High-fidelity model of a Tendon-driven Eversion Growing (Vine) Robot Using SOFA-Framework

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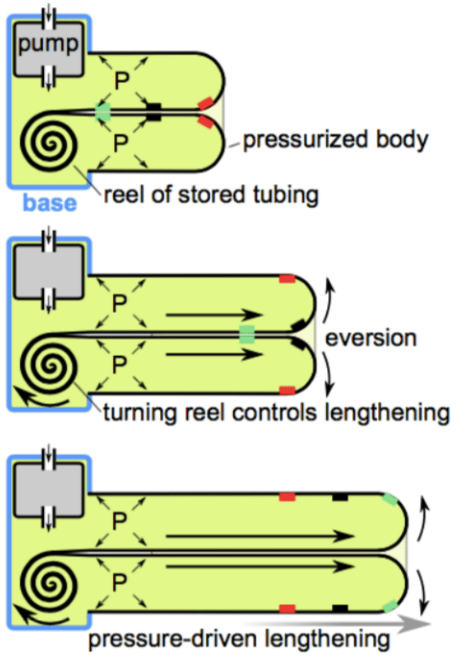
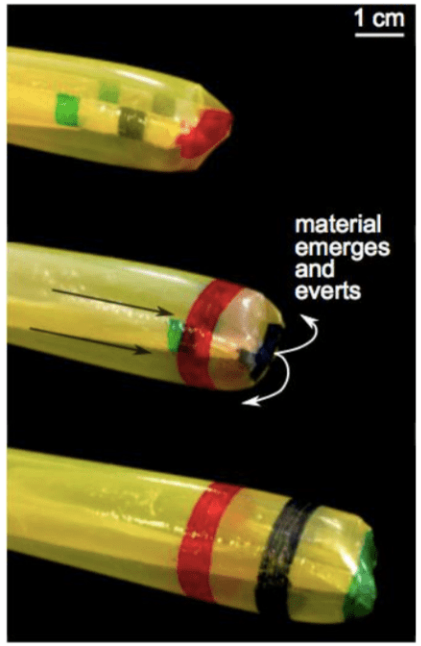
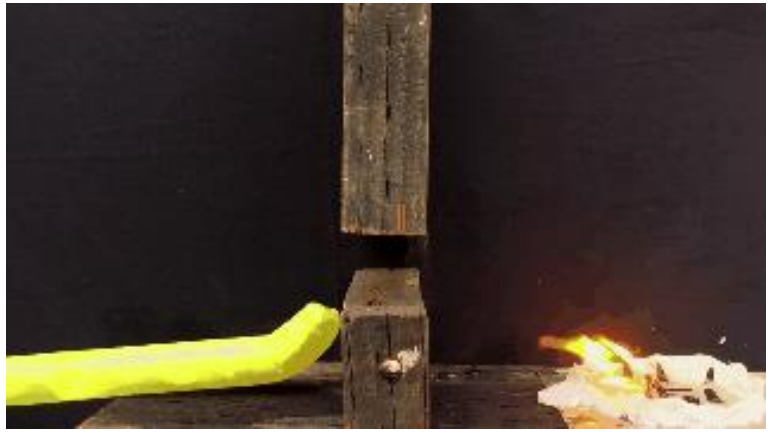
Eversion growing robots

- The main difference of eversion growing robots is that their growing is based on unfolding material at the tip of the robot
- This avoids the translational motion between robot body and the environment, very useful for confined narrow spaces
- For a more controllable navigation active steering is used, which changes the structural stiffness of the system in order to move in different directions.

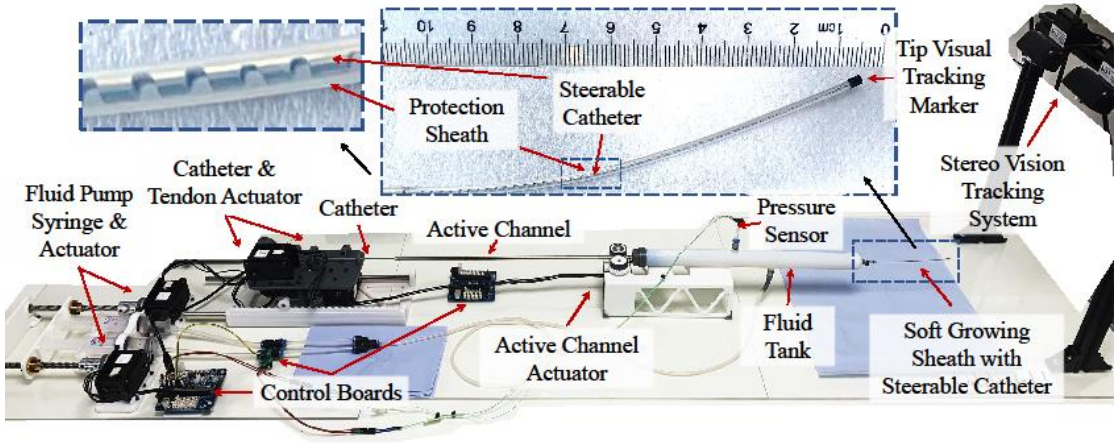




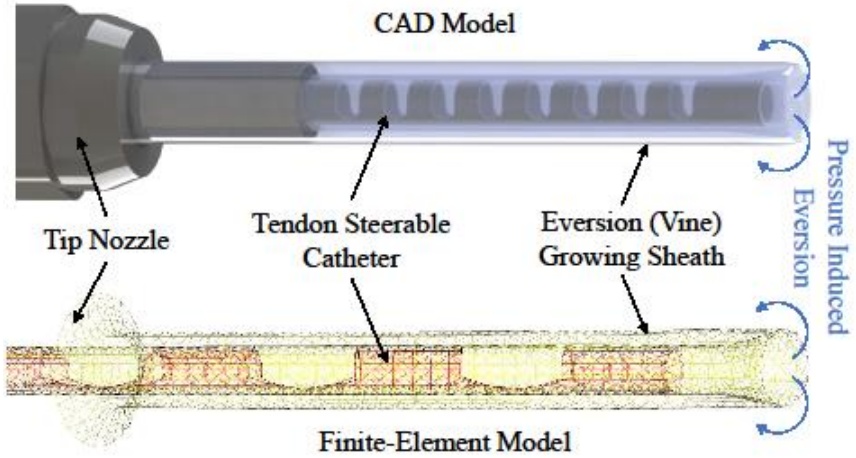


MaMMoBot real system vs high-fidelity model

Real setup



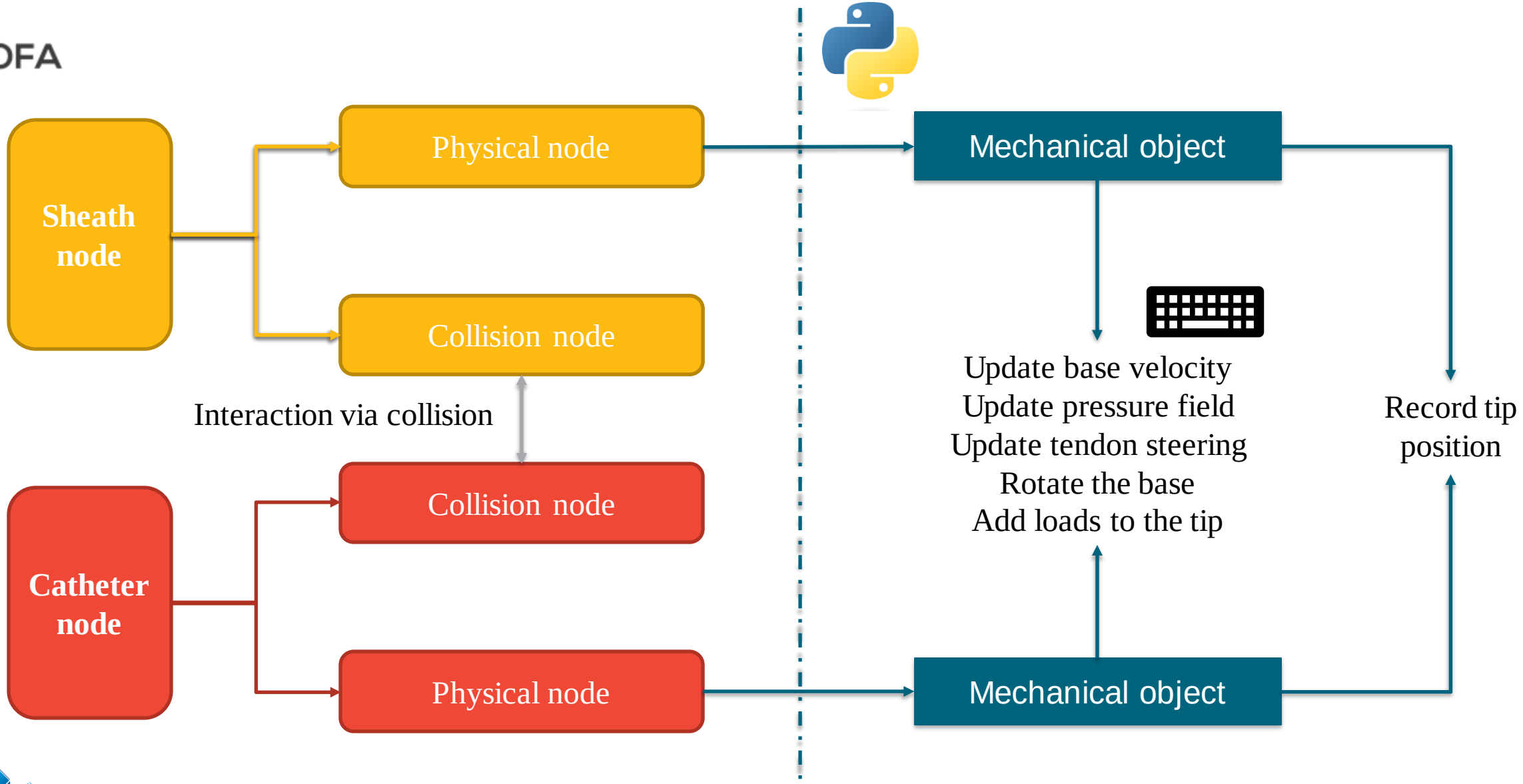
High-fidelity model



Our system is formed by two different components:

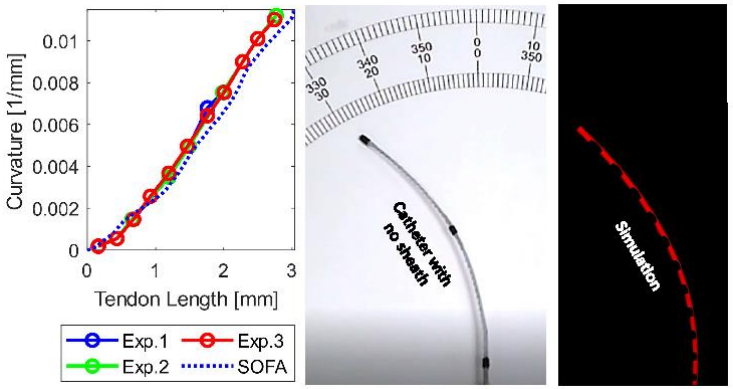
1. **Self-growing sheath:** A thin-walled structure with cone shape for an easier distribution of the pressure field during eversion growing
2. **Tendon-driven steerable catheter:** The tendon crosses the whole catheter structure under it and makes the catheter to actively steer.

Our implementation SOFAMaMMoBoT

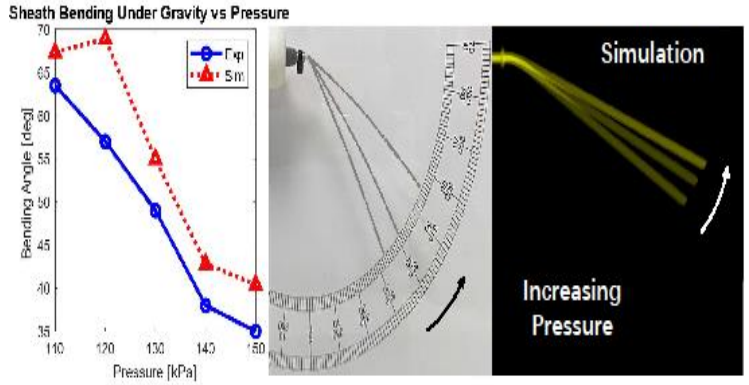


Model validation experiments

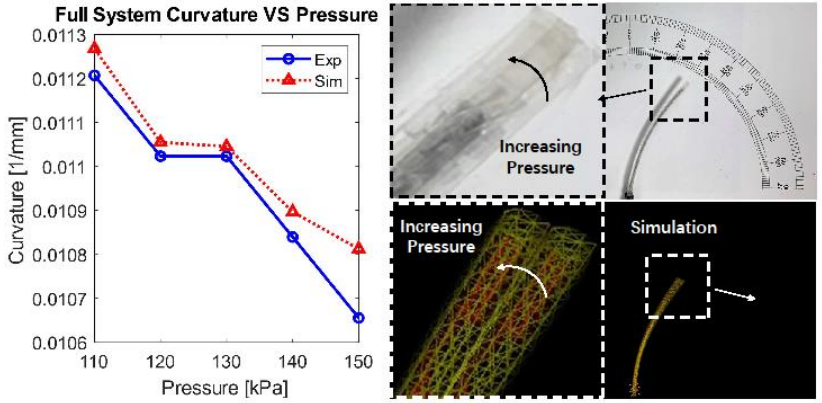
Tendon modelling for steerabe catheter



Sheath bending angle under gravity

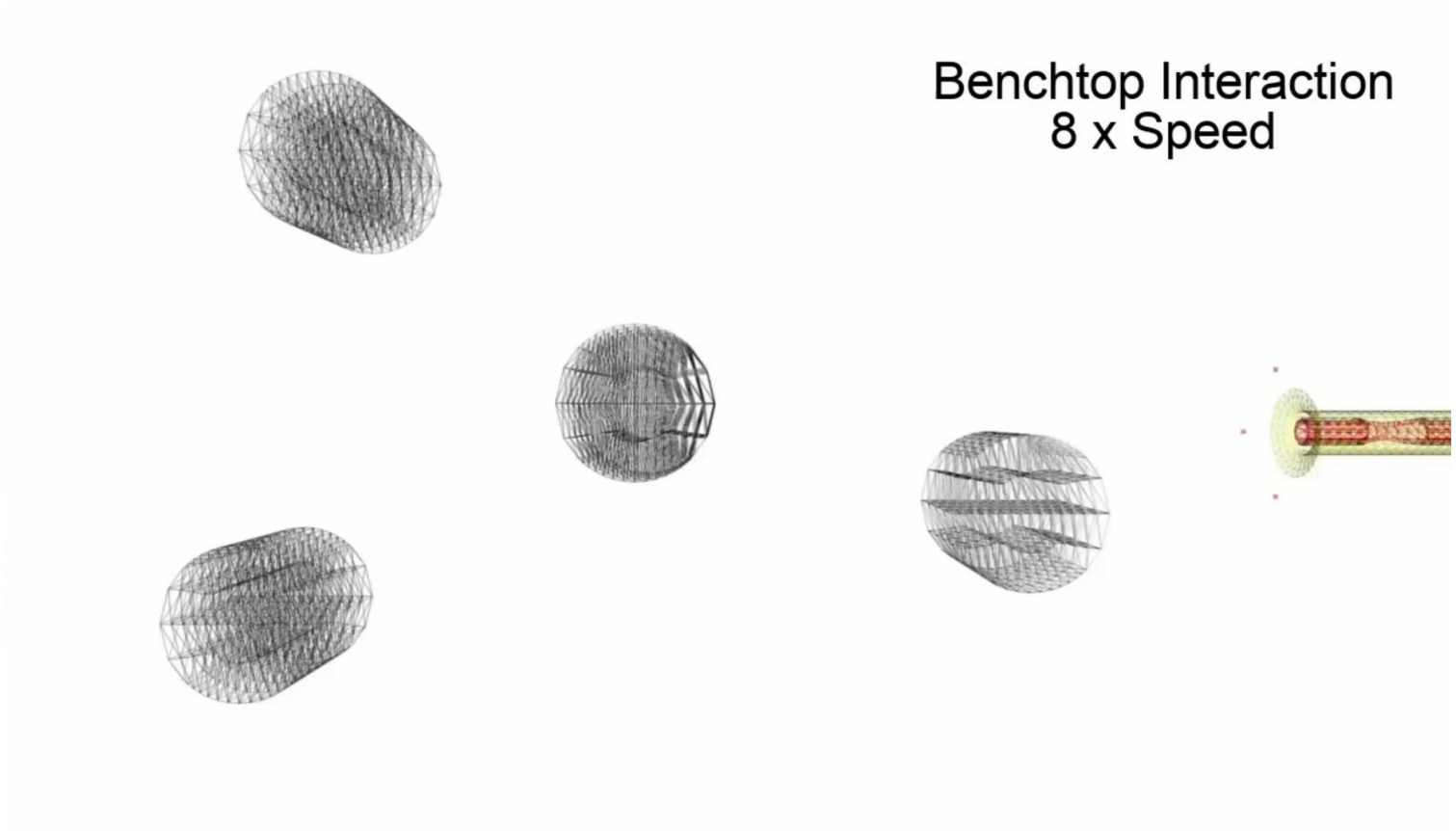


Full system under variable pressure

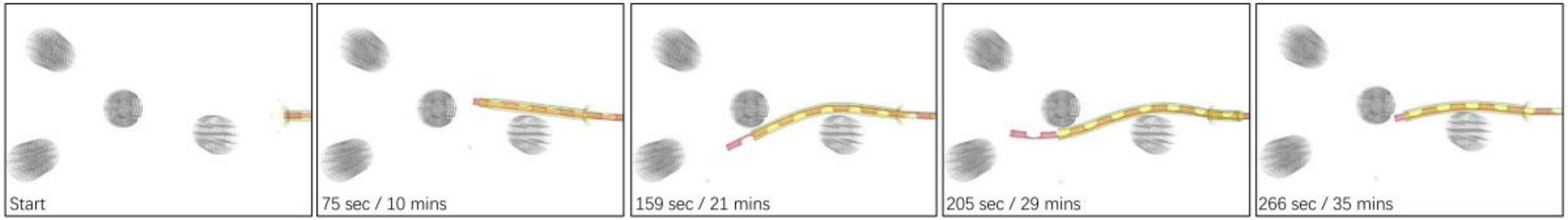


In order to reach these results, we finetuned the physical parameters (stiffness and damping) of the sheath and the catheter in the simulations based on different experimental runs and the real

Benchtop Interaction Simulation

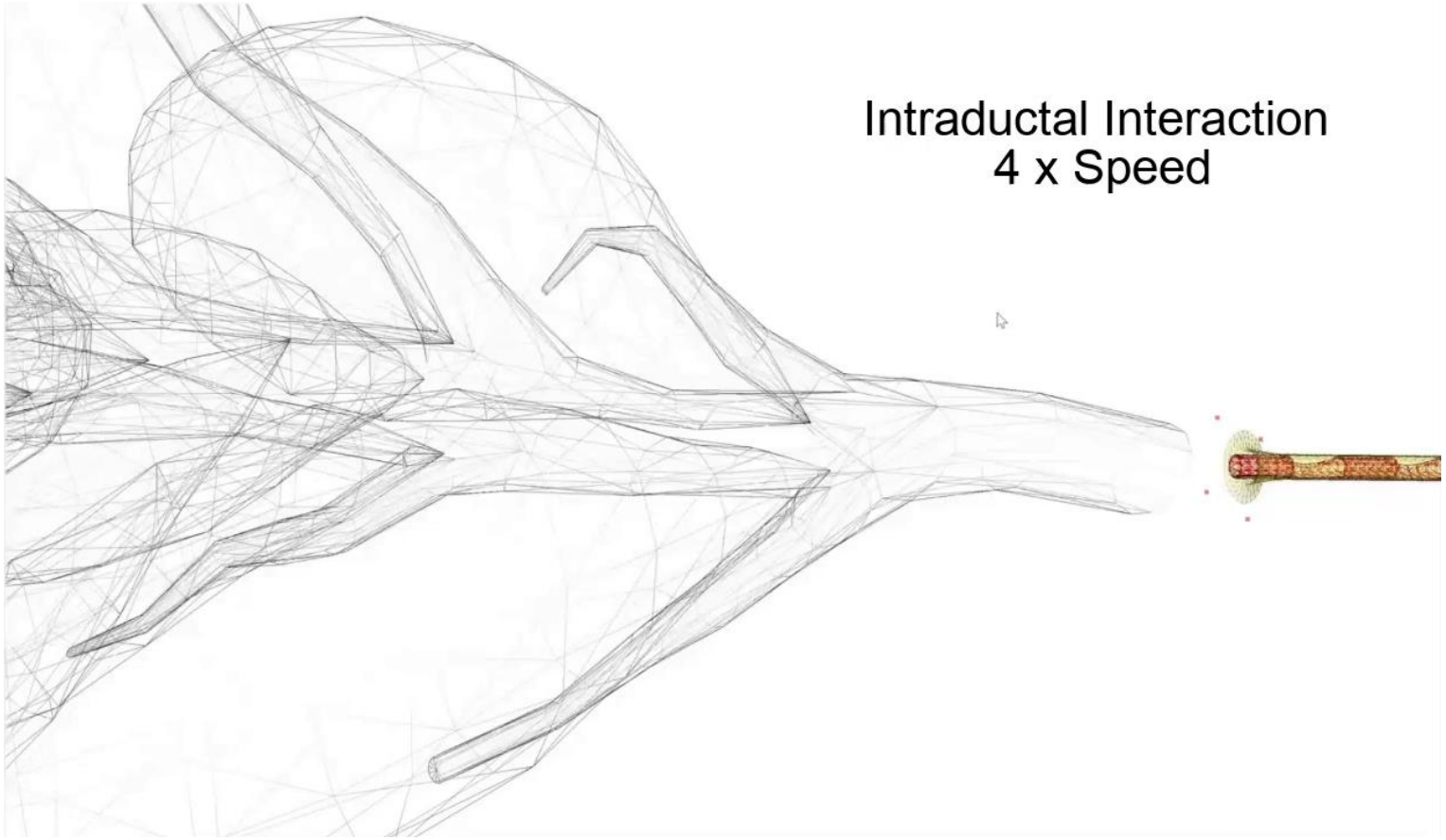


Benchtop Interaction Simulation

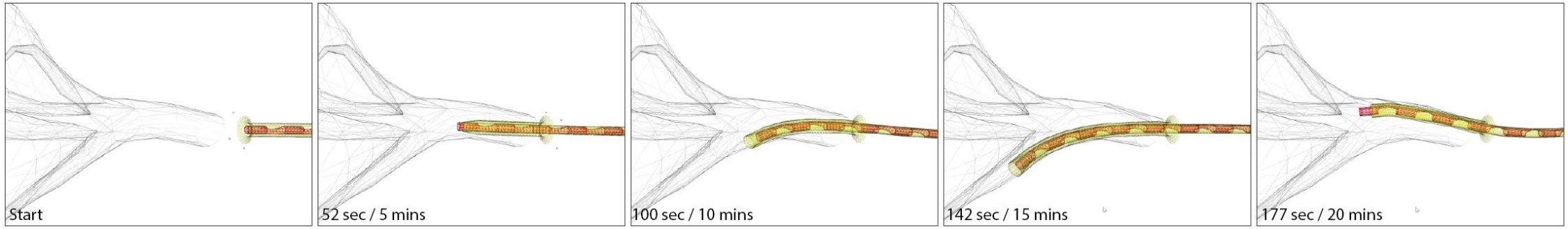


Deployment of the robot within simulated scene using rigid peg, referred as Fig. 12 top row

Intraductal Interaction Simulation



Intraductal Interaction Simulation



Deployment of the robot within simulated scene using duts phantom, referred as Fig. 12 bottom row

Conclusions & Future work

- In this work, we have developed to our knowledge the first high-fidelity model for our proof-of-concept model the MaMMoBot, however we believe it can address to model similar systems
- We have created a SofaPython3 package containing the necessary functions to add the system to your custom SOFA scenes
- The model demonstrate the effect of pressure on the curvature of the system and offers a reliable interaction with the environment
- However, the simulations take currently very long to run and intensive runs can cause the system to behave in unexpected ways
- For this reason, this model is not suitable for real-time application such as teleoperation or control