



HAL
open science

Augmented reality guidance in laparoscopic hepatectomy with deformable semi-automatic computed tomography alignment (with video)

B. Le Roy, E. Ozgur, B. Koo, E. Buc, A. Bartoli

► To cite this version:

B. Le Roy, E. Ozgur, B. Koo, E. Buc, A. Bartoli. Augmented reality guidance in laparoscopic hepatectomy with deformable semi-automatic computed tomography alignment (with video). *Journal of Visceral Surgery*, 2019, 156, pp.261 - 262. 10.1016/j.jviscsurg.2019.01.009 . hal-03486522

HAL Id: hal-03486522

<https://hal.science/hal-03486522>

Submitted on 20 Dec 2021

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial 4.0 International License

Title: Augmented reality guidance in laparoscopic hepatectomy with deformable semi-automatic computed tomography alignment (with video)

Titre : Réalité augmentée en chirurgie hépatique laparoscopique avec recalage semi-automatique déformable du volume tomodensitométrique (avec vidéo)

Authors: Bertrand Le Roy, MD^{1,2}, Erol Ozgur, PhD¹, Bongjin Koo, PhD¹, Emmanuel Buc, MD, PhD^{1,2}, Adrien Bartoli, PhD¹

- (1) Institut Pascal, UMR6602, Endoscopy and Computer Vision group, Faculté de Médecine, Bâtiment 3C, 28 place Henri Dunant, 63000 Clermont-Ferrand
- (2) Department of Digestive and Hepatobiliary Surgery, Hopital Estaing, CHU de Clermont-Ferrand, 1 Place Lucie et Raymond Aubrac, 63003 Clermont-Ferrand

Corresponding author

Bertrand Le Roy, M.D.

Department of HPB surgery, Clermont-Ferrand University Hospital Estaing

1, place Lucie et Raymond Aubrac

63003 Clermont-Ferrand Cedex

Tel: +33473752389, Fax: +33473750459

Email: leroybertrand8@gmail.com

Running head: Laparoscopic hepatectomy with augmented reality

Key words: laparoscopy, liver, resection, augmented reality, deformable 3D model, overlay

TEXT:

Laparoscopic liver resection has many known advantages but its use remains limited in clinical practice. A major reason for this limitation is the difficulty to use laparoscopic ultrasonography to localize intrahepatic tumours. Today, augmented reality (AR) guidance for monocular laparoscopic hepatectomy requires the surgeon to *manually* overlay a *rigid* preoperative model onto a laparoscopy image (1,2). This strategy is sometimes inaccurate because the liver deforms significantly (3). We propose a new algorithm to improve AR guidance. This algorithm overlays a *deformable* preoperative model semi-automatically onto a laparoscopy image using a new AR software named *Hepataug*. This software, developed in our group composed by surgeons and scientists runs in several steps. First, a preoperative 3D model of the liver and its internal anatomy is reconstructed from the CT. Second, this model is aligned to a laparoscopy image and AR delivered to the surgeon. Because the liver offers very few anatomical external landmarks, finding a method to compute the alignment was the core scientific challenge. *Hepataug* allows to complement the anatomical landmarks by natural visual cues such as the silhouette. Then, the software can deform the preoperative 3D model to compensate for the changes between the CT and the laparoscopy. This allows surgeons to locate tumors intraoperatively and resect those tumors in a safe manner. This video shows a proof-of-concept case of a laparoscopic segmentectomy 6 for two metachronous colorectal liver metastases. *Hepataug* was efficient in guidance where laparoscopic ultrasonography was not able to reveal the precise location of the tumors due to imaging artifacts. In this patient, the software indicated to the operating surgeon that the resection needed to be extended. Postoperative histopathology confirmed that margins were lower than 1 mm on the initial specimen but was greater than 1 cm on

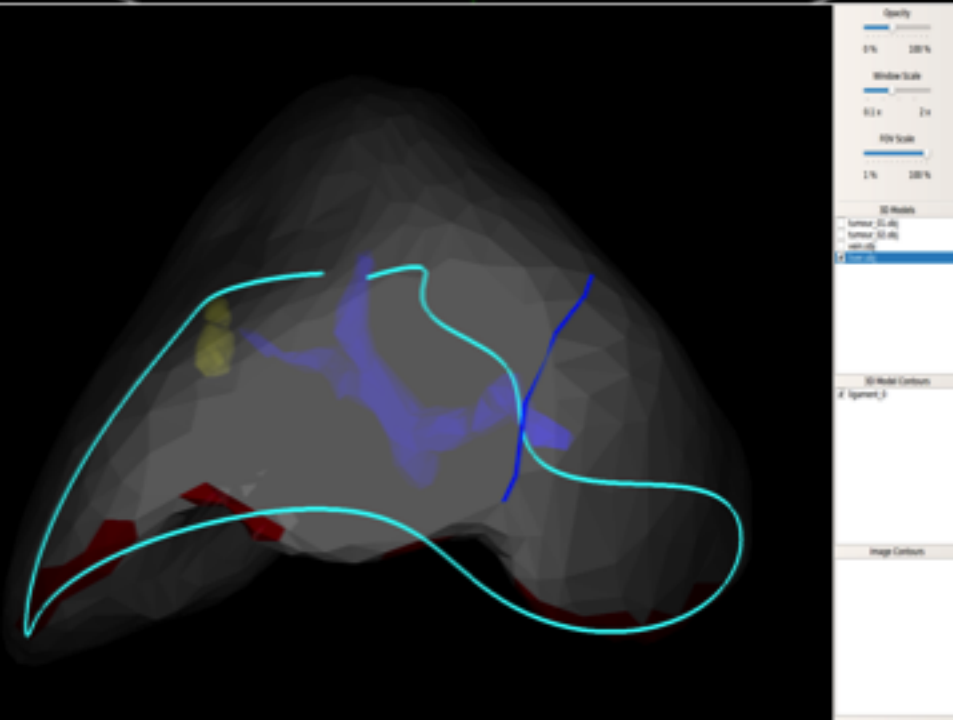
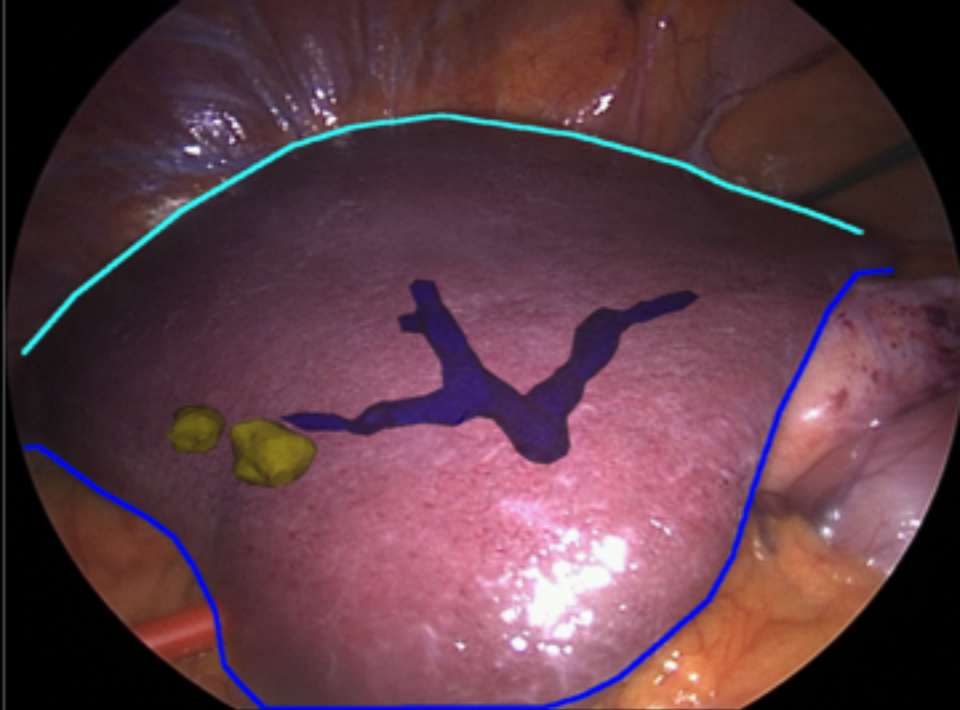
the secondary specimen. In conclusion, this video showed the first AR software able to localize intrahepatic tumors accurately in monocular laparoscopy using a new algorithm of semi-automatic deformable alignment. *Hepataug* is easy to use and could be deployed in the future in any existing operating room. This tool represents a promising new step in AR with encouraging initial clinical results but it still needs good quality comparative assessment.

References:

1. Bernhardt S, Nicolau SA, Soler L, Doignon C. The status of augmented reality in laparoscopic surgery as of 2016. *Med Imaging Anal* 2017 37:66–90
2. Phutane P, Buc E, Poirot K, et al. Preliminary trial of augmented reality performed on a laparoscopic left hepatectomy. *Surg Endosc*. 2018;32(1):514-515.
3. Özgür E, Koo B, Le Roy B, Buc E, Bartoli A. Preoperative liver registration for augmented monocular laparoscopy using backward-forward biomechanical simulation. *Int J Comput Assist Radiol Surg*. 2018;13(10):1629-1640.

Disclosure of interests and sources of funding:

The authors declare that they have no conflicts of interest concerning this article. The software we used was developed by our research group within the computer science department of Université Clermont Auvergne. It is a non-profit software used solely for research purposes within our group.



Quality
0% 100%

Window Scale
0.0 1.0

File Scale
1% 100%

3D Models
 Surface (3D-Only)
 Surface (3D-Only)
 Mesh (3D)
 Wireframe

3D Model Contours
Alignment

Image Contours

