UCLouvain

lgbio2050

2019

Medical Imaging

In view of the health context linked to the spread of the coronavirus, the methods of organisation and evaluation of the learning units could be adapted in different situations; these possible new methods have been - or will be - communicated by the teachers to the students.

5 credits	30.0 h + 30.0 h	Q1

Teacher(s)	Bol Anne ;Lee John ;Macq Benoît ;Peeters Frank ;
Language :	English
Place of the course	Louvain-la-Neuve
Main themes	The course deals with the basics of medical imaging, including digital image processing, as well as the main modalities of medical imaging (transmission imaging, emission imaging, ultrasound echography, and magnetic resonance imaging).
Aims	With respect to the AA referring system defined for the Master in Biomedical Engineering, the course contributes to the development, mastery and assessment of the following skills : • AA1.1, AA1.2, AA1.3 • AA2.1, AA2.2, AA2.3, AA2.4 • AA4.1, AA4.2, AA4.4 • AA5.2, AA5.4 a. Domain-related learning outcomes **Upon completion of the course, the student will be able to :** Part 1 (digital image processing) : • Define formally the concept of image and its properties (size, matrix of pixels/voxels, colormap, histogram, color or channel encoding, encoding of the matrix, compression, frequency space representation). (axis 1.1) • List the main classes of problems solved by image processing (denoising, deconvolution, filtering, edge detection, segmentation, registration). (axes 1.1 et 1.2) • List a few typical methods used to solve these different classes of problems. (axis 1.2) • Justify the choice of a method (data representation, criterion to be optimized) with respect to simple problems (segmentation of a slice, registration of two slices, etc.). (axes 1.3 et 2.3) • Solve these simple problems by implementing in Matlab the algorithms corresponding to the methods described in the course. (axes 2.1, 2.2, 2.3, 2.4) Part 2 (MRI and echography) : 1 • Describe the physical principle behind magnetic resonance imaging (MRI) : Nuclear Magnetic Resonance (spin, excitation, reception, relaxation, chemical shift,'). (axe 1.1) • Describe the principle that allows image reconstruction: gradients, slice/volume selection, frequency/ phase encoding, k-space, Fourier transform, resolution, ', and describe the possible artifacts. (axes 1.1 et 1.2) • List and describe some sequences used for image acquisition (spin echo and gradient echo, ultrafast sequences and echo planar imaging) and compare their advantages, drawbacks, and application conditions. (axe 1.1) • List and describe the possible contrasts : proton density, T1, T2, T2*, flow, diffusion, perfusion, functional and spectroscopic imaging. (axe 1.1) • Explain the principles of ultrasound imaging : ultrasounds, transducers, image formation and image quality, Doppler imaging,' (axe 1.1) Part 3 (imaging modalities using ionizing radiation) : • List the different imaging modalities described in the course (radiography, computerized tomography, scintigraphy, SPECT, and PET) and explain their underlying principle (mainly from the physics point of view), mention their applications, advantages and limitations. (axis 1.1) • Compare the performances of the different modalities together with the quality of the images (resolution, noise, contrast). (axis 1.2) • Discuss the specificity of each technique and the complementarity of the different modalities. (axis 2.3) b. Transversal learning outcomes **Upon completion of the course, the student will be able to :**

	• Meet the objectives of a course given in English (understanding of the magistral lecture and of the supporting material). (axes 5.2 et 5.4) • Work in groups of two on small projects (challenges), namely : be able to share and distribute the workload, understand and describe the work of the other student, write a joint report. (axes 4.1, 4.2 et 4.4) - - - - *The contribution of this Teaching Unit to the development and command of the skills and learning outcomes of the programme(s) can be accessed at the end of this sheet, in the section entitled "Programmes/courses offering this Teaching Unit".*
Evaluation methods	**Due to the COVID-19 crisis, the information in this section is particularly likely to change.** Evaluation of the exercises (challenges only) Each challenge report will be given a note. The global note for all challenges affects the final evaluation (see below). The introductory exercises that preceed the challenges will be evaluated in a formative way with no impact on the final evaluation. The submission of all challenge reports is mandatory to be admitted to the oral examination for part 1 of the course. Evaluation of the learning outcomes The students will be evaluated individually and orally on the basis of the contents and learning outcomes mentioned above. The oral examination (in French or English, at the student's choice) will address : Part 1 (10 points out of 20, image processing) : the student must answer two questions dealing with the methods and algorithms used in the challenges (see below). Starting from a simple problem (which can be solved with a pen and paper), the student should be able to justify his choices. On 10 points, one third results from the evaluation of the challenge reports, the other two thirds corresponding to the two questions. Part 2 (5 points out of 20, IRM and ultrasound imaging) : the student must answer two questions (oral examination with written preparation) Part 3 (5 pointsout of 20, imaging modalities using ionizing radiation) : the student must answer two questions (oral examination with written preparation).
Teaching methods	**Due to the COVID-19 crisis, the information in this section is particularly likely to change.** The course consists of 13 lectures in English, three sessions of exercises (mostly reminders or introductory exercises), and three small projects (challenges). For each challenge, groups of two students must submit a report. These reports are evaluated. During a debriefing session, the most commonly encountered issues will be presented and discussed between the teacher and the students. A visit of medical imaging facilities in Saint-Luc University Hospital (Brussels) completes the program
Content	The course is divided in three parts : Part 1 : digital image processing (definition and properties of an image, histogram, spectrum, segmentation, edge detection, filtering, mathematical morphology, registration) Part 2 : magnetic resonance imaging and ultrasound imaging (linear systems : convolution, point spread function, Fourier transform, sampling ; image reconstruction : Radon transform, filtered backprojection, algebraic reconstruction) Part 3 : transmission imaging (radiography and computerized tomography) and emission imaging (scintigraphy, SPECT and PET)
Inline resources	Moodle http://moodleucl.uclouvain.be/course/view.php?id=7712
Bibliography	Support de cours : Partie 1 : transparents. Parties 2 et 3 : transparents et syllabus. Les documents du cours sont disponibles sur Moodle.
Other infos	The first two sessions of exercise are organized in the computer room
Faculty or entity in charge	GBIO

Programmes containing this learning unit (UE)

Program title	Acronym	Credits	Prerequisite	Aims
Master [120] in Biomedical Engineering	GBIO2M	5		
Master [120] in Computer Science and Engineering	INFO2M	5		
Certificat universitaire en physique d'hôpital	RPHY9CE	5		
Master [120] in Mathematical Engineering	MAP2M	5		
Master [120] in Statistic: Biostatistics	BSTA2M	5		
Master [120] in Electrical Engineering	ELEC2M	5		
Master [120] in Physics	PHYS2M	5		