The Nav EVAR project: first steps in reducing radiation exposure

Motivation

X-rays → Carcinogenic Contrast agent → Kidney damage

https://youtu.be/tS8hvb9kf44
Goal of the Nav EVAR project

➢ Explore different technologies to guide EVAR procedures (AAA) minimizing radiation exposure and contrast agent administration

➢ Technologies under evaluation:

Horn M et al. Zentralblatt für Chirurgie, 2015

Bouchagiar J et al. European Journal of Vascular and Endovascular Surgery, 2018

https://www.ndigital.com/medical/products/aurora/
https://www.microsoft.com/en-us/hololens

Tsakanikas VD et al, editors
Zhao L et al. MICCAI 2016
Nav EVAR project

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More details:
Electromagnetic tracking system

EM sensor

EM sensor at the catheter tip

Torso model on the EM field generator

Electromagnetic tracking system

Position error (EM sensor): 1.53 ± 0.57 mm (mean ± standard deviation)
Maximum error → 2.55 mm
(Ground truth from CT scans of whole setting, plastic markers in registration process, three repetitions)

Fibre Bragg grating sensors

Flexible instrument

FBG sensor

FBG array

Sensing length 38 cm

Shape reconstruction error: $1.13 \pm 0.43$ mm
Maximum error $\rightarrow 2.11$ mm

FBG-EM catheter

FBGs $\rightarrow$ shape reconstruction

EM sensor $\rightarrow$ global position
Augmented reality (HoloLens)

HoloLens user’s perspective

Third-person perspective
Sonja J et al. 34. Jahrestagung der Deutschen Gesellschaft für Gefäßchirurgie und Gefäßmedizin (DGG), 2018

https://www.microsoft.com/en-us/hololens
Augmented reality (HoloLens)

HoloLens user’s perspective

Stamatis R et al. Student Conference on Medical Engineering Science, Medical Informatics, Biomedical Engineering and Auditory Technology, 2019
Augmented reality (HoloLens)

Camera perspective

HoloLens user’s perspective

Augmented reality guidance system

HoloLens user’s perspective
Augmented reality guidance system

Third-person perspective

Virtual angioscopy images based on the catheter pose

von Haxthausen F et al. 33rd International Congress and Exhibition on Computer Assisted Radiology and Surgery (CARS’19), 2019
von Haxthausen F et al. 53rd Annual Conference of the German Society for Biomedical Engineering (BMT’19), 2019
Intraoperative imaging (OCT, IVUS)

- Necessary to update the preoperative data to the current patient’s anatomy

Intravascular imaging: current applications and research developments. Tsakanikas VD et al, editors.


Zhao L et al. MICCAI, 2016
Zhao L et al. IEEE Robotics And Automation Letters, 2016
Augmented reality guidance system for endovascular repair

➢ Work in progress: FBG-EM catheter, intraoperative imaging for updating the current anatomy
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