Universitatea Națională de Știință și Tehnologie Politehnica București
Facultatea de Electronică, Telecomunicații și
Tehnologia Informației

COURSE DESCRIPTION

1. Program identification information

1.1 Higher education institution	**National University of Science and Technology Politehnica Bucharest**
1.2 Faculty	**Electronics, Telecommunications and Information Technology**
1.3 Department	**Applied Electronics and Information Engineering**
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Masters
1.6 Programme of studies	Advanced Techniques for Digital Imaging

2. Date despre disciplină

2.1 Course name (ro) (en)				Fotografie computaţională			
2.2 Course Lecturer				Prof. Dr. Corneliu Nicolae FLOREA			
2.3 Instructor for practical activities				Prof. Dr. Corneliu Nicolae FLOREA			
2.4 Year of studies	2	2.5 Semester	I	2.6. Evaluation type	V	2.7 Course regime	Ob
2.8 Course type		DA	2.9 Course code	UPB.04.M3.A.15-18		2.10 Tipul de notare	Nota

3. Total estimated time (hours per semester for academic activities)

3.1 Number of hours per week	4	Out of which: 3.2 course	2.00	3.3 seminary/laboratory	2
3.4 Total hours in the curricula	56.00	Out of which: 3.5 course	28	3.6 seminary/laboratory	28
Distribution of time:					hours
Study according to the manual, course support, bibliography and hand notes Supplemental documentation (library, electronic access resources, in the field, etc) Preparation for practical activities, homework, essays, portfolios, etc.					60
Tutoring					5
Examinations					4
Other activities (if any):					0

3.7 Total hours of individual study	69.00
3.8 Total hours per semester	125
3.9 Number of ECTS credit points	5

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Completion of the following disciplines: Decision and estimation in information processing,Color image processing and analysis

4.2 Results of learning	Elements of algebraic calculation; Elements of mathematical analysis;

5. Necessary conditions for the optimal development of teaching activities (where applicable)

5.1 Course	The course will take place in a room equipped with a video projector
5.2 Seminary/ Laboratory/Project	The project will take place in a room equipped with a video projector

6. General objective *(Reffering to the teachers' intentions for students and to what the students will be thought during the course. It offers an idea on the position of course in the scientific domain, as well as the role it has for the study programme. The course topics, the justification of including the course in the currcula of the study programme, etc. will be described in a general manner)*

The objective of the **course** is to familiarize students with the specific vocabulary of computational photography. The main limitations of common camera models are discussed, highlighting potential artifacts and quality limitations. Image alignment techniques are studied to use multiple frames with relative displacement for the same solution. Methods of transferring a certain property of a target image to a subject image are discussed. Emphasis is placed on the computational cost of image artifact removal solutions and their comparison with the hardware variant.

The objective of the **project** is for the students to learn about the study, description and construction of a specific complex method that solves a practical problem of computational photography. In the end, a solution (not necessarily original) will be proposed, which will be comparatively evaluated from the point of view of quality or running time with other solutions from the literature. Specific examples will be identified on which to study the effectiveness of the solution

7. Competences *(Proven capacity to use knowledge, aptitudes and personal, social and/or methodological abilities in work or study situations and for personal and proffesional growth. They refflect the empolyers requirements.)*

Specific Competences	• Defines domain-specific notions: image alignment, optical flow, diffusion, motion blur, etc. • Describe/ the process of hard/slow convergence, • It uses principled approaches (based on concepts and structures math) for image analysis and problem identification. • It highlights relationships between the nature of the image acquisition system and performance, between the trainable model and performance, etc

Transversal (General) Competences	• Works in a team and communicates effectively, coordinating efforts with others to solve problem situations of medium complexity. • Autonomy and critical thinking: the ability to think in scientific terms, search and analyze data independently, and draw and present conclusions / identify solutions. • Ability to analyze and synthesize: presents the acquired knowledge in a synthetic way, as a result of a process of systematic analysis. • Respects the principles of academic ethics: correctly cite the bibliographic sources used in the documentation activity. • Places elements of emotional intelligence into practice in the appropriate social-emotional management of real-life/academic/professional situations, demonstrating self-control and objectivity in decision-making or stressful situations.

8. Learning outcomes *(Synthetic descriptions for what a student will be capable of doing or showing at the completion of a course. The learning outcomes reflect the student's acomplishments and to a lesser extent the teachers' intentions. The learning outcomes inform the students of what is expected from them with respect to performance and to obtain the desired grades and ECTS points. They are defined in concise terms, using verbs similar to the examples below and indicate what will be required for evaluation. The learning outcomes will be formulated so that the correlation with the competences defined in section 7 is highlighted.)*

Knowledge	*The result of knowledge aquisition through learning. The knowledge represents the totality of facts, priciples, theories and practices for a given work or study field. They can be theoretical and/or factual.* • Defines domain-specific notions: image alignment, inpainting, image deblurring, high dynamic range. • Describes/ the process of algorithmic digital modification of images. • Uses principled approaches (based on mathematical concepts and structures) for data analysis. • Highlights relationships between the nature of the problem and performance, between computing capacity and performance, etc

Skills	*The capacity to apply the knowledge and use the know-how for completing tasks and solving problems. The skills are described as being cognitive (requiring the use of logical, intuitive and creative thinking) or practical (implying manual dexterity and the use of methods, materials, tools and intrumentation).* • Select and group relevant information in the context of training applications. • Reasonably uses specific principles in view of computational photography. • Work productively in a team. • Elaborates a scientific text, on the occasion of the report associated with the project. • Experimentally verifies applied solutions with performances reported in the literature. • Solves practical applications, one of which is extensive in the project and several shorter ones in association with the laboratory. • Interpret causal relationships appropriately. • Identifies solutions and develops resolution/project plans. • Formulate conclusions to the experiments carried out. • Argue the identified solutions/workarounds
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* • Selects appropriate bibliographic sources and analyze them. • Respects the principles of academic ethics, correctly citing the bibliographic sources used. • Demonstrates responsiveness to new learning contexts. • Demonstrates collaboration with other colleagues and teaching staff in carrying out teaching activities • Demonstrates autonomy in organizing the learning situation/context or the problem situation to be solved • Demonstrates social responsibility through active involvement in student social life/involvement in academic community events • Promotes/contributes through new solutions related to the specialized field to improve the quality of social life. • Realizes the value of his contribution in the field of engineering to the identification of viable/sustainable solutions to solve problems in social and economic life (social responsibility). • Apply principles of professional ethics/deontology in the analysis of the technological impact of the solutions proposed in the specialized field on the environment

9. Teaching techniques *(Student centric techniques will be considered. The means for students to participate in defining their own study path, the identification of eventual fallbacks and the remedial measures that will be adopted in those cases will be described.)*

- Starting from the analysis of students' learning characteristics and their specific needs, the teaching process will explore both expository (lecture, exposition) and conversational-interactive teaching methods, based on discovery learning models facilitated by direct exploration and indirect of reality(experiment - especially in the case of the laboratory, demonstration, modelling), but also on action-based methods, such as exercise and practical activities.
- In the teaching activity, lectures will be used, based on some Power Point presentations that will be made available to the students.
- The presentations are interrupted by free discussions that appeal to the students' direct experience,respectively to small mathematical demonstrations.

- Each course will start with a recap of the chapters already covered, with an emphasis on the concepts covered in the last course.
- Presentations use images and diagrams so that the information presented is easy to understand and assimilate.
- This discipline covers information and practical activities designed to support students in their learning efforts and the development of optimal collaborative and communicative relationships in a climate conducive to discovery learning.
- The practice of active listening and assertive communication skills, as well as feedback construction mechanisms, will be taken into account, as ways of regulating behavior in various situations and adapting the pedagogical approach to the students' learning needs.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	The problem of computational photography 1.1 Review the standard camera model 1.2 Presentation of specific problems. Practical applications	2
2	Adaptive demosaicing 2.1 Primary solutions 2.2 Adaptation to gradient direction 2.3 Computational efficiency	2
3	Image registration 3.1 Block matching methods. Patch Match 3.2 Holistic methods	2
4	Super resolution 4.1 Solutions based on a single image 4.2 Multi-image solutions	2
5	High dynamic range 5.1 Dynamic range 5.2 Merger of cadres 5.3 Fusion of radiance maps 5.4 Perceptual tone compression operators	2
6	Key point detectors 6.1 Scale space 6.2. SIFT 6.3. SURF, ORB	4
7	123 / 5,000 Translation results Construction of panoramic images 7.1 Alignment of image blocks with keypoint detectors. 7.2 Stitching images	2
8	Blurred image restoration 8.1 Hand tremor 8.2 The mathematical model. Stationary and non-stationary motion 8.3 Deconvolution with known PSF. Wiener filter 8.4 Deconvolution with unknown PSF	2

9	Color constancy 9.1 Color gamut 9.2 Lighting 9.3 Algorithms of the "gray shades" type 9.4 Algorithms based on neural networks	2
10	Textures synthesis 10.1 Statistical modeling of textures 10.2 Inpainting	2
11	Transfer of image parameters 11.1 Color transfer 11.2 Texture Transfer 11.3 Contrast transfer 11.4 Style Transfer	2
12	Image relighting 12.1 The geometric model of illumination 12.2 Lighting Solutions	2
13	Automatic image quality assessment 13.1. Defects in images. objective assessment 13.2 Subjective perceptual evaluation	2
	Total:	28

Bibliography:

- Prelegerile de curs pe pagina de Moodle a materiei https://curs.upb.ro/2023/course/view.php?id=9736
- Constantin Vertan, Mihai Ciuc, Marta Zamfir, Corneliu Florea, Laura Florea, Alina Sultana, Tiberiu Radulescu: "Prelucrarea si analiza imaginilor digitale - elemente fundamentale si aplicatii avansate", Editura MatrixRom, Bucuresti, Romania, 2013. 270 pag. ISBN978-973-755-367-6 Cod CNCSIS 139
- Corneliu Florea, Bogdan Ionescu, Constantin Vertan: "Computer Vision - Tehnici de calibrare a camerei digitale si analizei informatiei vizuale", Editura MatrixRom, Bucuresti, Romania, 2013. ISBN978-973-755-942-5, 180 pag. Cod CNCSIS 139
- Corneliu Florea, Laura Florea, „Logarithmic Type Image Processing Framework for Enhancing Photographs Acquired in Extreme Lighting” in Advances in Electrical andComputer EngineeringVol. 13, No. 2, pp. 97-104, 2013,WOS:000322179400016
- Corneliu Florea, Constantin Vertan; Laura Florea "High Dynamic Range Imaging by Perceptual Logarithmic Exposure Merging", in International Journal of Applied Mathematics and Computer Science (AMCS) in 2015,Vol. 25, No. 4, pp. 943–954 WOS:000367468200017
- M. Badea, C. Florea, L. Florea, C. Vertan "Can We Teach Computers to Understand Art? Domain Adaptation for Enhancing Deep Networks Capacity to De-Abstract Art" Image and Vision Computing Journal, Volume 77, September 2018, Pages 21-32, WOS: 000446282900003
- Marc Levoy Lectures on Digital Photography, diponibil on-line la adresa https://sites.google.com/site/marclevoylectures/
- Szeliski, R. (2010). Computer vision: algorithms and applications. Springer Science & Business Media.
- Szeliski, R. (2007). Image alignment and stitching: A tutorial. Foundations and Trends® in Computer Graphics and Vision, 2(1), 1-104
- Zitova, Barbara, and Jan Flusser. "Image registration methods: a survey." Image and vision computing 21, no. 11 (2003): 977-1000.
- Gijsenij, Arjan, Theo Gevers, and Joost Van De Weijer. "Computational color constancy: Survey and experiments." IEEE Transactions on Image Processing 20, no. 9 (2011): 2475-2489.
- Tursun, O. T., Akyüz, A. O., Erdem, A., & Erdem, E. (2015, May). The state of the art in HDR deghosting: a survey and evaluation. In Computer Graphics Forum (Vol. 34, No. 2, pp. 683-707)

PROJECT

Crt. no.	Content	No. hours
1	The project is individualized, each student receiving a specific and unique topic. The bibliography for each theme is specific. This bibliography must be expanded by the student. The project contains 2 stages: the theoretical presentation of the problem and the main solutions proposed in the specialized literature and, the second step, involves the presentation of a functional solution and its demonstration on some specific examples.	14
	Total:	

Bibliography:
The individual assignments are on the Moodle page of the course https://curs.upb.ro/2023/course/view.php?id=9736

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	Knowledge of the fundamental theoretical notions of image processing and analysis in the context of computational photography;	Oral exam in the exam session corresponding to the semester; the subjects cover the entire subject, achieving a synthesis between the comparative theoretical course of the subject and the clarification through exercises and problems of the application models	20%
	knowledge of how to apply the theory to specific problems;	Oral exam in the exam session corresponding to the semester; the subjects cover the entire subject, achieving a synthesis between the comparative theoretical course of the subject and the clarification through exercises and problems of the application models	20%
11.5 Seminary/laboratory/project	Project: coherent presentation of a specific problem with limits, solutions from specialized literature and performance	Oral examination during the semester with emphasis on understanding the specific problem	30%
	Project: coherent presentation of a solution to a the specific problem	Oral examination during the semester with emphasis on the argumentation of the solution used	30%
11.6 Passing conditions			
Grade >= 50 pts			

12. Corroborate the content of the course with the expectations of representatives of employers and representative professional associations in the field of the program, as well as with the current state of knowledge in the scientific field approached and practices in higher education institutions in the European Higher Education Area (EHEA)

Every year the course is updated with recent discoveries that convince the community

Date	Course lecturer	Instructor(s) for practical activities
09.10.2024	Prof. Dr. Corneliu Nicolae FLOREA	Prof. Dr. Corneliu Nicolae FLOREA

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Date of department approval	Head of department
29.10.2024	Conf. Dr. Bogdan Cristian FLOREA
Date of approval in the Faculty Council	Dean
17.10.2024	Prof. Dr. Mihnea Udrea