imaging Science Professional Elective

STUDENTS WHO MIGHT ELECT TO TAKE THE COURSE:
Imaging Science, Color Science, 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 the basic knowledge and skills to analyze hyperspectral, multispectral and multi-channel data using student written and commercially available tools. The student will use pre-existing algorithmic implementations in a commercially-available software package as well as code their own implementations in a high-level programming language such as IDL, MATLAB, C++ or Java.

4.0 COURSE DESCRIPTION:

This course discusses the digital image processing concepts and algorithms used for the analysis of hyperspectral, multispectral and multi-channel data in multiple imaging application areas. Concepts are covered at the theoretical and implementation level using current, popular commercial software packages and high-level programming languages to work examples, homework problems and programming assignments. The requisite multivariate statistics will be presented as part of this course as an extension of the univariate statistics that the students have previously been exposed to in the introductory statistics classes. Topics to be covered will include methods for supervised data classification, clustering algorithms and unsupervised classification, multispectral data transformations, data redundancy reduction techniques, derivation of non-spectral images features to aid in the classification process, and data fusion for resolution enhancement. (Prerequisites: 1051-211 (or equivalent), 1016-314) Class 4, Credit 4 (W)

5.0 POSSIBLE RESOURCES:
- 5.1 Richards, J.A and X. Jia, *Remote Sensing Digital Image Analysis, An Introduction*, 3rd Edition, Springer-Verlag, New York, 1999, ISBN: 3-540-64860-7
- 5.2 Freely provided image analysis software; ENVI/IDL

6.0 TOPICS:
- 6.1 Multivariate statistics
  - 6.1.1 Conditional probability
  - 6.1.2 The normal probability distribution
    - 6.1.2.1 Univariate case
    - 6.1.2.2 Multivariate case
  - 6.1.3 Statistical distance measures
- 6.2 Data types
  - 6.2.1 Multi-channel data
  - 6.2.2 Multispectral data
  - 6.2.3 Hyperspectral data
- 6.3 Supervised Data Classification
  - 6.3.1 Training
  - 6.3.2 Minimum distance to the mean classifiers
  - 6.3.3 Parallelepiped classifiers
  - 6.3.4 Maximum likelihood classifiers
    - 6.3.4.1 Bayesian assumptions
    - 6.3.4.2 Linear discriminant functions
  - 6.3.5 Mahalanobis distance
  - 6.3.6 Spectral angle mapper (SAM)
- 6.4 Clustering and Unsupervised Classification
  - 6.4.1 Similarity metrics and clustering criteria
  - 6.4.2 Iterative clustering algorithms (migrating means)
    - 6.4.2.1 Seeding techniques
    - 6.4.2.2 K-Means
    - 6.4.2.3 ISODATA
    - 6.4.2.4 Merging, splitting and deleting classes
  - 6.4.3 Single pass techniques
- 6.5 Multispectral Data Transformations/Data Redundancy Reduction

6.5.1 Eigenvector transformations
6.5.2 Principal components analysis
6.5.3 Kauth-Thomas (KT) tasseled cap transformation
6.5.4 Minimum Noise Fraction (MNF)

6.6 Non-spectral Image Features
6.6.1 Concepts of image understanding
6.6.2 Texture
6.6.3 Grey-level co-occurrence matrices
6.6.4 Haralick's textural features

6.7 Data Fusion
6.7.1 Multispectral resolution enhancement
6.7.1.1 Using color transformations
6.7.1.2 Radiometry preserving techniques

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

7.1 Ability to use multivariate statistical analysis techniques to analyze multi- and hyper-channel image data (HOMEWORK/PROGRAMMING ASSIGNMENTS / EXAMS)

7.2 Ability to use the IDL/ENVI 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 data analysis tools with which they can perform multi- or hyper-channel data exploitation and information extraction

8.2 The student will enhance their proficiency in using IDL and ENVI as an image analysis environment and further enhance their readiness to become active algorithm developers in industry

8.3 The student will extend the univariate statistical methods to which they have been exposed in earlier course work to applied multi-channel 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