YALES2BIO

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Motivation

YALES2BIO aims at solving the equations of fluid dynamics in the context of biological flows. The main application is cardiovoscular flows, involving microscale (at the level of cells) and macro-scale applications (blood flow in the heart).

YALES2BIO was developed from 2010 to 2013 by S. Mendez and C. Chnafa and is maintained since 2012 by S. Mendez at I3M, together with the YALES2 developers at CORIA.

Solvers

YALES2BIO is based on YALES2. In addition to the solvers implemented in YALES2, YALES2BIO has several specific solvers.

- Red blood cell solver (RBC)
- Electrostatics solver (ESS)
- ALE solver, with specific routines for heart (ALE)

All the following features are inherited from the YALES2 kernel:

Models

- Turbulence (Large-Eddy Simulation)
 Constant Smagorinsky

 - Localized dynamic Smagorinsky WALE
 - ♦ SIGMA

Numerics

- Spatial: 2nd- and 4th-order finite-volume schemes • Temporal:
 - 4th-order explicit time integration (RK4 and TFV4A) of convective terms
 - explicit and implicit diffusion and source terms
- Stabilization: Cook & Cabot 4th-order artificial viscosity
- Linear solvers:
 - PCG BICGSTAB, BICGSTAB2, BICGSTAB(2)
 - Deflated PCG
 - Deflated BICGSTAB(2)
 - Residual recycling

Data Structures

- 1D, 2D, 3D unstructured solver
- Full dual decomposition based on METIS
- Data registration (int, real, char, node, elem, face, pair, scalar, vector, tensor)
- Optimized non-blocking MPI communications
- Parallel load balancing
- Automatic reconnection of periodic boundaries Automatic homogeneous mesh refinement
- IO formats: Gambit (Fluent), Ensight, prepartionned HDF5 (XDMF) with compression
- Cartesian mesh generator
- Partitioned mesh support for HDF5 independent of the number of processors
- Parallel interpolator for partitioned HDF5 meshes
- Automatic sponge layers
- · Built-in Gaussian filters of arbitrary size

Software engineering

- 185,000 lines of codeObject-oriented fortran with modules (f90)
- Version management with GIT
- Inline documentation in the source code (XML + Latex)
- GUI with client/server mode (wxwidgets, C++)
 Automatic validation tests (AQAT, AVVT)
 Automatic dependency of f90 modules in makefiles
- Keyword-based input file
- Easy profiling with timers

Gallerv

Some computation examples are given in the gallery (Simulation of a cardiac cycle).

Private wiki

To access the YALES2BIO private wiki, click on this link [1].