Supporting Information

Multiscale Mechano-biological Finite Element Modelling of Oncoplastic Breast Surgery – Numerical Study Towards Surgical Planning and Cosmetic Outcome Prediction

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Implementation of the Multiscale Mechano-biological FE Framework

The proposed multiscale mechano-biological Finite Element (FE) framework has been incorporated into the existing in-house numerical analysis framework FEB3 – pronounced Phoebe – which is freely available upon request from: https://bitbucket.org/vasvav/feb3-finite-element-bioengineering-in-3d/wiki/Home. The FE computational framework has been implemented in an object-oriented, scalable, C++ code that incorporates several open-source numerical libraries:

- *blitz++*\(^1\) is a meta-template library in C++ which was utilised in *FEB3* for tensor algebra and multi-dimensional tensor manipulation [1].
- *GNU Scientific Library* is an ANSI-C library that contains a wide range of mathematical routines (over 1000 in total) such as random number generators, special functions, statistics, numerical differentiation, data fitting, etc. (see online documentation: https://www.gnu.org/software/gsl/manual/html_node/) [2].
- *METIS*\(^2\) and *ParMETIS*\(^3\) is a pair of libraries containing established algorithms for partitioning graphs, partitioning finite element meshes and producing fill-reducing orderings for sparse matrices, in serial and in parallel computing respectively [3].
- *MPICH*\(^4\) is a standardized and portable message-passing system which is a communication protocol for programming parallel computers.
- *PETSc*\(^5\) is a suite of data structures and routines for the solution of scientific applications, and is been used within *FEB3* in solving linear and nonlinear systems [4, 5]. *PETSc* is also integrated with *MPICH* to facilitate parallel computations, while it communicates with *METIS* and *ParMETIS* for sparse system partitioning.
- *libMesh*\(^6\) [6] is the top-level library used by *FEB3*. *libMesh* is an object-oriented C++ framework for the numerical simulation of partial differential equations using arbitrary unstructured discretisations on serial and parallel platforms, while it integrates with high-performance computing libraries such as *PETSc*.

\(^1\)http://sourceforge.net/projects/blitz/
\(^2\)http://glaros.dtc.umn.edu/gkhome/metis/metis/overview
\(^3\)http://glaros.dtc.umn.edu/gkhome/metis/parmetis/overview
\(^4\)http://www.mpich.org
\(^5\)http://www.mcs.anl.gov/petsc/
\(^6\)http://libmesh.github.io/
References


