Project Proposal: HPC

Introduction

Stents are used inside the brain blood vessels to cure aneurysm, a neurological disorder which is caused by the dilation of the blood vessel, creating a sac/balloon in the brain. The blood flow can cause the aneurysm to rupture and cause stroke. Stent is a cylindrical mesh, which can be placed inside the blood vessel to divert the blood flow away from aneurysm and resume normal flow conditions inside the brain.

In my research I focus on modeling the stent placement in the blood vessel. For this I have a code which uses mathematical forces to expand the stent inside the vessel until the stent touches the vessel-wall. The vessel wall is modeled as a structure of small triangular mesh, and the stent is modeled as simplex mesh.

Code Details

The forces depend on the distance of every stent point from the vessel. Number of stent points in a stent are 64X48, 48 points in one circular cross-section. Now for every point, the most time consuming part in the code is to find the triangle in the vessel which is closest to the point and also the distance. This code is implemented in Matlab for now, and it takes around 5 minutes to complete one time step, total time steps required are somewhere in the range 15-20, making the code to run for more than an hour to get one final result.

Goals for Project

- Implement the code in Fortran (learned in the course)
- Implement an algorithm for efficient calculation of point-triangle distance (right now it is basic Euclidean distance formula, which consumes a lot of time)
- Parallelize the code, in both Matlab (Matlab Parallel Programming Workshop) and Fortran (using MPI) and compare the results
    - Fortran parallel vs Matlab parallel vs Matlab serial (existing code)
- Study and compare the performance of the codes across platform and decide on the best one to use in terms of performance time wise
- Use the most efficient code to run on a few real-time cases to check the validity of the codes

Future Use

The final result out of this project would be very useful to carry out a large study on real clinical patient data. Right now it is not possible to wait for an hour to find out the result for one patient. We currently have a very large patient data, and with current performance time, it is not feasible to use this tool. If the code can give better performance, it can be used for various clinical studies that can be designed on basis of the ease of use of this code on a large pool of patient data.