

Subject: Automating Augmented Reality in Laparoscopy: Towards a New Type of Surgery

Supervisor: Adrien Bartoli

Laboratory: Institut Pascal, UMR6602 CNRS/UCA/SIGMA

Email and phone: Adrien.Bartoli@uca.fr, 06 74 87 85 01

Co-advisor(s): Christophe Tilmant, Christophe.Tilmant@uca.fr

Abstract (up to 10 lines):

Finding the tumours and other anatomical structures lying inside the organs is to date the strongest limitation of laparoscopy. This technique has nonetheless revolutionised surgery over the past 30 years or so. The new findings of robotics allowing the surgeon to telemanipulate do not change this fact, it is a visualisation problem. We will be researching in this PhD studentship to improve a prototype allowing one to visualise the internal anatomical structures using augmented reality. More precisely, we will seek to automatically detect the anatomical landmarks allowing one to register the preoperative imagery such as MRI and CT onto the laparoscopy image. We will follow a scientific approach based on deep learning.

Skills: some skills amongst computer science, mathematics, machine learning, 3D vision, medical imager processing.

Keywords: laparoscopy, augmented reality, computer vision, machine learning.

Description (up to 1 page):

Context. Laparoscopy is a surgical technique which consists in introducing an optics fibre connected to a camera into the abdominal cavity via a small incision. This strongly reduces the intervention trauma compared to open surgery but limits the surgeon's field of view and gesture. Augmented reality is a promising approach to assist this type of intervention as it indicates the surgeon in realtime the location of the anatomical structures to preserve (for instance the blood vessels) and the target structures (for instance the tumours). These structures are often invisible because they lie inside the organ. The potential impact in terms of healthcare quality is thus major and concerns organs including the uterus, the kidney, the liver and the pancreas.

State of the Art. Augmented reality requires one to register information available from the preoperative imaging such as MRI onto the laparoscopy images in realtime, which represents a difficult and open scientific problem. Current methods require user intervention to provide the location of anatomical landmarks in the images. This forms a strong limitation because in the operating theatre the surgeon's attention must be focused on their gesture and not on auxiliary tasks and because every minute spent is worth a fortune.

Research Subject. The central idea of this PhD is to develop computer vision and image processing by deep learning methods to replace the surgeon's identification of anatomical landmarks. This will allow one to automatically register the preoperative information and so to considerably streamline the use of augmented reality in clinical routine. This subject is interdisciplinary by nature. It will involve tools from computer vision (camera geometry and calibration), from artificial intelligence (neural networks, deep learning) and a direct application of the developed techniques to synthetic organ models, animal models and clinical cases.

Supervising and Location. The PhD study will take place within the EnCoV group (Endoscopy and Computer Vision) of Institut Pascal, located at the Faculty of Medicine, in collaboration with CHU de Clermont-Ferrand (the local university hospital). The PhD will be formally directed by Adrien Bartoli and co-supervised by Christophe Tilmant. EnCoV is a pioneer and leading group in the development of augmented reality for laparoscopy. Its members are scientists and surgeon and radiologist MDs.

Références (up to ½ page):

For more information on EnCoV's work, see:

- Webpage: <http://igt.ip.uca.fr/encov>
- Publications: <http://igt.ip.uca.fr/encov/publications>
- Commented augmented reality videos:
<https://www.youtube.com/channel/UCYO1dGfQXbYOHDlbdDis3HQ>

How to candidate?

Contact the supervisors by email.

Ecole doctorale sciences pour l'ingénieur – Université Clermont Auvergne,
Bat DRV, Campus des Cézeaux, 7 avenue Blaise Pascal CS60026 63178 Aubière Cedex
web : <http://edspi.univ-bpclermont.fr/>

Directeur
Thierry Chateau
tél. +33(0)4.73.40.76. 60
E-mail :
Thierry.Chateau@uca.fr

Secrétaire
Dominique TORRISANI
tel. +33 (0)4.73.40.76.09
edspi.driv@uca.fr