G3D::Flow

A Massively Parallel CFD Solver Framework

Niklas Andersson

Chalmers University of Technology Department of Applied Mechanics Division of Fluid Mechanics Gothenburg, Sweden



G3D::Flow in Short



- ♥ Written in C++ (~70000 lines of code)
- Based on datatypes and solvers available in the open-source library PETSc
 - Blas/LaPack
 - D MPI
 - distributed data types
 - Krylov solvers and preconditioners
 - parallel vector and matrix operations

G3D::Flow in Short

- VolSol++ is a CFD code written in C++ developed with the starting point in the G3D Fortran codes used at Chalmers
- VolSol++ was introduced at Volvo Aero 2007 as a candidate for the replacement of VolSol and was verified for compressor CFD 2012
- G3D++ (used at Chalmers) was forked from VolSol++ 2011 and these codes have developed independently since
- the G3D++ is now, five years later, significantly different from the VolSol++ code used at GKN
- The G3D::Flow code framework is intended to be a common code platform for Chalmers and GKN (and other organizations?)

G3D::Flow in Short

THIS IS GIT. IT TRACKS COLLABORATIVE WORK ON PROJECTS THROUGH A BEAUTIFUL DISTRIBUTED GRAPH THEORY TREE MODEL . COOL. HOU DO WE USE IT? NO IDEA, JUST MEMORIZE THESE SHELL COMMANDS AND TYPE THEM TO SYNC UP. IF YOU GET ERRORS, SAVE YOUR WORK ELSEWHERE, DELETE THE PROJECT, AND DOWNLOAD A FRESH COPY.

Version control using git
Revision and issue tracking github ()

Why Version Control?



- Recommended for all development (including your own small code snippets)
- Essential for collaborative development

Code Structure



Developing good code

- First rule: think before implementing
- Second rule: think again
- With version control it is easy and harmfull to implement changes and test - failures can easily be discarded

Version Control



- Synergies
- Knowledge transfer
- Natural way to achieve archiving and documentation

G3D::Flow@Github



General 3D Flow Solver (compressible & incompressible) https://nikander.github.io/g3dflow — Edit

🕞 371 comm	its 🖗 11 branches	○ 4 releases	1	5 contributors	
Branch: develop - N	w pull request	Create new file	Upload files Find f	ile Clone or download -	
> nikander committed on GitHub Merge pull request #90 from nikander/harmonic-balance					
in config	version tag updated			7 days ago	
🖿 data	README file added in data directory			11 months ago	
include	added status parameter "CheckedOut" and associated check function "Is			a day ago	
iii peri	reworked config scripts			11 months ago	
SIC SIC	added status parameter "CheckedOut" and associated check function "Is			a day ago	
.gitignore	added g3d_installer.log to .gitignore			22 days ago	
	updated headers 9 months			9 months ago	
README.md	Update README.md			22 days ago	

G3D::Flow@Github



Code Development Workflow

G3D::Flow git Code Repository



Niklas Andersson - Chalmers

Developer Team



Niklas Andersson	2011 -	Main developer and code owner
Markus Olander Burak	2016 -	Main developer
Elías Siggeirsson	2015 -	Turbomachinery - Large-scale simulations
Daniel Lindblad	2015 -	Aeroacoustics - Turbomachinery noise
Haukur Hafsteinsson	2015 - 2016	Aeroacoustics - Jet noise
Huadong Yao	2014 -	Incompressible flow - Turbulence modeling
Marcus Lejon	2013 -	Turbomachinery - Compressor design & optimisation
Ragnar Lárusson	2012 -	Nozzle flow - Flow instabilities







"Bespin. It's pretty far, but I think we can make it." – Han Solo



G3D::Flow 2.0

Centralized storage (updated flux molecules) Coefficients for calculation of face gradients (preferred direction) Acoustic analogies and buffer zones Spalart-Allmaras turbulence model (compressible) Silding-Grid interface Wall pressure force integration Wall-distance modified length scale threshold (for hybrid RANS/LES) Reworked CGNS export DDES model (k-epsilon) DDES model (k-omega SST) Upgrade from PETSc 3.5.X to PETSc 3.7.X Niklas Andersson Niklas Andersson Haukur Hafsteinsson/Niklas Andersson Elias Siggeirsson Daniel Lindblad Niklas Andersson Ragnar Lárusson Ragnar Lárusson Ragnar Lárusson Niklas Andersson Niklas Andersson

G3D::Flow 3.0

Incompressible solver Preferred direction scheme for convective fluxes Harmonic-balance solver DMD postprocessing General Grid Interface (GGI) DES model (Spalart-Allmaras) python-based optimization tool

Implicit compressible solver

Niklas Andersson Niklas Andersson Daniel Lindblad Markus Olander Burak Daniel Lindblad Elías Siggeirsson Marcus Lejon

Niklas Andersson

Collaboration With External Partners



Collaboration With External Partners



- The G3D::Flow solver framework is owned, developed and maintained by Chalmers
- User access is controlled by Chalmers

G3D::Flow Documentation



https://nikander.github.io/g3dflow

