Parallelize CU-BEN for Fluid-Structure Interaction Simulations

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Fluid-structure interaction (FSI) numerical method becomes more prominent nowadays due to its wide range applications in many engineering disciplines. FSI can be used to investigate how wind patterns affect airplane engine performance, how coastal waves affect both the structural and physical responses of ships, and how blood pressure deforms the wall of blood vessels. One of the most challenging parts in FSI computation is to ensure the stability of bi-directional coupling between the fluid and the structure domains.

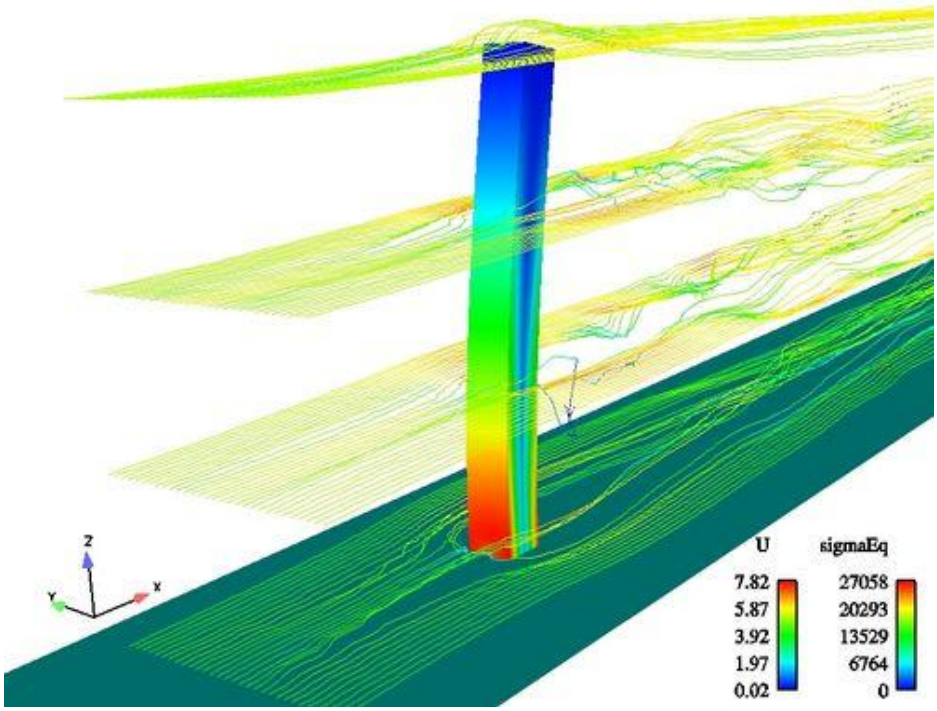

Figure 1. Streamlines pattern and equivalent Cauchy stress at the beam boundary

CU-BEN and OpenFOAM are the programs that are used for FSI simulations in my research group. CU-BEN is an in-house finite element solver in which has the capabilities to perform both linear and non-linear structures analysis using varies structural elements such as truss and shell. OpenFOAM is an open source computational fluid dynamic software package contains extensive range of features to solve complex fluid flows. However, CU-BEN is a serial code written in C whereas OpenFOAM is structured around parallel implementations. Although some efforts were put into parallelizing CU-BEN in the past, but no significant computation performance improvement has shown in the parallelized version of CU-BEN. For the final project, I am interested in further improving the performance of the parallelized version of CU-BEN via domain decomposition[1], OpenMP and other possible optimization methods.

[1] http://www1.mat.uniroma1.it/people/garroni/Quarteroni-Lecture-1-DDM.pdf