COURSE TITLE
DIGITAL IMAGE PROCESSING III (1051.463)

INSTRUCTOR INFORMATION
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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

LEARNING OUTCOMES/METHOD OF EVALUATION
- Ability to use multivariate statistical analysis techniques to analyze multi- and hyper-channel image data (HOMEWORK/PROGRAMMING ASSIGNMENTS / EXAMS)
- Ability to use the IDL/ENVI environment as an interactive problem solving tool and visualization system (HOMEWORK/PROGRAMMING ASSIGNMENTS)

MEETING TIMES
Tuesday, Thursday / 8:00-9:50AM / Room 76:1235
READING MATERIALS

• Crist, E.P. and R.C. Cicone, Application of the tasseled cap concept to simulated thematic mapper data, Photogrammetric Engineering and Remote Sensing, Vol. 50, No. 3, March 1984, pp. 343-352. (PDF)

COURSE MECHANICS

60% Programming Assignments
10% Homework Assignments
15% Oral Examination 1
15% Oral Examination 2

TOPICAL OUTLINE

Multivariate statistics
  • Conditional probability
  • The normal probability distribution
    o Univariate case
    o Multivariate case
  • Statistical distance measures

Data types
  • Multi-channel data
  • Multispectral data
  • Hyperspectral data

Supervised Data Classification
  • Training
  • Minimum distance to the mean classifiers
  • Parallelepiped classifiers
  • Maximum likelihood classifiers
    o Bayesian assumptions
    o Linear discriminant functions
  • Mahalanobis distance
  • Spectral angle mapper (SAM)
Clustering and Unsupervised Classification

- Similarity metrics and clustering criteria
- Iterative clustering algorithms (migrating means)
  - Seeding techniques
  - K-Means
  - ISODATA
  - Merging, splitting and deleting classes
- Single pass techniques

ORAL EXAMINATION 1

Multispectral Data Transformations/Data Redundancy Reduction

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

Non-spectral Image Features

- Concepts of image understanding
- Texture
- Grey-level co-occurrence matrices
- Haralick’s textural features

Data Fusion

- Multispectral resolution enhancement
  - Using color transformations
  - Radiometry preserving techniques

ORAL EXAMINATION 2