Surgical Navigation and Imaging

Academic Year: (2023 / 2024) **Review date: 19/12/2023 17:50:27**

Department assigned to the subject: Bioengineering Department

Coordinating teacher: PASCAU GONZALEZ GARZON, JAVIER

Type: Electives ECTS Credits : 3.0

Year : 1 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Biosignals and Bioimages
Biomedical image processing (or equivalent course)

OBJECTIVES

CB6 Having and understanding the knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context
CB7 Students know how to apply their acquired knowledge and problem-solving skills in new or unfamiliar settings within broader (or multidisciplinary) contexts related to their field of study.
CB8 Students are able to integrate knowledge and to face the complexity of making judgments based on information that, being incomplete or limited, includes reflections on the social and ethical responsibilities linked to the application of their knowledge and judgments.
CB9 Students know how to communicate their conclusions and the knowledge and ultimate reasons behind them to specialised and non-specialised audiences in a clear and unambiguous way.
CB10 Students have the learning skills that will enable them to continue studying in a way that will be largely self-directed or autonomous.

General competences

CG2 Ability to apply the knowledge of skills and research methods related to engineering.
CG3 Ability to apply the knowledge of research skills and methods related to Life Sciences.
CG4 Ability to contribute to the widening of the frontiers of knowledge through an original research, part of which merits publication referenced at an international level.
CG5 Ability to perform a critical analysis and an evaluation and synthesis of new and complex ideas.
CG6 Ability to communicate with the academic and scientific community and with society in general about their fields of knowledge in the modes and languages commonly used in their international scientific community.

Specific competences

CE6 Ability to understand the basis of the main technologies involved in biomedical imaging systems.
CE7 Ability to solve a biomedical problem from an engineering perspective based on the acquisition and processing of biomedical images

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction. Course description. Historical background on surgical navigation. History of navigation and image guided surgery.

2. Tracking systems.
Mechanical, optical and magnetic tracking systems: operating principles, advantages and limitations.

3. Image registration.
Need and definition of the image registration.Landmark-based registration; methods based on surfaces and volumes: Procrustes, ICP, Mutual Information. Accuracy measurements and error estimation.

4. Clinical applications of navigation.
Examples of applications in neurosurgery, orthopedic surgery and traumatology, training of clinical staff, acquisition and fusion of ultrasound, radiotherapy ...

5. Detection and improvement of workflow in surgery.
Algorithms for estimation of workflow in surgery. Automatic analysis of video sequences.

6. Augmented reality in surgery.
Technical bases of augmented reality and virtual systems. Required hardware. Application development tools.

7. Laparoscopy and robotics in surgery. Device requirements in endoscopy. Surgical microscope. Use of infrared image in surgery.

8. 3D printing in the clinical setting.
Background on 3D printing. Printing technologies. From the image to the printed model. Utility of customized phantoms. Clinical applications.

9. Development tools in image-guided surgery.
Libraries and protocols: PLUS, OpenIGTLink .. 3DSlicer environment with Python. Development of specific modules.

LEARNING ACTIVITIES AND METHODOLOGY

AF3 Theoretical practical classes
AF4 Laboratory practices
AF6 Team work
AF7 Student individual work
AF8 Partial and final exams

METHODOLOGY
MD1: Class lectures by the professor with the support of computer and audiovisual media, in which the main concepts of the course are developed and complemented with bibliography.
MD2: Critical reading of texts recommended by the professor of the course.
MD3: Resolution of practical cases, problems, etc. .... posed by the teacher individually or in groups.
MD4: Presentation and discussion in class, under the moderation of the professor, of topics related to the content of the course, as well as case studies.
MD5: Elaboration of works and reports individually or in groups.

Mainly, the classes will be developed with practical theoretical content and will be complemented with practices to be carried out by the student individually or in groups.

TUTORING REGIME

There will be 2 hours a week of tutoring for students where the teacher will be available in his office.

ASSESSMENT SYSTEM

% end-of-term-examination/test:	30
% of continuous assessment (assigments, laboratory, practicals…):	70

The evaluation of the students will be carried out through continuous evaluation (100%) based on

SE2 Individual or group work or exams carried out during the course
SE3 Individual partial and/or final exams

The extraordinary evaluation (june call) will be carried out with a final exam (SE3) that weighs 100% of the grade.

BASIC BIBLIOGRAPHY

- Terry Peters; Kevin Cleary Editors Image-Guided Interventions: Technology and Applications, Springer, 2008

BASIC ELECTRONIC RESOURCES

- 3DSlicer . Slicer IGT: http://www.slicerigt.org/wp/

- Perklab . 3DSlicer BootCamp: https://github.com/PerkLab/PerkLabBootcamp/

- Rafael Moreta-Martinez, David García-Mato, Mónica García-Sevilla, Rubén Pérez-Mañanes, José A. Calvo-Haro, Javier Pascau . Combining Augmented Reality and 3D Printing to Display Patient Models on a Smartpho: https://www.jove.com/v/60618/combining-augmented-reality-3d-printing-to-display-patient-models-on