Surgical Navigation and Imaging

Academic Year: (2023 / 2024) **Review date: 11/01/2024 10:14:35**

Department assigned to the subject: Bioengineering Department

Coordinating teacher: GARCIA SEVILLA, MONICA

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

In this course, students will learn about the algorithms, methods and devices used in image-guided medical interventions: positioning systems, patient-image registration, 3D printing or augmented reality. The concepts will be presented from a theoretical point of view to then perform a laboratory practice where they will be used to solve a specific problem. The clinical application of these methods in laparoscopic surgery, maxillofacial surgery and traumatology will also be presented, as well as the possibilities for training and clinical simulation. The orientation of the course is mainly practical so that the knowledge learned will be demonstrated in a final group project.

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

SE1   Participation in class
SE2   Individual or team works or exams made during the course
SE3   Final exam

SE1 and SE2: 70%
SE3: 30%

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