Applications of finite element methods in biomechanics

Krister Stræte Karlsen

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1 Stokes flow in zebrafish

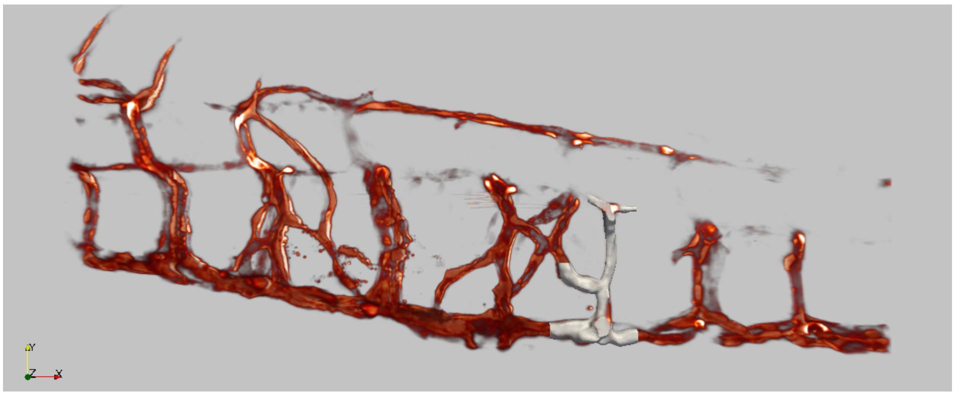

Figure 1: The circulatory system of a zebrafish where a small part is meshed.

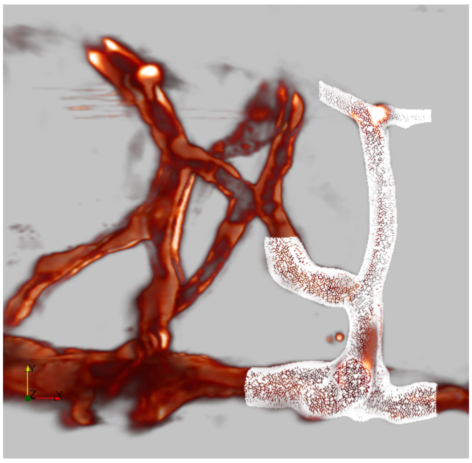

Figure 2: Zooming in to see the meshed region.

1.1 Mathematical formulation

2 Squeezing a postdoc's brain

We would very much like to squeeze postdoc Erika Lindström's brain. Since she has refused to let us do this with our hands in her office, we must do this on a computer using her brain as our computational domain. The brain will be deformed as a result of the squeezing and to capture this effect we will use a *linear elastic* model.

A mesh of Erika's brain can be found in the git repository: https://github.com/krikarls/fun-with-fem.

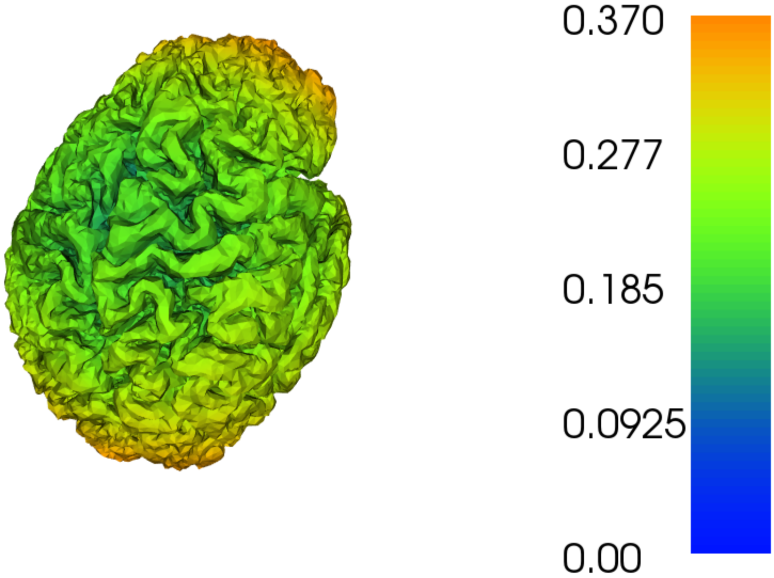

Figure 3: Numerical solution using FEniCS. Displacement measured in mm.

The brain is not clamped in the skull, but in a sence floating around. This means that we must employ *neumann booundary conditions* on the entire boundary. As we know, there are no unique solution to such a problem since all *rigid motions* satify the equation. So in order to obtain a unique solution we must remove all rigid motions. All the possible rigid motions in 3D are: translations in x, y, z-direction and rotations around the corresponding axes. Thus six in total.

An example using *FEniCS* on how to remove these can be found in the same repository as the brain.

2.1 Mathematical formulation