Irregular Frequencies Assembly Deployment Guide

Revision History

Author	Revision Number	Date
TCSASSEMBLER	1.0	12/03/2015

Deployment Instructions

1. Organization of Submission

Nemoh/ Contains the modified source of Nemoh Fortran software
docs/ Contains this deployment guide
docs/Irregular Frequencies Assembly.pdf Contains the deployment guide for this assembly
NemohPython/ Contains the modified Nemoh python code
lib/ Contains the precompiled nemoh library for Windows 64 bits
Changelogs.txt The change logs

Base code can be downloaded from
http://apps.topcoder.com/forums/?module=Thread&threadID=849058&start=0

2. Application Setup

Linux

- GCC with GFortran >= 4.8

- BLAS
- LAPACK
- OpenMP provided by GCC
- HDF5 >=1.8.11 http://www.hdfgroup.org/HDF5/ Optionally provided by Anaconda
- HDFView http://www.hdfgroup.org/products/java/release/download.html
- Python 2.7 Optionally provided by Anaconda
- H5py >= 2.3.1 Optionally provided by Anaconda
- Numpy Optionally provided by Anaconda
- CMake >= 2.8 http://www.cmake.org/cmake/resources/software.html
- Anaconda (with Python 2.7) >= 2.1.0 http://continuum.io/downloads

Windows

- MinGW 4.8.1 http://sourceforge.net/projects/MinGWbuilds/files/host-windows/releases/4.8.1/
- BLAS http://icl.cs.utk.edu/lapack-for-windows/lapack/#libraries
- LAPACK http://icl.cs.utk.edu/lapack-for-windows/lapack/#libraries
- OpenMP provided by MinGW
- HDF5 >=1.8.11 http://www.hdfgroup.org/HDF5/ Optionally provided by Anaconda
- HDFView http://www.hdfgroup.org/products/java/release/download.html
- Python 2.7 Optionally provided by Anaconda
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- Numpy Optionally provided by Anaconda
- CMake >= 2.8 http://www.cmake.org/cmake/resources/software.html
- Anaconda (with Python 2.7) >= 2.1.0 http://continuum.io/downloads

MAC OS X

- Brew http://brew.sh/
- GCC >= 4.8 installed by brew
- XCode Command Line Tools installed by brew
- BLAS provided by XCode commands
- LAPACK Provided by XCode commands
- OpenMP provided by GCC
- HDF5 >=1.8.11 http://www.hdfgroup.org/HDF5/ Optionally provided by Anaconda
- HDFView http://www.hdfgroup.org/products/java/release/download.html
- Python 2.7 Optionally provided by Anaconda
- H5py >= 2.3.1 Optionally provided by Anaconda
- Numpy Optionally provided by Anaconda
- CMake >= 2.8 installed by brew
- Anaconda (with Python 2.7) >= 2.1.0 http://continuum.io/downloads

Variables

Let's call:
$NEMOH_FORTRAN the directory Nemoh/ in the root of the submission directory
$NEMOH_PYTHON the directory NemohPython/
$FORTRAN_BUILD the build directory for the FORTRAN version of Nemoh
$MINGW_ROOT the directory where MINGW will be installed

3. Configuration

The python code can be configured using the file **$NEMOH_PYTHON/nemoh/settings.py**
Newly added properties are in red

Property	Definition	Example
REMOVE_IRREGULAR_FREQUENCIES	Whether or not to remove the irregular frequencies	True
USE_DIPOLES_IMPLEMENTATION	Whether or not to use the dipoles implementation	True
THIN_PANELS	A list containing the index of the panel which are thin dipoles. The index should be 0-based. Set the list to [-1] to indicate that all panels are thin dipoles.	[1, 2]
USE_HIGHER_ORDER	Whether or not to use higher order panel method.	True
NUM_PANEL_HIGHER_ORDER	The number of panel per patch in the higher order method. Read section 4 and 7 before attempting to increase this	1

Property	Definition	Example
B_SPLINE_ORDER	The order of the B-Spline for the potential in the higher order panel method. Read section 4 and 7 before attempting to increase this	1
USE_ODE_INFLUENCE_COEFFICIENTS	Indicate whether or not to use the ode method to compute the influence coefficients	True
GREEN_TABULATION_NUMX	Number of points in x direction of tabulated data	500
GREEN_TABULATION_NUMZ	Number of points in z direction of tabulated data	60
GREEN_TABULATION_SIMPSON_NPOINTS	Number of sub intervals used to approximate the Green's function integral using simpson rule	551
HDF5_FILE	The path to the HDF5 file where to save and load the results and input. Required	'db.hdf5' No need to change
NEMOH_CALCULATIONS_FILE	The old nemoh calculation file. Not required but it is needed to automatically convert the old Nemoh.cal file to HDF5 storage	'Nemoh.cal' No need to change but then make sure you have the nemoh calculation file Nemoh.cal in your working directory. Also make sure the path to the mesh file references in Nemoh.cal exists. For example if in the Nemoh.cal file you have 'Cylinder.dat', then you should have the Cylinder.dat file in your current directory
NEMOH_INPUT_FILE	Same as above but applied to the nemoh input file	'input.txt' No need to change but then make sure you have the nemoh input file input.txt in your working directory
NEMOH_INT	Represents the integer type to use when performing computations. It should be a valid numpy integer type. See http://docs.scipy.org/doc/numpy/reference/arrays.scalars.html#arrays-scalars-built-in for possible values	'i'
NEMOH_FLOAT	Represents the float type to use	'f'

Property	Definition	Example
	when performing computations. It should be a valid numpy float type. See http://docs.scipy.org/doc/numpy/reference/arrays.scalars.html#arrays-scalars-built-in for possible values	
NEMOH_COMPLEX	Represents the complex type to use when performing computations. It should be a valid numpy complex type. See http://docs.scipy.org/doc/numpy/reference/arrays.scalars.html#arrays-scalars-built-in for possible values	'F'
MESH_TEC_FILE	The path to the file where to save the mesh tec file	No need to change. The default value is fine.
FK_FORCE_TEC_FILE	The path to the froudkrylov force data in tec format	No need to change. The default value is fine.
RADIATION_COEFFICIENTS_TEC_FILE	The path to the file where to save the added mass and damping forces for the radiation problems in tec format.	No need to change. The default value is fine.
DIFFRACTION_FORCE_TEC_FILE	The path to the file where to save the diffraction force for the diffraction problems in tec format.	No need to change. The default value is fine.
EXCITATION_FORCE_TEC_FILE	The path to the file where to save the excitation force for the diffraction problems in tec format.	No need to change. The default value is fine.
IRF_TEC_FILE	The path to the file where to save the IRF tec file	No need to change. The default value is fine.
WAVE_FIELD_TEC_FILE	The path to the file where to save the wave field tec file	No need to change. The default value is fine.

4. Implementation details

The references are listed in section 9.

The implementation used method II of reference R1 (section 5, page 29 of that reference).
The potential formulation with the extended integral equations is used as detailed in equations (5.33) and (5.34) of reference R1.

The implementation is mainly divided in two parts: The first part is solving the extended integral equations and it has be done in **"$NEMOH_FORTRAN/Solver/Core/SOLVE_BEM_IRREGULAR.f90"**. The main subroutine for the computation is **SOLVE_POTENTIAL_IRREGULAR**

The second part is the discretization of the interior of the free surface domain S_i.
As explained in R1, it can be done by doing a triangle mesh of the waterline plan.
This part has been mainly implemented in the preprocessor
"$NEMOH_PYTHON/nemoh/preprocessor.py"

Check the function **generate_mesh(raw_points)** which given a list of points for a body determine the waterline plan and then return the mesh of this plan using the Delanauy triangulation.

Appropriate changes to the code has been performed to take the new discretization into account especially in the **read_mesh(hdf5_data, custom_config)** function

5. Deployment Instructions

5.1. Generic Instructions

5.1.1. Install a Fortran and C/C++ compiler which support OpenMP (Currently gcc and ifort are supported)
5.1.2. Install Python 2.7
5.1.3. Install pip
5.1.4. Install CMake version greater or equal to 2.8
5.1.5. Install BLAS and LAPACK and make sure there are in the library search paths
5.1.6. Install HDF5 libraries version greater or equal to 1.8.11 and make sure they are in the library search path

5.1.7. Compile the Fortran version of Nemoh Solver:
5.1.7.1. Create a build directory $FORTRAN_BUILD different from $NEMOH_FORTRAN
5.1.7.2. Go to $FORTRAN_BUILD folder.
5.1.7.3. Delete the file CMakeCache.txt and the directory CMakeFiles if it exists
5.1.7.4. Run the command cmake $NEMOH_FORTRAN
5.1.7.5. Run make. The Nemoh library will be created

5.1.8. Compile the Nemoh python against the Nemoh Fortran
5.1.8.1. Go to $NEMOH_PYTHON
5.1.8.2. Install the python module prerequisites pip install -r requirements.txt
5.1.8.3. Make sure the $FORTRAN_BUILD is in the library search paths for compilation and for linking
5.1.8.4. Run python setup.py build_ext --inplace

5.2. Linux Instructions with Ubuntu commands

(If you are not using Ubuntu, you should be able to use your distribution package manager to install equivalent commands)

5.2.1. Install GFortran and gcc by running: sudo apt-get install build-essential gfortran gcc

5.2.2. Install CMake by running sudo apt-get install cmake

5.2.3. Install BLAS and LAPACK and make sure there are in the library search paths by running sudo apt-get install liblapack-dev libblas-dev

5.2.4. Install python 2.7, HDF5 libraries, and the nemoh python module requirements. To do so, we just need to install Anaconda:

5.2.4.1. Download Anaconda >= 2.1.0 from http://continuum.io/downloads .
For linux 64 bits the direct link is (with no space) http://09c8d0b2229f813c1b93-c95ac804525aac4b6dba79b00b39d1d3.r79.cf1.rackcdn.com/Anaconda-2.1.0-Linux-x86_64.sh

5.2.4.2. Install Anaconda by running bash Anaconda-2.1.0-Linux-x86_64.sh

5.2.4.3. When prompted, accept to add it's path to your ~/.bashrc.

5.2.4.4. Make sure the python version you are using is the one from Anaconda by logout then login or by running source ~/.bashrc

5.2.4.5. If successful, when you run python --version you should see something like **Python 2.7.8 :: Anaconda 2.1.0 (64-bit)**

5.2.5. Compile the Nemoh Fortran

5.2.5.1. Create a build directory $FORTRAN_BUILD different from $NEMOH_FORTRAN

5.2.5.2. Go to $FORTRAN_BUILD folder by running cd $FORTRAN_BUILD .

5.2.5.3. Delete the file CMakeCache.txt and the directory CMakeFiles if it exists by running rm -rf CMakeCache.txt CMakeFiles/

5.2.5.4. Run cmake -DCMAKE_Fortran_COMPILER="gfortran" $NEMOH_FORTRAN to generate the Makefiles

5.2.5.5. Run make to build the library

5.2.5.6. The library libnemoh.so will be created

5.2.6. Compile the nemoh python against the nemoh Fortran

5.2.6.1. Go to $NEMOH_PYTHON/nemoh

5.2.6.2. Make sure the $FORTRAN_BUILD is in the library search paths for compilation and for linking by running:
export LD_LIBRARY_PATH=$FORTRAN_BUILD
export LDFLAGS="-L$FORTRAN_BUILD"

5.2.6.3. Run python setup.py build_ext --inplace to build the python module in place

5.3. Windows Instructions

5.3.1. *Install MinGW 4.8.1*

5.3.1.1. You should install posix threads MinGW from
http://sourceforge.net/projects/MinGWbuilds/files/host-windows/releases

The 64 bits version is located at
http://sourceforge.net/projects/MinGWbuilds/files/host-windows/releases/4.8.1/64-bit/threads-posix/sjlj/x64-4.8.1-release-posix-sjlj-rev5.7z/download

The 32 bits version is located at
http://sourceforge.net/projects/MinGWbuilds/files/host-windows/releases/4.8.1/32-bit/threads-posix/sjlj/x32-4.8.1-release-posix-sjlj-rev5.7z/download

5.3.1.2. Download the binaries for your platform and extract it somewhere. By default the 64 bits get extracted in a directory named "MinGW64". Let's call this directory **$MINGW_ROOT**

5.3.1.3. Now add the full path to the folder **$MINGW_ROOT\bin** and **$MINGW_ROOT\lib** to your Path. Make sure those directories are at the leftmost (the beginning) of the Path. See **Setting Path on Windows** sub section for more information

5.3.2. Install CMake 2.8

5.3.2.1. Download and install CMake from http://www.cmake.org/files/v2.8/cmake-2.8.12.2-win32-x86.exe

5.3.2.2. Choose to add CMake to the path for all users. By default CMake doesn't put the path at the beginning.
So, you need to make sure the CMake path is at the beginning of your path. It is by default " C:\Program Files (x86)\CMake 2.8\bin". See **Setting Path on Windows** sub section for more information

5.3.3. Install LAPACK and BLAS

Download and install LAPACK and BLAS from http://icl.cs.utk.edu/lapack-for-windows/lapack/#libraries Choose the dll libraries for MinGW

The 64 bits BLAS is http://icl.cs.utk.edu/lapack-for-windows/libraries/VisualStudio/3.5.0/Dynamic-MINGW/Win64/libblas.dll
And the 64 bits LAPACK is
http://icl.cs.utk.edu/lapack-for-windows/libraries/VisualStudio/3.5.0/Dynamic-MINGW/Win64/liblapack.dll

5.3.3.1. Copy them to **$MINGW_ROOT\lib** (the lib directory inside MinGW installation root)

5.3.4. Install Anaconda >= 2.1.0

5.3.4.1. Download and install Anaconda Windows version greater than or equal to 2.1.0 from http://continuum.io/downloads . *The 64 bits Windows version is located at* http://09c8d0b2229f813c1b93-c95ac804525aac4b6dba79b00b39d1d3.r79.cf1.rackcdn.com/Anaconda-2.1.0-Windows-x86_64.exe

5.3.4.2. When installing accept adding anaconda to the path and using it's python version as the default python.
By default Anaconda would not put it's path to the beginning of the Windows Path.

You need to move the anaconda paths to the beginning of the Path list.
See **Setting Path on Windows** sub section for more information

For me the paths were C:\Users\yedtoss\Anaconda (the most important) and C:\Users\yedtoss\Anaconda\Scripts. You should replace C:\Users\yedtoss\Anaconda by the location where you install Anaconda

5.3.5. *Compile the Nemoh Fortran*

5.3.5.1. Start Powershell (Or windows cmd if you prefer it)
Make sure that all paths were correctly set. If not then you should close Powershell/Cmd, set the path and reopen it. Basically run python --version, cmake --version, gfortran --version and verify that they come from the one you just installed

5.3.5.2. Create a build directory $FORTRAN_BUILD different from $NEMOH_FORTRAN

5.3.5.3. Go to $FORTRAN_BUILD folder.
5.3.5.4. Delete the file CMakeCache.txt and the directory CMakeFiles if it exists *or better make sure* $FORTRAN_BUILD is empty
5.3.5.5. Run *cmake -DCMAKE_Fortran_COMPILER="gfortran" "*$NEMOH_FORTRAN**"** -G "MinGW Makefiles"

Please note the "" surrounding $NEMOH_FORTRAN. You need it even if the directory does not contain space. Make sure **"**$NEMOH_FORTRAN" is a full path to avoid any CMake bug

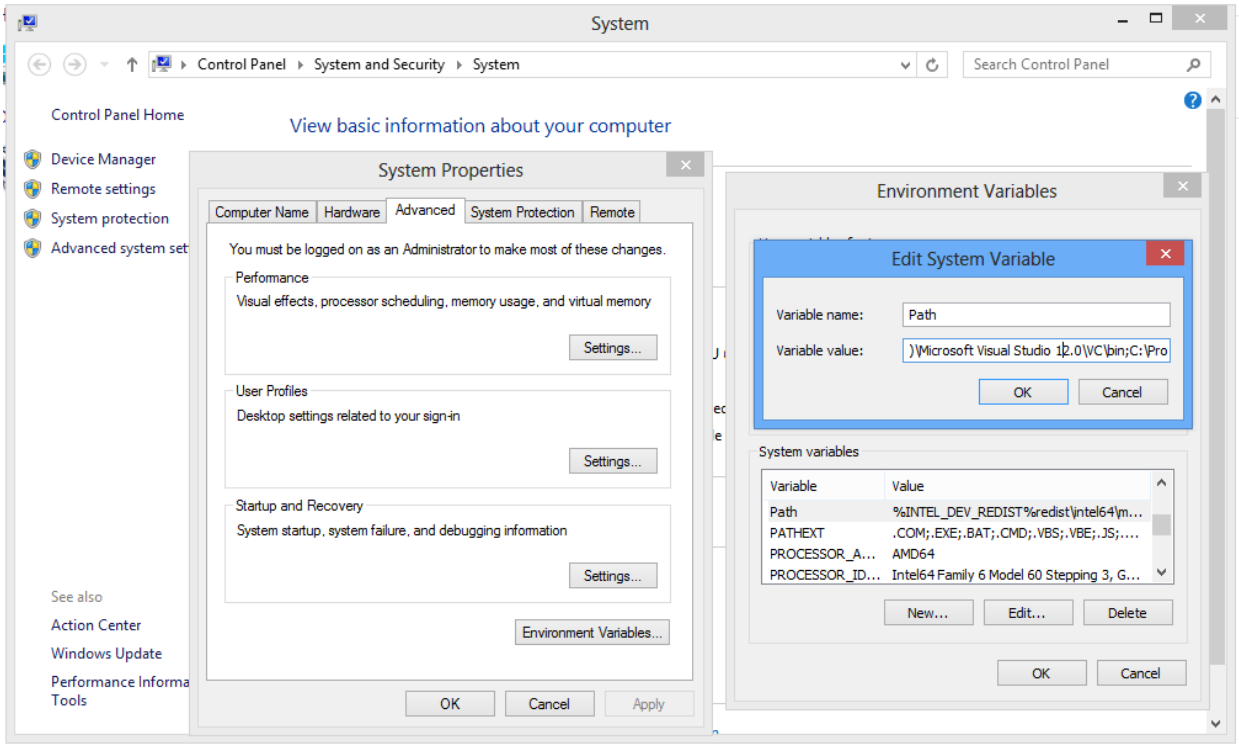
5.3.5.6. Run mingw32-make and you will get libnemoh.dll and libnemoh.dll.a
5.3.5.7. Copy both generated files to **$MINGW_ROOT\lib**

5.3.6. Compile the nemoh python against the nemoh Fortran
5.3.6.1. Go to $NEMOH_PYTHON\nemoh
5.3.6.2. Run python setup.py build_ext --inplace

5.3.7. **Setting Path on Windows**

You need to go to Computer → Right click and choose Properties → Advanced System Settings → Advanced Tabs → Environment Variables → Look for path.

A screenshot



Note that when setting the path, you need to separate the different directories by **;** Also make

sure your new directory is not at the end of the list but at the beginning because Windows reads the environment variables from left to right.

5.4. MAC OS X Instructions

We will use homebrew to install most software

5.4.1. Install brew: ruby -e "$(curl -fsSL https://raw.githubusercontent.com/Homebrew/install/master/install)"
(If you did not have XCode Command Line Tools, it will request it, install it and when done press enter on the terminal)

5.4.2. Run brew doctor

5.4.3. Install GCC and GFortran brew install gcc You can ignore any warning about multilib. It won't affect us

5.4.4. Install CMake brew install cmake

5.4.5. Download and Install anaconda from http://continuum.io/downloads
You can get the 64 bits version from http://09c8d0b2229f813c1b93-c95ac804525aac4b6dba79b00b39d1d3.r79.cf1.rackcdn.com/Anaconda-2.1.0-MacOSX-x86_64.pkg
We will export anaconda bin to the Path before compiling and using the nemoh python module

5.4.6. *Compile the Nemoh Fortran*

5.4.6.1. Create a build directory $FORTRAN_BUILD different from $NEMOH_FORTRAN

5.4.6.2. Go to $FORTRAN_BUILD folder cd $FORTRAN_BUILD .

5.4.6.3. Delete the file CMakeCache.txt and the directory CMakeFiles if it exists *rm -rf CMakeCache.txt CMakeFiles/*

5.4.6.4. *Run cmake -DCMAKE_Fortran_COMPILER="gfortran"* $NEMOH_FORTRAN

5.4.6.5. *Generate nemoh Fortran library by running make*
The library libnemoh.dylib will be created
(If you get a warning about CMake policy ignore it)

5.4.6.6. Copy libnemoh.dylib from **$FORTRAN_BUILD** to the lib/ directory inside the Anaconda installation root:
cp $FORTRAN_BUILD/libnemoh.dylib /Users/tcs/anaconda/lib
(Replace "tcs" with your own user name.)

5.4.7. Compile the nemoh python against the nemoh Fortran

5.4.7.1. Go to $NEMOH_PYTHON/nemoh

5.4.7.2. Make sure you are using python from Anaconda
By running export PATH=/Users/tcs/anaconda/bin:$PATH
Replace /Users/tcs/anaconda/bin according to the location where anaconda was installed

5.4.7.3. Make sure the $FORTRAN_BUILD is in the library search paths for compilation and for linking by running
export LD_LIBRARY_PATH=$FORTRAN_BUILD
export LDFLAGS="-L$FORTRAN_BUILD*"*

5.4.7.4. Run python setup.py build_ext --inplace

Note that in the above process we did not explicitly install LAPACK or BLAS libraries. This is because it is implicitly installed with brew (XCode Command Line Tools). If for some reason you receive an error when linking against LAPACK or BLAS you can install a custom version by running brew install https://raw.githubusercontent.com/Homebrew/homebrew-dupes/master/lapack.rb

Also note that the Intel Fortran Compiler (ifort) is fully supported on all three platforms. It comes bundled with LAPACK and BLAS so if you choose it, you won't need them.

Installing VMTK (Optional, you can skip)

VMTK is used by $NEMOH_PYTHON/nemoh/export_tec.py to export the generated .tec files to other formats. To install it for Mac, Windows or Linux follow instructions at
http://www.vmtk.org/documentation/installation.html
Note that unless you are using the .egg for Anaconda (Windows only), you should not use it with the python from Anaconda. More specifically, on Linux and Mac you have to use it with the built-in python when installing or using it.

6. Starting

You need to setup all environment variables as described in the deployment instructions.
You should also configure the application as described in the configuration section
Enter the directory $NEMOH_PYTHON/nemoh/
Run *python preprocessor.py* to run the preprocessor
Then run the solver with *python solver.py*
Finally run the post processor with *python postprocessor.py*

7. Verification

Setup your environment using the deployment instructions.
Then run the tools by following the Starting section

By default, the cylinder example has been configured. You can run other example by modifying the configuration. You can find additional cases files in $NEMOH_FORTRAN/Verification folder
The HDF5 file db.hdf5 will be generated.

You can visualize it with HDFView from http://www.hdfgroup.org/products/java/release/download.html
It has a version for Windows, Mac and Linux

For example, to install the Ubuntu 64 bits:

- Download http://www.hdfgroup.org/ftp/HDF5/hdf-java/current/bin/HDFView-2.10.1-centos5-static64.tar.gz
- Extract it to /tmp so that you have /tmp/HDFView-2.10.1-Linux, then locate the file hdfview.sh inside it. It should be located at /tmp/HDFView-2.10.1-Linux/HDF_Group/HDFView/2.10.1/bin/hdfview.sh
- Open the file hdfview.sh and set INSTALLDIR to ■■
- Enter the bin directory (/tmp/HDFView-2.10.1-Linux/HDF_Group/HDFView/2.10.1/bin)

- Make sure you have java from Sun, JRE is enough. You can use JRE 6 or JRE 7
- Run bash hdfview.sh

Then open the HDF5 file (Click File → Open)

Enter the directory $NEMOH_PYTHON/nemoh/
Run *python preprocessor.py* to run the preprocessor
Then run the solver with *python solver.py*
Finally run the post processor with *python postprocessor.py*

Ignore the warning of the type "Warning: normal vector of panel 14 points towards the x axis". It is caused by the input mesh used.
The default example for test is $NEMOH_PYTHON/test_files/remove_irregular_frequencies

To run the irregular frequency removal, set REMOVE_IRREGULAR_FREQUENCIES settings to True (the default)
The lower order results are located in *$NEMOH_PYTHON/test_files/ remove_irregular_frequencies /db_old.hdf5*
and the dipoles implementation results in $NEMOH_PYTHON/test_files/ *remove_irregular_frequencies*/db.hdf5

ACCURACY VERIFICATION

Open the file $NEMOH_PYTHON/test_files/ remove_irregular_frequencies/db.hdf5

And observe the dataset results/potential. You will notice that it has a shape of 7x4668

Now Open $NEMOH_PYTHON/test_files/ remove_irregular_frequencies/db_old.hdf5
And observe the dataset results/potential. It should have a shape of 7x4275

The additional potential are due to the discretization of the interior of the free surface in order to remove the irregular frequencies

8. Limitations of the current irregular frequencies removal

- The current implementation does not compute the Kochin function and thus does not compute the drift forces, yaw moment and wave elevation (in postprocessing module). The Kochin function is not computed because the previous method to compute it uses the source strength which is not available in the implementation of the dipoles implementation. Other technique to compute the Kochin function should be performed.

- The irregular frequency removal implementation does not support the technique for symmetry in the body. You should describe the whole geometry of the body to use it. It should be possible to extend the dipoles implementation to support fast computation when there is symmetry.
  To run your problem containing a symmetry in the mesh, disable the symmetry switch by setting the second number in the mesh file to 0 before running the preprocessor. Alternatively you can also set the second number in input/bodies/body1/mesh of the input HDF5 file to 0. You should do this for all bodies of your problem.
  An error message will be given and program will stop if one attempts to use the new method with symmetry.

- The current implementation does not support computing the Green's function using an ODE as supported in the lower order panel method. If such an attempt is made, a warning will be shown and the method to compute the Green's function will fall back to the default (tabulation, series approximation and interpolation).

9. References

R1. **Irregular frequency removal from the boundary integral equation for the wave-body problem** http://dspace.mit.edu/bitstream/handle/1721.1/11691/32279180.pdf?sequence=1

10. Resource Contact List

Name	Resource Email
TCSASSEMBLER	Contact me through Topcoder