# Stage 2018 Project: Learning-based optical flow for tissue registration in laparoscopic surgery

An important open problem in computer-assisted minimally invasive surgery is to automatically track visible tissue surfaces that are visible to the endoscopic camera. There are several important applications for this. Currently the most important of these are as follows:

1. To enable Augmented-Reality based surgical guidance of soft-body organs (Figure 1).
2. To enable automatic tracking and motion compensation for robotic assisted surgery and robotic performed surgery. One concrete example of this is robot guided laser ablation [1].
3. To compute fluorescence accumulation over time in fluorescence-guided laparoscopic surgery.
4. To compute the laparoscope's 3D pose using SLAM-based approaches.

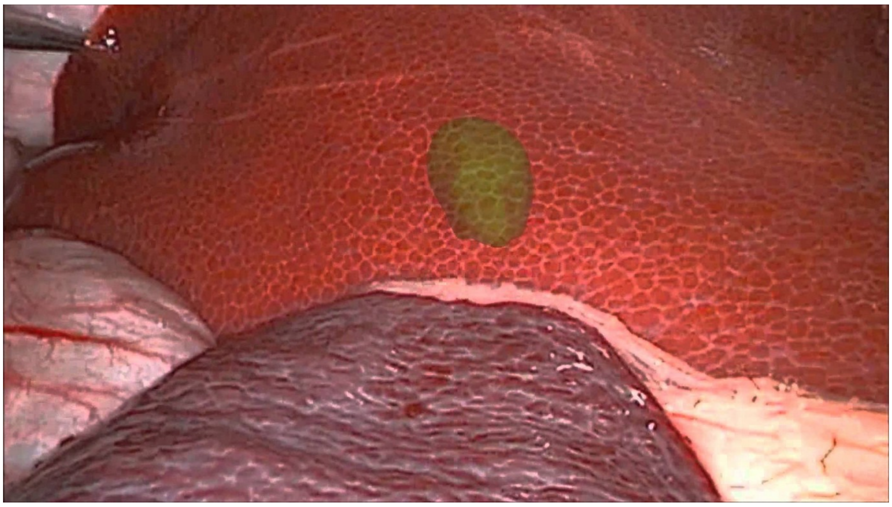

*Illustration 1: Augmented Reality guidance in hepatic laparoscopic surgery, showing a hidden tumor.*

Currently state-of-the-art methods are based on classical variational optical flow methods, such as TVL1 [2]. However these tend to not work highly robustly with laparoscopic videos for several reasons, including motion blur, strong illumination changes and poorly-textured regions. Recently methods based on deep learning have been proposed to solve optical flow in non-medical images, such as urban environments (figure 2). However the performance of deep learning-based methods depends strongly on large amounts of annotated training data, which is difficult to acquire in laparoscopic surgery. The main goal of this project is twofold: to collect a large database of laparoscopic images with ground-truth optical flow information, using automatic approaches developed at IRCAD. Secondly, to train several state-of-the-art deep learning architectures for optical flow computation, and to perform a systematic comparison. This is an exciting project to work on as it combines medical imaging with state-of-the-art deep learning techniques, with the goal of having a significant health benefit in computer assisted surgery.

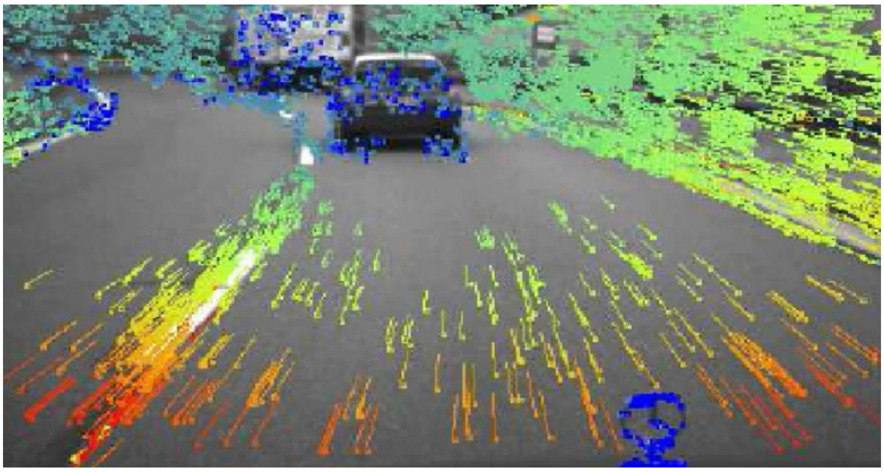

*Illustration 2: Optical flow for tracking vehicles and roadsides*

Required skilles: Programming experience in python and C++. Prior experience with Tensorflow/Torch or Keras is desirable. A background in machine learning is desirable.


[1] Stereo Vision-Based Tracking of Soft Tissue Motion with Application to Online Ablation Control in Laser Microsurgery, Schoob et al., Medical Image Analysis 2017

[2] An Improved Algorithm for TV-*L* Optical Flow, Wedel et al., SGAVMA 2008

[3] FlowNet 2.0: Evolution of Optical Flow Estimation with Deep Networks, Ilg et al., CVPR2016.

[4] https://github.com/lmb-freiburg/flownet2

[5] https://www.ndigital.com/medical/products/polaris-family/

[6] SLAM based Quasi Dense Reconstruction For Minimally Invasive Surgery Scenes, Mahmoud et al., arXiv preprint arXiv:1705.09107

[7] Discriminative Learning of Deep Convolutional Feature Point Descriptors, Imo-Serra et al., CVPR 2015



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**Rémunération** : 1100 € brut/mois – BAC+5/Master2
**Durée du stage** : 6 mois
**Date de début du stage** : Durant le 1er trimestre 2018
**Lieu du stage** : IRCAD – Strasbourg – Centre-ville

**Développement** :
Linux/Windows
C++