Master in Information and Communications Sciences

Emphasis Geomatics

NAME OF THE SUBJECT: Advanced Mathematics and Geoprocessing
Seminary 1 XXX

- Obligatory ( ): Basic ( ) Complementary ( )
- Elective (X): Intrinsic (X) Extrinsic ( )

NUMBER OF ACADEMIC CREDITS: Four (4).

COURSE TYPE: THEORETICAL: ___ PRACTICAL: ___ THEORETICAL-PRACTICAL: _X_
Methodological alternatives:
Master Class (X), Seminar ( ), Seminar - Workshop (), Workshop ( ), Practice (),
Tutored projects (), Other: _____

Justification

The mathematical foundations necessary for the student, the arguments necessary to face the basic concepts not only in training as an engineer and in postgraduate studies, which allow him to carry out logical and analytical processes that depend on the development of scientific thought

The study of Linear Algebra, Series, Fourier Series, Fourier Transform, Wavelet Transformation are today basic topics in any Engineering and Master's program, since the analysis and interpretation that is made of the world makes them fundamental tools in any discipline. In the Master's program in Information and Communication Sciences, they become the basis of almost all their subjects, especially in the study of Advanced Methods in image analysis.

PREREQUISITE / PRIOR KNOWLEDGE: Digital Image Processing

Content

OVERALL OBJECTIVE:
At the end of this course, students will have the ability to use the knowledge of Linear Algebra, Series, Fourier Series, Fourier Transform, Wavelet Transformation not only as a support tool, analysis and application to the different Engineering areas in their training. Integrals of the Master in Information and Communication Sciences, are also used as a fundamental support in the processing of digital images. Where the study of mathematical and statistical algorithms improves and obtains information from satellite images.

SPECIFIC OBJECTIVES:

1. Faculty of the student in the management of matrix operations and satellite images. Analyze the classes of matrices and apply the systematic procedure for the analysis of principal components in satellite images.

2. Define, calculate and analyze your results using the properties of the two-dimensional Fourier transformation in the study of satellite images.

3. Provide the student with the basic concepts of the Wavelet Transformation, a particular case of wavelet haar and its correspondence with matrices, to analyze and apply in the fusion of satellite images.

Strategies

TRAINING COMPETENCES

General:

Throughout the course, the student is expected to master and interpret the mathematical language, develop generic instrumental skills that allow them to identify, resolve, and identify situations that arise in their daily lives and in the professional environment, especially in digital image processing.

Specific:

Provide the foundations for solving systems of linear equations, use matrices and satellite images, as special types of matrices for the study of the arithmetic matrix that allows to simplify data handling and provide solid bases in vectors.

Define, interpret and conceptualize eigenvectors and eigenvalues to represent modeling situations using mathematical language and their graphic representation and analyze the main components in satellite images.

Provide the fundamentals of the One-Dimensional and Two-Dimensional Discrete Fourier Transformation (DFT). Analysis of the properties of two-dimensional DFT and applications in digital image processing.

Relate the knowledge of the Fourier Transform for the analysis of the Wavelet Transform and, in particular, the wavelet for the study of an application of the Wavelet Transform in the fusion of satellite images.

Programa sintético

Advanced mathematics and geoprocessing, is an academic space that is made up of 5 units: nuance algebra, two-dimensional transformations, Wavelet transform that allows an analysis of the different image fusion methods, starting with image algebra, the classic fusion methods of images and finally, the Fourier and Wavelet transformation is deepened to merge the images.

Unit 1 Algebra of nuances
1. Linear algebra in digital image processing.
2. Add, subtract, multiply, and divide images.

Unit 2. Fusion of satellite images
1. Image fusion using conventional methods.
2. Brovey transformation
3. Multiplication
4. RGB to IHS, HSV and LHS transformation

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Unit 3. Two-dimensional transformation
1. Fourier transform.
2. Application using the Fourier transform
3. Wavelet transformation in digital image processing
4. RGB to IHS, HSV and LHS

Unit 4. Wavelet transform
1.Transformed Wavelet Haar.

2. Application of the Wavelet transform in fusion of satellite images

Unit 5 Evaluation of the merged images
1. Statistical algorithms for the evaluation of satellite images.
2. Entropy
3. ERGAS, RASE RMSE
4. Universal Quality Index Qu
5. Correlation index, BIAS and divergence

Strategies

METHODOLOGY:

In the academic space, master classes are proposed, in which the topics proposed in the units are oriented and mandatory and optional readings are indicated. Also, practical workshops are carried out that allow to know the functionalities and basic parameters of use of the different algorithms. In addition, theoretical and practical work is done to understand and apply the concepts and evaluate the usefulness of the different algorithms.

	Hours			Teacher hours / week	Student hours / week	Total Hours Student / semester	Academic credits
Type of course	DW	CW	AW	(DW + CW)	(DW + CW +AW)	X 16 weeks	
	3	1	8	4	12	192	4

Direct Presential Work (DW): classroom work in plenary session with all students.
Mediated-Cooperative Work (CW): Teacher tutoring work to small groups or individually to students.
Autonomous Work (AW): Student work without the presence of the teacher, which can be done in different instances: in work groups or individually, at home or in a library, laboratory, etc.)

Resources

Next, each of the proposed resources will be described according to the model that must be completed:

Means and supports:

This course will use images of remote sensors in digital format available in the public domain and computer equipment with open source software, for example, the statistical program R, SNAP. Proprietary software such as ERDAS, ENVI and Matllab.

Virtual classrooms:

There is a virtual learning space where information specific to the academic program is shared https://ingenieria.udistrital.edu.co/course/view.php?id=1151. Moodle-UDIN - Francisco District University

Institutional mail:

The institutional email through which information is received from the University of the District and can be used for different academic purposes.

Orientation and complementary texts:

- Chuvieco, Emilio, Fundamentos de teledeteccion espacial, Madrid: Rialp, 1990.
- Chuvieco, Emilio,Teledeteccion ambiental, Barcelona.,3 a Edición., Arial Ciencias , 2008.
- Gonzalez, Rafael y Richard E. Woods, Tratamiento digital de imagenes, Wilmington (Delaware): Addison-Wesley - Diaz de Santos, 1996.
- Hwei P. Hsu, Análisis de Fourier. Ed Prentice Hall. 1973
- Medina, Javier e Iván Lizarazo, Fusión de imágenes satelitales usando la transformada de Wavelet, Bogotá: Universidad Distrital Francisco José de Caldas,2004.
- Medina, Javier, Cálculo Integral con aplicación en la descomposición de una Imagen usando la Transformada de Wavelet Haar, Bogotá: Universidad Distrital Francisco José de Caldas, 2010.
  NIEVERGEL Yves, Wavelets made easy, 1999, Ed Birkhäuser, Boston, pp 297.

BIBLIOGRAPHIC RESOURCES:

- IEEE Database
- SPRINGER Database
- ELSEVIER Database

Manuales de Consulta:

ERDAS\IMAGINE 8.5\help\html\image_interpreter\resolution_merge.htm
Image Processing. Toolbox For Use whit MATLAB. The Math Works Inc
MICHEL, Misiti. Wavelet Toolbox For Use whit MATLAB. The Math Works Inc.Image Processing. Toolbox For Use whit MATLAB. Reference. The Math Works Inc.

Procesamiento Digital de Imágenes. Introducción a ILWIS bajo Windows. Guía de Usuario. (Traducción: Alberto Boada. Revisión y adaptación por Orlando Riaño M.)
Matlab Edición del Estudiante. Versión 4 Guía del usuario. The Math Works Inc. Ed. Prentice may. 1996
SPOT IMAGE. The catalogue of SPOT products and services.

Textos Complementarios

Lira, Chávez Jorge, *Introducción al tratamiento digital de imagenes*,Universidad Autonoma de Mexico. 2002.
Murray, R Spiegel, *Analisis de Fourier Teoria y 250 problemas resueltos*., MacGraw-Hill, 1976.
Pinski, Mark A. Introducción al Análisis de Fourier y las Onduletas. Editorial Thomson 2003.
O'Neil, Piter V. *Matemáticas Avanzadas para ingeniería*., 5 a ed., Editorial Thomson 2004.
Zill, Dennis, *Ecuaciones diferenciales con aplicaciones*, 2.a ed., Mexico: Iberoamerica, 1986.

Course Schedule

It is recommended to work one unit every four weeks, work in small groups of students, use the Internet (virtual classroom, institutional mail, institutional web portal, among others) to communicate with students, for progress reviews and solution of questions (consider this between cooperative work hours).

Week / thematic unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Linear algebra in digital image processing.	X	X	X													
2. Fusion of satellite images using conventional methods.				X	X	X										
3. Two-dimensional Fourier transform. Application that uses the Fourier and Wavelet transform in digital image processing							X	X	X	X						
4. Wavelet Haar transform. Application of the Wavelet transform in fusion of											X	X	X			

satellite images.																
5. Evaluation of the merged images.														X	X	X

Evaluation

The evaluation criteria must be previously known by the students.

1. Assessment of student learning in its dimensions: individual / group, theory / practice, written oral.
2. Self-assessment: the evaluation of student performance by the student.
3. Co-evaluation of student performance among students and teachers.
4. Evaluation of teaching performance.

The evaluation will be carried out taking into account:

	TYPE OF EVALUATION	DATA	PERCENTAGE
FIRST **NOTE**	Partial in Moodle-UDIN - University of the District of Francisco 20%, Written report 15%	Week 5	35%
SECOND **NOTE**	Partial in Moodle-UDIN - University of the District of Francisco 20%, Written report 15%	Week 10	35%
Exam	Delivery of the final report and support.	Week 16	30%