Open source airway navigation: initial experiences with CustusX and Anser EMT

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1. Introduction

Electromagnetic tracking (EMT) is a common navigation technology used in image guided applications. EMT is particularly useful in procedures where line-of-sight of the operating field is not feasible. We present a major update of the open source electromagnetic tracking platform Anser EMT [1] and present its results when performing bronchoscopy in a pre-clinical setting using the CustusX navigation suite [2]. The updated system design is open source and free to use and modify under the Berkeley Standard Distribution (BSD) license.

2. Methods

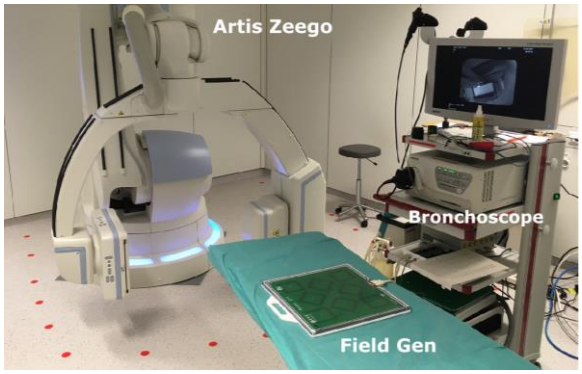
The original design of the Anser system [3] was consolidated onto single printed circuit board (PCB). An ergonomic enclosure for the field generator was also constructed. The system was tested and calibrated using the Matlab programming environment. EM guided bronchoscopy navigation was performed using the CustusX navigation suite on a 28 kg pig model. Four calcium chloride tumour models we're percutaneously placed in the upper right, centre left, centre right and lower right of the outer airways using CT guidance. An airway segmentation was performed on the post-placement CT scan using an OpenCL accelerated algorithm [4]. Image to patient registration was performed by aligning the acquired point clouds of a patient airway survey with the extracted segmentation centreline using the iterative closest point (ICP) method in CloudCompare [5]. A custom manufactured tip tracked bronchial catheter (Teleflex OEM Inc., Ireland) was used for airway navigation through a 3.2mm working channel of bronchoscope (EB-1970TK, Pentax Europe GmbH). Navigation to four tumour models was performed using electromagnetic tracking. Tornado® embolization coils (Cook Medical Inc., USA) we're placed at each tumour site for post procedure targeting verification.

3. Results

The system was calibrated using 81 pre-defined test points in a single plane at a height of 85mm above the field generator with an RMS registration error of 1.52mm. Airway segmentation was performed using CustusX in 18 seconds. ICP image-to-patient registration yielded a single rigid registration matrix. Successful navigation and to each tumour target was achieved using EM guided catheter navigation. Targeting errors were measured as the Euclidean distance between the centres of each tumour site and their respective embolization coils, using the post procedure Zeego DynaCT scan of the pig model. Absolute targeting errors of 2.48mm, 6.95mm, 3.79mm and 8.07mm were recorded.

4. Discussion & Conclusion

We have shown successful airway navigation and tumour targeting using a combination of open source hardware and software navigation technologies. Overall tumour targeting accuracy is comparable with previously reported procedures for electromagnetic navigation bronchoscopy [x].



5. References

[1] H. A. Jaeger *et al.*, "Anser EMT: the first open-source electromagnetic tracking platform for image-guided interventions." *Int J Comput Assist Radiol Surg.* 2017 Jun; 12(6): 1059-1067

[2] Askeland C *et al.*, "CustusX: an open-source research platform for image-guided therapy." *Int J Comput Assist Radiol Surg.* 2016 Apr; 11(4): 505-1

[3] Anser EMT - http://anser.io. (Accessed on 29/07/2017)

[4] Erik Smistad et al., "GPU Accelerated Segmentation and Centerline Extraction of Tubular Structures from Medical Images" *Int J Comput Assist Radiol Surg.* 2014 July; 9(4): 561-575

[5] CloudCompare (version 2.9) [GPL software]. (2017). Retrieved from http://www.cloudcompare.org/ (Accessed on 29/07/2017)