
2D Navier Stokes Solver in Stream Function Vorticity Form Documentation

Release 2019

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Apr 09, 2019

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1.1 Link to Codebase:

[code on github](https://github.com/LukeMcCulloch/stream_function_vorticity_form_NSE)

1.2 Features

- Cartesian Vorticity form of the Equations
- Helmholtz Hodge Decomposition into a vorticity equation and a stream-function Poisson's equation.
- Approximate factorization with lagged variables for the vorticity equations
- Interior nodes discretized with central 2nd order accurate differences
- Tri-diagonal vorticity updates in x and y for fast sweeps.
- Boundary terms handled by augmented (1 sided FD)
- Gauss-Seidel iteration with successive over-relaxation for the Poisson Update of the scalar stream function.
- Fortran 90 implementation

1.3 Build

Build the executable:

- make currently requires gfortran
- assumes you have make tools.
- cd into the src directory for this project and run:

```
$ make
```

1.4 Run

Run the included fifi.dat inputs example with

```
$ ./test fifi.dat test1.out
```

- ./test runs the executable
- fifi.dat is the input file.
- See fifi.dat for details. Basic plate geometry,

mesh size, and Reynolds number are set. - Courant number can be set here, but the code encourages experimentation with step sizes at runtime. - Suggestions for best results are given based on experience. - Once the code is running, follow the prompts to select time step and SOR factor.

1.5 Results

- plotting of primitive variables u, v, stored in u.dat and v.dat
- plotting of stream functions stored in strm-func.dat
- plotting of vorticity stored in vorticity.dat
- requires Numpy and Matplotlib
- Run the python file to plot outputs:

```
$ python 2DCavityPlotTest.py
```

1.6 Notes

This version tested on:

- OSX
- Linux