Fast Prototyping of Blood Flow with Matlab-MPI

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Abstract

We present in this paper an integrated approach to compute quickly an incompressible Navier Stokes (NS) flow in a section of a large blood vessel using medical imaging data. The goal is essentially to provide a first order approximation of some main quantities of interest in cardiovascular disease: the shear stress and the pressure on the wall. The NS solver relies on the L_2 penalty approach pioneered by Caltagirone and co-workers and combines nicely with a level set method based on the Mumford-Shah energy model. Simulations on Stenosis cases based on angiogram are run in parallel with MatlabMPI on a shared memory machine. While MatlabMPI communications are based on the load and save functions of Matlab and have high latency indeed, we show that our Aitken-Schwarz domain decomposition algorithm provides a good parallel efficiency and scalability of the NS code.

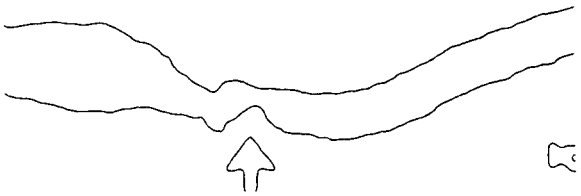

Figure 1: Image segmentation of a Stenose in a Carotide.

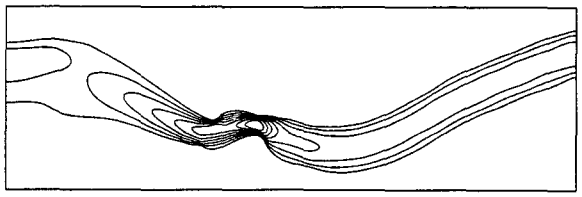

Figure 2: Flow amplitude for a stationary problem.