Module Information	
Module Title	**Advanced Digital Image Processing**
Module Code	**SPC513**

1. MODULE SUMMARY

Aims and Summary

This module intends to prepare students to analyse techniques and implement algorithms for advanced digital image processing. Image analysis based on segmentation, shape & texture, registration, recognition and classification will be taught. In addition, real-time image and video coding and compression techniques will be discussed. Students will be trained on the design flow of image processing solutions and their implementation using MATLAB.

Module Size and Credits

Module size	Single
CATS points	12
ECTS credits	N/A
Open / restricted	Restricted
Availability on/off campus	On Campus/Off campus
Total student study hours	120
Number of weeks	4 weeks Full-time or 8 weeks Part-time.
Centre responsible	CE & DSIP Centre/Department of Electronics and Communication Engineering
Academic Year	2009

Entry Requirements (pre-requisites and co-requisites)

Normally to be qualified for entry to the Postgraduate Engineering Programme

Excluded Combinations

None

Composition of Module Mark (including weighting of components)

Full-time / Part-time : 50% Written Examination and 50 % Assignment

Pass Requirements

A minimum of 40 % marks in the written examination and a minimum of 40% marks in the assignment are required for a pass and overall 40% marks

Special Features

80% attendance in theory and 80% attendance in laboratory are required.
It is likely that considerable time will be spent in School facilities outside of normal timetabled class time.

Courses for which this module is mandatory

M.Sc. [Engg] in Signal Processing and Communication Technologies

Courses for which this module is a core option

None

2. TEACHING, LEARNING AND ASSESSMENT

Intended Module Learning Outcomes

After undergoing this module, students will be able to:

1. Explain and analyse the techniques, algorithms and design flow of image processing solutions
2. Implement and evaluate algorithms for image analysis based on segmentation, shape & texture, registration, recognition and classification
3. Evaluate and synthesize the data coding and compression techniques on images.
4. Proficiently use MATLAB for implementing image processing algorithms of segmentation, registration, object recognition and classification

Indicative Content

Class Room Lectures

1. **Edge Detection:** Computing the gradient, Roberts, Prewitt, Sobel operators, Second derivative – Laplacian, Canny edge detector, Edge linking - Local processing, Hough transform.

2. **Image Morphology:** Dilation, Erosion, Opening, Closing, Boundary extraction, Region filling, Hit or Miss transform, Thinning, Thickening, Skeletonization, Pruning

3. **Image Segmentation:** Pixel-based methods: thresholds level adjustment, continuity-based methods: - multi-thresholding, morphological operations, edge-based segmentation, detection of regions of interest - thresholding and binarization, detection of isolated points and lines (Hough transform), edge detection, region growing, watershed algorithm.

4. **Discrete Image Transforms:** Discrete cosine transforms, Karhunen-Loeve transform, Sine transforms, Walsh-Hadamard transform, Haar Transform

5. **Image Analysis of Shape and Texture:** Representation of shapes and contours, shape factors, Fourier descriptors, fractional concavity, analysis of specularity, texture in biomedical images, models for the generation of texture, statistical analysis of texture, Law's measures of texture energy, fractal analysis, Fourier-domain analysis of texture, structural analysis of texture.

6. **Image Registration:** Geometric mappings, numerical methods and optimization in registration, Intensity based registration, Feature based registration, Initialization techniques, Multiresolution techniques, parametric deformable registration, non-parametric deformable registration, image match metrics in registration.

7. **Image Coding and Data Compression:** Considerations based on information theory, noiseless coding theorem for binary transmission, lossy versus lossless compression, distortion measures and fidelity criteria, fundamental concepts of coding (direct source coding, Huffman coding, run-length coding, arithmetic coding, Lempel-Ziv coding, contour coding), the need for decorrelation: transform coding, interpolative coding, predictive coding, compression standards: the jbig standard, the jpeg standard and jpeg 2000.

8. **Object Recognition and Classification:** Patterns and pattern classes, Statistical Decision Making (Bayesian Classifiers), Non-Parametric Decision Making (Histogram based, k Nearest Neighbors), Clustering based methods (Agglomerative and Partitional), Neural Networks (Single and Multi layer perceptron, Back propagation algorithm).

9. **Video Processing:** Introduction to video signal processing, video processing standards, MPEG block diagram and data flow, MPEG-2 and MPEG-4 standards, motion estimation and compensation algorithms, block matching algorithms, video compression and decompression, interactive video techniques.

Laboratory Practice

Design and simulate the following exercises using MATLAB:

1. Edge detection and linking
2. Image morphological operators
3. Image segmentation
4. Shape and texture analysis
5. Registration
6. Coding and compression

7. Object recognition
8. Classification
9. Motion estimation

Teaching and Learning Methods

1. Theoretical Knowledge [~30% of module time]
    a. Face to face lectures from a module leader- 30 hours
    b. Case study teaching and discussion from a practicing engineer- 6 hours

36 hours

2. Laboratory Practice (Skills) [~ 25% of module time]

30 hours

3. Application Orientation and Problem Solving [45% of module time]
    a. Reading
    b. Research
    c. Written Examination
    d. Assignment Solving and Documentation

54 hours

Method of Assessment

Part-A

Written Examination [50% Weightage]

At the end of the module, normally on the last day of the last week of the module, written examination is conducted to test students' understanding of taught theoretical concepts. The question paper will comprise either or a combination of the following:

- 6 questions, out of which 5 questions need to be answered
- Practical laboratory work
- Presentations
- Field work
- Creation of a physical model

The marks scored by the student will be scale down to 50% weight.

Part –B

Assignment [50% Weightage]

Students are required to submit word processed assignment report on formally announced last day of the module. Assignment tests students' problem solving skills based on taught concepts. The assignment is assessed for 100 marks but scored marks is scaled down to 50%

	Assessment			
Learning Outcomes	**1**	**2**	**3**	**4**
Part A	**X**	**X**	**X**	**X**
Part B	**X**	**X**	**X**	**X**

Both written examination scripts and assignment reports will be double marked/valued

Re-assessment

A minimum of 40 % marks in the written examination and a minimum of 40% marks in the assignment are required for a pass in the module.
A student failing in any one of the components or both is considered as FAIL in the module. A failed student is required to retake the module at the next opportunity. A maximum of 3 attempts including the original are allowed.

Date of Last Amendment

May 2009

3. MODULE RESOURCES

Essential Reading

1. Module Notes

Recommended Reading

Books

1. William K Pratt, *Digital Image Processing*, John Wiley & Sons, 2001
2. Milan Sonka, Vaclav Hlavac and Roger Boyle, *Image Processing Analysis and Machine Vision*, Brooks, 1999
3. Gonzalez and Richard E Woods, *Digital Image Processing*, Addison-Wesley, 2000
4. Anil K Jain, *Fundamentals of Digital Image Processing*, Prentice-Hall India, 2001.
5. Earl Gose, Richard Johnsonbaugh and Steve Jost, *Pattern Recognition and Image Analysis*, Prentice-Hall India, 2002.
6. R. O. Duda, P. E. Hart and D.G. Stork, *Pattern Classification*, Wiley–Interscience, 2000.
7. Gerard Blanchet and Maurice Charbit, *Digital Signal and Image Processing using MATLAB*, ISTE, 2006.
8. Gonzalez, Steven Eddins and Richard E Woods, *Digital Image Processing using MATLAB*, Prentice-Hall, 2000
9. Mark S. Nixon and Alberto S. Aguado, *Feature Extraction and Image Processing*, Academic Press, 2008

Journals

IEEE Transactions in Imaging Processing

IEEE Transactions in Computer Vision

Journal of Real-Time Image Processing

Signal, Image and Video Processing

International Journal of Signal Processing, Image Processing and Pattern Recognition

Journal of Visual Communication and Image Representation

Magazines

Machine Vision and Image Processing Technology

Internet Sites

http://homepages.inf.ed.ac.uk/rbf/HIPR2/

Laboratory

Hardware: PC with MATLAB tool

Software: MATLAB

Software Manual: MATLAB User Manual

4. MODULE ORGANISATION

Module Leader

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Date and Time of Examination

As per time table

Subject Quality and Approval Information

Subject Quality Group / Subject Board	Electronics and Communication Engineering
Subject Assessment Board	Postgraduate Engineering Programmes
Shortened title	ADIP
Date of approval by MARP	May 2009