PhD subject: Using deep learning for deformable registration and 3D reconstruction with application to augmented reality in laparoscopic surgery

Co-supervisors: Daniel Pizarro and Adrien Bartoli

Host Intitutions: GEINTRA, University of Alcala (Madrid), Spain and Institut Pascal, UMR6602 CNRS/UCA/CHU, Clermont-Ferrand, France.

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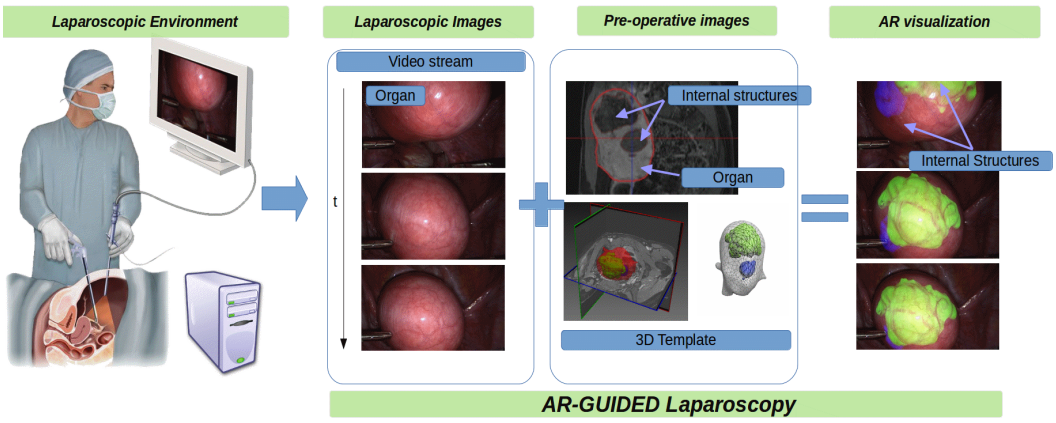
Abstract:

This PhD proposal fits into project ATHENA (PID2020-115995RB-I00), funded by the Spanish Ministry of Science and Innovation within the program "R+D+i applied to Societal Challenges 2020". Project ATHENA investigates new methods that recover the 3D volume or surface of a deforming object from images. This task is fundamental in computer vision due to its high-impact applications in robotics, human-machine interfaces, video editing techniques, and medicine. Project ATHENA investigates the application of deformable registration and 3D reconstruction methods from images to build Augmented Reality (AR) systems in laparoscopic surgery. The objective is to visualize on the laparoscopic image, and in real-time during surgery, anatomical structures segmented in 3D preoperative images. AR facilitates real-time planning of laparoscopic surgery based on the displayed information, improving feedback and spatial vision. However, the state-of-the-art deformable registration and 3D reconstruction solutions required in AR do not work well in the conditions of laparoscopic surgery, where there is an abundance of occlusions, illumination changes, motion blur, large camera movements, and organ deformations. Project ATHENA investigates techniques based on deep learning as the primary tool to solve deformable registration and 3D reconstruction problems under these conditions. For this purpose, project ATHENA investigates novel unsupervised learning techniques to cope with the lack of large, labeled databases, which is the main challenge of applying deep learning systems to these vision problems. Classical 3D vision models will serve as inspiration to develop the proposed system architectures, training pipelines and loss functions. The general objectives of Project ATHENA are 1) to contribute to the state-of-the-art in 3D reconstruction and deformable registration of objects in challenging conditions, and 2) to develop an AR system for the improvement of laparoscopic surgery. The PhD topic will emphasize any of the project's objectives, focusing on proposing new unsupervised deep-learning strategies to solve 3D vision problems.



Recommended skills: Python/C++/Matlab coding, mathematics, machine learning theory and coding (Tensorflow, Pytorch), 3D vision, medical image analysis.

Position: The PhD scholarship is funded for 4-years within the University of Alcala. It includes a special budget to spend at least 3 months in the co-supervisor institution Institut Pascal. Applicant's official deadline is November 11th and the details are published in the Spanish Government Research portal. The applicants are required to prepare a formatted CV (see the above link for the details) and must select the project's ID: PID2020-115995RB-I00 and title "TECNICAS DE APRENDIZAJE PARA RESOLVER LA RECONSTRUCCION Y REGISTRO DEFORMABLES APLICADOS A IMAGENES DE LAPAROSCOPIA" when filling the application.

For more information on the surgical applications and the host team's work, see:

Videos:

- https://www.youtube.com/channel/UCYO1dGfQXbYOHDIbddis3HQ

Webpages:

- http://www.geintra-uah.org/
- http://igt.ip.uca.fr/encov

Publications:

- https://scholar.google.com/citations?user=edEqzWEAAAAJ&hl=es
- http://igt.ip.uca.fr/encov/publications