AN ITERATIVE DATA ASSIMILATION PROCEDURE FOR INCLUDING VELOCITY MEASUREMENTS INTO NAVIER-STOKES SIMULATIONS

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ABSTRACT

The development of numerical methods in incompressible fluid dynamics has recently received a strong impulse from cardiovascular applications; moreover, the integration of data and numerical simulations has always been an issue of outstanding relevance in the prediction of fluid-geophysics phenomena. Due to the improvement of measurement devices and to advanced techniques in biomedical imaging, we can now collect a huge amount of data for the cardiovascular system [3]. Beyond validation, we can use these noisy and sparse data to get an accurate approximation of the blood flow, getting rid of the noise. The combination of measurements and governing principles is known in literature as Data Assimilation (DA) [2].

In this work we introduce an iterative technique for including sparse and noisy velocity measurements into the simulation of the Navier-Stokes (NS) equations. We solve the problem with a Discretize then Optimize approach, where discretization is performed with the Finite Element method [1]. Starting from a method of misfit minimization between data and recovered velocity, designed for the Oseen problem, we show how to solve the NS system.

Numerical results on a 2D test case are presented; we are mainly interested in the behavior of the method in terms of computational error (with respect to an exact solution) and computational effort. Picard, Newton and mixed formulations are investigated in terms of computational time and number of iterations. Simulations are performed with both noisy and noise free data.

REFERENCES

[1] M.D. Gunzburger, Perspectives in Flow Control and Optimization, *Society for Industrial Mathematics* (2002).

[2] A.R. Robinson, P.F.J. Lermusiaux. Overview of data assimilation. *Technical Report* **62**, Harvard University, Cambridge, (2000).

[3] P. van der Velden, D. Sallee, E. Zaaijer, W.J. Parks, S. Ramamurthy, T.Q. Robbie, J. Huckaby, S. Chochua, M.E. Brummer, Systolic flow jet is an indicator of aortic root dilation for bicuspid aortic valves, *Poster* (2008).