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Fiber Optical Shape Sensing of Flexible Instruments

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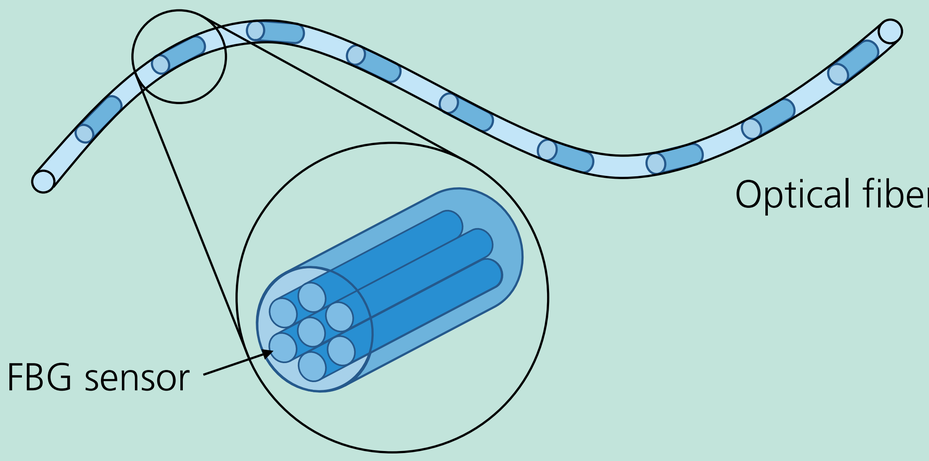
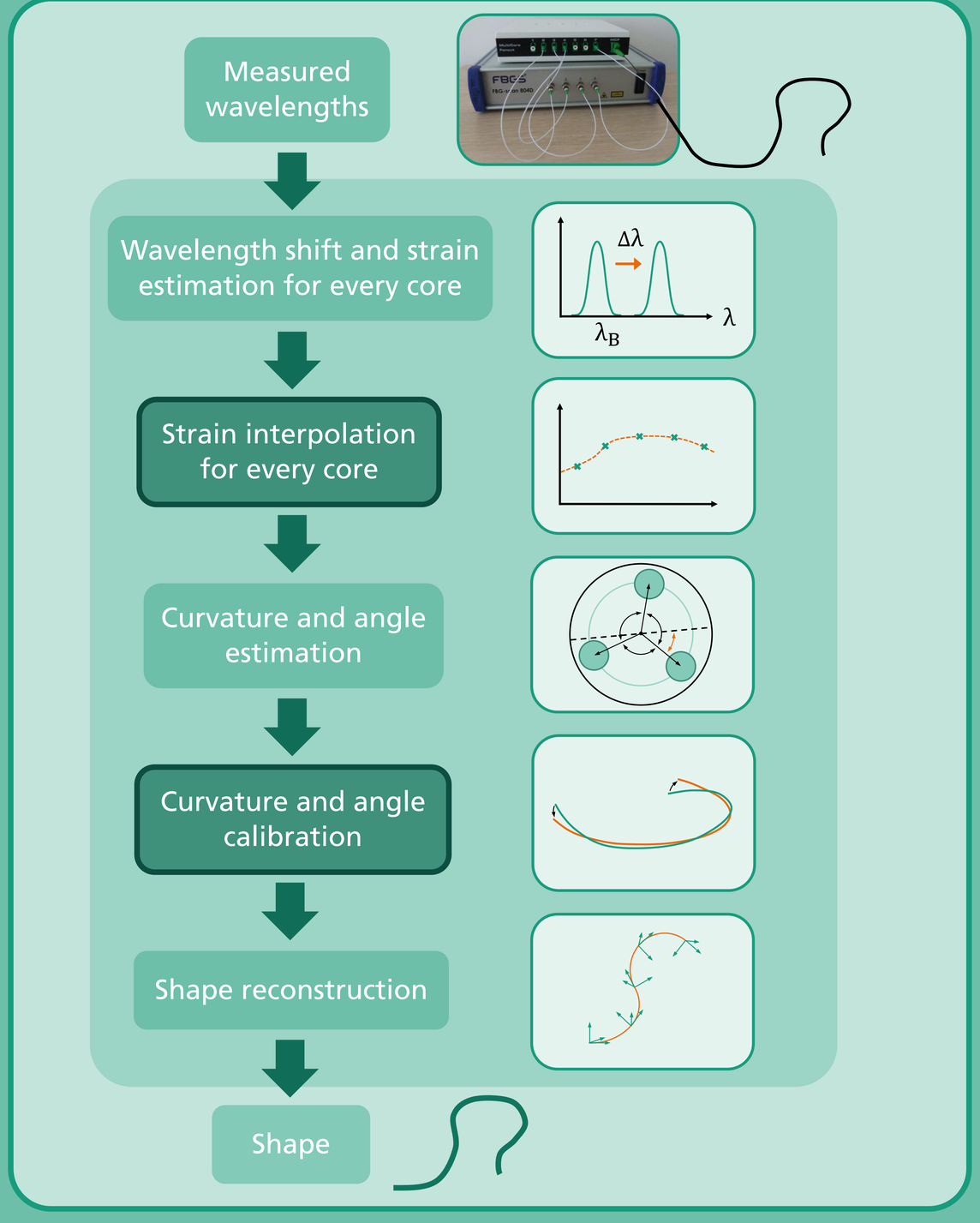
MOTIVATION



- Fiber Bragg gratings (FBGs): interference filters inscribed into the core of an optical fiber, which reflects a specific wavelength
- Multicore fiber: Optical fiber with multiple cores containing multiple FBGs at the same longitudinal position, which allows to estimate the shape of medical tools (e.g. needles, catheters)

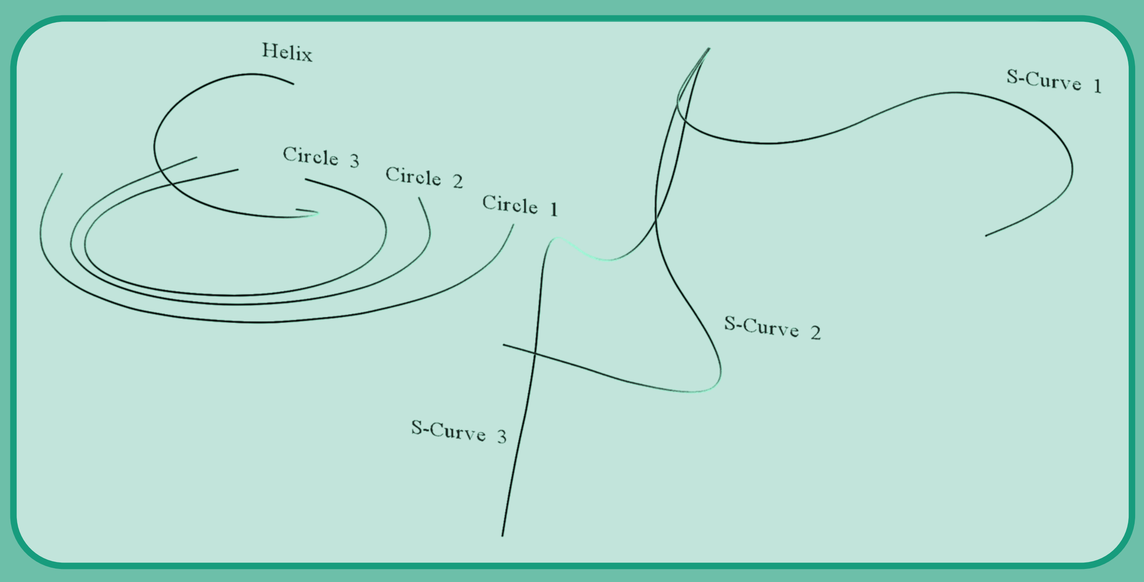
OUR OPTIMIZED SHAPE SENSING MODEL

- Shape sensing model [1,2] optimized for our multicore fiber (major improvements highlighted; for details see [3]):

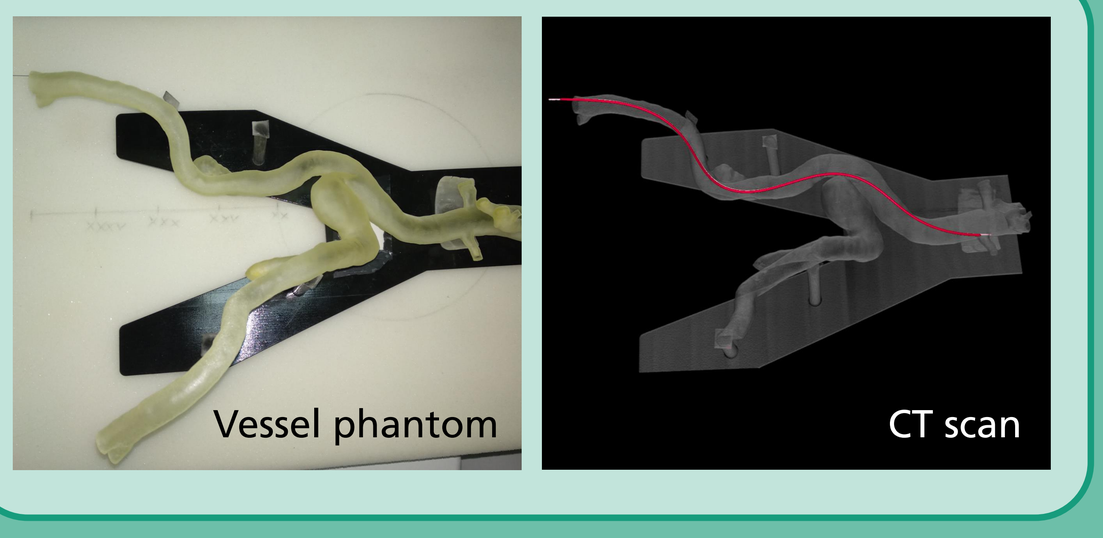


EXPERIMENTS

- 8 studies: 7 basic shapes + 1 vessel phantom
- Shape sensing length: 38 cm
- Ground truth: CT acquisition and 3D segmentation
- Basic shape studies:

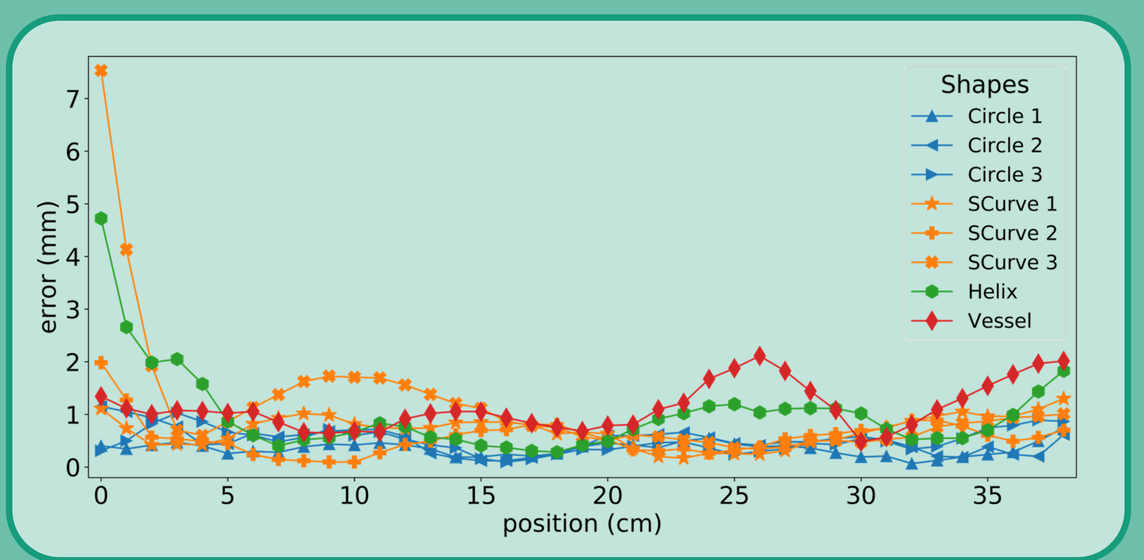


- Endovascular study: setup (left image) and the CT scan (right image) with the reconstructed shape (red)



RESULTS

- Accuracies (in mm) along the reconstructed shapes:



CONCLUSION

- First results on shape sensing of flexible shapes with 38 cm length using a multicore fiber with FBGs
- Promising accuracies:
  → Usage for endovascular navigation
- Future work:
  → Combination with EM tracking to enable a 3D catheter guidance

IJCARS Paper:

REFERENCES

[1] Roesthuis et al. Three-dimensional needle shape reconstruction using an array of fiber bragg grating sensors. IEEE ASME Trans Mechatron. 2014; 19(4):1115-1126.

[2] Khan et al. Multi-core optical fibers with Bragg gratings as shape sensor for flexible medical instruments. 2019; IEEE Sens J. 19(14):5878–5884.

[3] Jäckle et al., Fiber optical shape sensing of flexible instruments for endovascular navigation, IJCARS. 2019; 14(12): 2137–2145.

CONTACT

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