3D Guidance including Shape Sensing of a Stentgraft System

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During endovascular aneurysm repair (EVAR) procedures, medical instruments are guided with two-dimensional (2D) fluoroscopy and conventional digital subtraction angiography. However, this guidance requires X-ray exposure and contrast agent administration, and the depth information is missing. To overcome these drawbacks, a three-dimensional (3D) guidance approach based on tracking systems is introduced and evaluated [1]. A multicore fiber with fiber Bragg gratings for shape sensing and three electromagnetic (EM) sensors for measuring the position and orientation were integrated into a stentgraft system. A model for obtaining the located shape of the first 38 cm of the stentgraft system with two EM sensors is introduced and compared with a method based on three EM sensors. Both methods were evaluated with a phantom containing a 3D printed vessel made of silicone and agar-agar simulating the surrounding tissue. The evaluation of the guidance methods resulted in average errors from 1.35 to 2.43 mm and maximum errors from 3.04 to 6.30 mm using three EM sensors, and average errors from 1.57 to 2.64 mm and maximum errors from 2.79 to 6.27 mm using two EM sensors. The results showed that an accurate guidance with two and three EM sensors is possible and that two EM sensors are already sufficient. Thus, the introduced 3D guidance method is promising for navigation in EVAR procedures. Future work will focus on developing a method with less EM sensors and a detailed latency evaluation of the guidance method.

References

1. Jäckle S, García-Vázquez V, Eixmann T, et al. Three-dimensional guidance including shape sensing of a stentgraft system for endovascular aneurysm repair. Int J Comput Assist Radiol Surg. 2020;15(6):1033–1042.