SYLLABUS

1. Data about the program of study

1.1	Institution	The Technical University of Cluj-Napoca
1.2	Faculty	Electronics, Telecommunications and Information Technology
1.3	Department	Communications
1.4	Field of study	Electronics and Telecommunications Engineering
1.5	Cycle of study	Bachelor of Science
1.6	Program of study/Qualification	Telecommunications Systems and Technologies, Applied Electronics
1.7	Form of education	Full time
1.8	Subject code	TST-E48.20, EA-E48.20

2. Data about the subject

2.1	Subject name					Digital Image Processing					
2.2	Subject area					Electronics and Telecommunications Engineering					
2.3	Course responsible/lecturer					Associate Professor Mihaela GORDAN, PhD					
2.4	Teachers in charge of applications					Assistant Professor Camelia FLOREA, PhD					
2.5	Year of study	IV	2.6	Semester	1	2.7	Assessment	V	2.8	Subject category	DS/DOP

3. Estimated total time

Year/ Sem.	Subject name	No. of weeks	Course [hours/ week]	Applications [hours/ week]			Course [hours/ semester]	Applications [hours/ semester]			Indiv. study	TOTAL	Credits
				S	L	P		S	L	P			
IV/1	Digital Image Processing	14	2	0	1	1	28	0	14	14	48	104	4

3.1	Number of hours per week	4	3.2	of which, course	2	3.3	applications	2
3.4	Total hours in the curriculum	56	3.5	of which, course	28	3.6	applications	28

Individual study	Hours
Manual, lecture material and notes, bibliography	24
Supplementary study in the library, online and in the field	4
Preparation for seminars/laboratory works, homework, reports, portfolios, essays	14
Tutoring	2
Exams and tests	3
Other activities	1

3.7	Total hours of individual study	48
3.8	Total hours per semester	104
3.9	Number of credit points	4

4. Pre-requisites (where appropriate)

4.1	Curriculum	Linear Algebra; Signals Theory
4.2	Competence	NO

5. Requirements (where appropriate)

5.1	For the course	Technical University of Cluj-Napoca
5.2	For the applications	Technical University of Cluj-Napoca

6. Specific competences

Professional competences	C4. To design, implement and operate data, voice, video and multimedia services, based on the understanding and application of fundamental concepts from the field of communications and information transmission. C5. To select, install, configure and exploit fixed and mobile telecommunications equipment. To equip a site with common telecommunications networks.
Cross competences	N.A.

7. Discipline objectives (as results from the key competences gained)

7.1	General objectives	Developing professional competences regarding the acquisition, processing, analysis and coding/compression of digital images, from the point of view of understanding the theoretical fundamentals and of their integration in practical interdisciplinary applications
7.2	Specific objectives	1. Recognizing and understanding basic concepts specific to the acquisition, processing, coding/compression and analysis of digital images 2. Understanding the similarities and differences between the representation, processing and coding of digital images (2-D signals) and 1-D signals 3. Developing skills and abilities to generalize the theoretical concepts for signal processing and analysis and to apply them for the particular case of digital images and videos 4. Developing skills and abilities to combine basic image processing, analysis and coding algorithms for practical applications specific to automation, robotics, medical imaging and industrial imaging systems 5. Developing skills and abilities needed to implement and test the performance of digital image acquisition, processing and analysis systems

8. Contents

8.1. Lecture (syllabus)		Teaching methods	Notes
1	Course description. General notions regarding the processing, analysis and coding/compression of digital images. Mathematical representation of grey scale and color digital images.	Presentation; explanation; demonstration; debates; conversation; learning through discovery	Video-projector; interactive teaching style: alternation of multimedia teaching tools with the classical teaching tools (whiteboard); use of applets during teaching, to illustrate the operation of the methods/algorithms discussed
2	Image digitization. Image sampling/down-sampling: the sampling theorem in the 2-D space, the Nyquist rates, the alias effect.		
3	Image reconstruction from its samples / image up-sampling. Brightness/color quantization: general process; uniform quantization.		
4	Other brightness quantization methods: optimal (MMSE) quantization; visual quantization.		
5	Transform-based digital image representation. Unitary separable two-dimensional image transforms. Properties and applications.		
6	Two-dimensional unitary sinusoidal image transforms (DFT, DCT); two-dimensional unitary rectangular image transforms (Walsh, Haar). Applications of transform-based image representation: compression and coding; image denoising; image analysis/object recognition.		
7	Histogram statistics of digital images. Grey scale transformations for image enhancement; contrast enhancement algorithms.		
8	Spatial image filtering for image enhancement: low-pass spatial filtering and image denoising; unsharp masking; high-pass and band-pass spatial filtering.		
9	Other spatial image processing operations: contrast inversion; statistical scaling; image zooming. Transform domain image enhancement. Applications of image enhancement in communication systems and medical imaging systems.		
10	Digital image analysis: structure of an image analysis system; feature extraction; feature selection. Edge detection.		
11	Characterization of objects in digital images by their contour and/or their inner region. Contour extraction; contour descriptors. Region extraction; region descriptors. Shape descriptors; shape-based object recognition. Geometrical features; statistical moment features; regenerative features.		
12	Binary image morphology: erosion; dilation; other morphological operations. Median axis transforms; object skeleton; boundary thinning.		
13	Texture representation; texture descriptors. Digital image segmentation algorithms.		
14	Topics review and synthesis. Preparation for the final verification.		
8.2. Applications (lab)		Teaching methods	Notes
1	Introduction to IMAQ Vision. Structure of the image processing applications in LabView	Group debates; experiments; learning through discovery; case study; exercises; learning through cooperation	Use of computers, LabView software and the IMAQ Vision library, video-capture boards and video cameras
2	Video capture boards. Acquisition, rendering and storage of digital images in LabView		
3	The discrete Fourier transform; image filtering in the transform domain		
4	Image enhancement through grey scale transformations		
5	Spatial filtering for image enhancement: noise removal (low pass spatial filtering); edge detection (high pass spatial filtering).		
6	Binary image morphology		
14	Final lab assessment; make-up missed lab sessions.		
8.2. Applications (project)		Teaching methods	Notes
1	Presentation of the projects topics. Presentation of the implementation requirements general to all projects and particular to each topic. Work plan specification. Discussion about the presentation of the results.	Group debate; exercise; presentation-debate; algorithmic; case study; project;	Use of computers, software development environments.
2	The study phase. Presentation of theoretical reports describing the algorithms selected for implementation. Discussions and questions.		
3	The design phase. Presentation of the block diagram of the application. Discussions, questions, suggestions		
4	The implementation of the components of the application. Verification		

	on test data. Presentation of the preliminary results. Discussion of the encountered difficulties and finding ways to solve them		
5	Final application implementation phase – linking the components into the end-user application. Functional verification of the application on test data. Discussion of the encountered difficulties and finding ways to solve them		
6	Generation of the set of test images and videos. Experiments to obtain the results. Evaluation of the application performance and comparison to the target results/state of the art. Editing the written documentation of the project.		
7	Theoretical and practical presentation of the project. Evaluation/grading of the project.		

Bibliography

1. A. Vlaicu, *Prelucrarea numerică a imaginilor*, Editura Albastră, Cluj-Napoca, 1997, 393 pagini, ISBN 973-9215-41-6
2. B. Orza, A. Vlaicu, C. Popa, M. Gordan, *Viziunea computerizată în exemple şi aplicaţii practice*, Editura U.T.Pres, Cluj-Napoca, 2007, 160 pagini, ISBN 978-973-662-294-6
3. M. Gordan**,** *Sisteme de analiză a imaginilor digitale folosind clasificatoare maşini cu vectori suport*, Ed. Casa Cărţii de Ştiinţă, Cluj-Napoca, 2006, ISBN 973-686-867-2
4. Rafael C. Gonzalez, Richard E. Woods, *Digital Image Processing (3rd Edition)*, Prentice Hall, 2008
5. M. Sonka, V. Hlavac, R. Boyle, *Image Processing, Analysis, and Machine Vision*, Thomson Learning, 2007

On-line teaching materials:

1. A. Vlaicu, *Prelucrarea numerică a imaginilor – prezentări curs (Powerpoint)*, http://ctmtc.utcluj.ro:8080/sites/pni/pni
2. M. Gordan, A. Vlaicu, *Prelucrarea imaginilor digitale – probleme rezolvate*, manuscris, http://ctmtc.utcluj.ro:8080/sites/pni/pni

9. Bridging course contents with the expectations of the representatives of the community, professional associations and employers in the field

Competences acquired will be used in the following COR occupations (Electronics Engineer; Telecommunications Engineer; Electronics Design Engineer; System and Computer Design Engineer; Communications Design Engineer; Security Systems Engineer) or in the new occupations proposed to be included in COR (Multimedia Applications Developer; Project Manager; Image and Sound Processing Engineer; Communications Systems Consultant).

10. Evaluations

Activity type	10.1	Assessment criteria	10.2	Assessment methods	10.3	Weight in the final grade
Course		Discussion during the lectures on different problems and their solutions. Two written tests, in the middle and in the end of the semester, consisting in a quiz part (with questions from theory and from exercises) with multiple possible correct answers, and an essay part, with three theoretical subjects and two practical problems to be solved.		Continuous formative evaluation Written verification		C, max. 10 pts. 7.5% E, max 10 pts. 52.5%
Laboratory		The level of acquired abilities based on questions in the end of each lab session. Two laboratory reports, graded		Continuous formative evaluation Grades on two laboratory reports		L, max. 10 pts. 15%

Project		Presentation of the partial results in the form of written reports during the semester. The reports are graded. Presentation of the project (theoretical and practical) – implementation, results, comment on the results – also graded.		Continuous formative evaluation Grade on the final project, presentation and validation through experiments		P, max. 10 pts. 25%
10.4 Minimum standard of performance						
$L \geq 5$ and $E \geq 4$ and $0.75(0.7E+0.2L+0.1C) +0.25P \geq 4.5$						

Date of filling in
01.10.2018

Course responsible
Associate Professor
Mihaela GORDAN, PhD

Teachers in charge of applications
Assistant Professor
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