Address Information.
123 Main St. ☎ (777) 777-7777
City, State (777) 777-7777
ZIP tex.stackexchange.com

TEST REPORT

Prepared for:	–prepared–	Project Number:	–project-number–
PO Reference:	–PO–	Test Report Number:	–test-report-number–

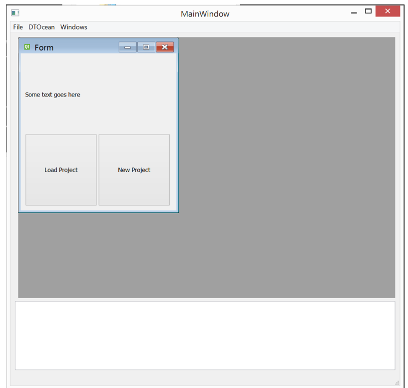

Figure 1: caption

0.1 Objective

The objective of the following notes is to give the user a quick-start documentation on the usage of the DTOcean-WEC module.

0.2 Launch the GUI

The GUI is written in python 2.7, with the list of dependency given in the appendix.

At the actuals tage of development the GUI can be launched from a command windows, by typing:

$>> cd \quad to-the-GUI-folder$

$>> python \quad main.py$

The start-up window is given in Fig. 1. Two option are available:

- New Project
- Load Project

Once the option is selected/clicked the start-up window will close and open the relative module.

Chapter 1

Create New Project

The create new project panel is divided in two areas, In the top part, highlighted in green, the user is asked to browse for an empty project folder. If the project folder is not empty, the user is asked to select another folder or clear the actual folder. In the last case, all the data contained will be deleted.

In the lower part, highlighted in blue, the user is asked to select which type of project he/she wants to open. Four different types of project are possible:

1. Load WEC database case-study
2. Run Nemoh BEM Software
3. Load Nemoh Solution
4. Load WAMIT Solution

The project type is driven by the hydrodynamic sub-module to be used, which description is given in the Project Structure Chapter. Note that it is not possible to select a project type prior to define a valid project folder.

The clicked option will generate an empty project, with the selected hydrodynamic module, the performance fit module and the data visualisation module.

Address Information.
123 Main St.
City, State
ZIP
(777) 777-7777
(777) 777-7777
tex.stackexchange.com

TEST REPORT

Prepared for:	–prepared–	Project Number:	–project-number–
PO Reference:	–PO–	Test Report Number:	–test-report-number–

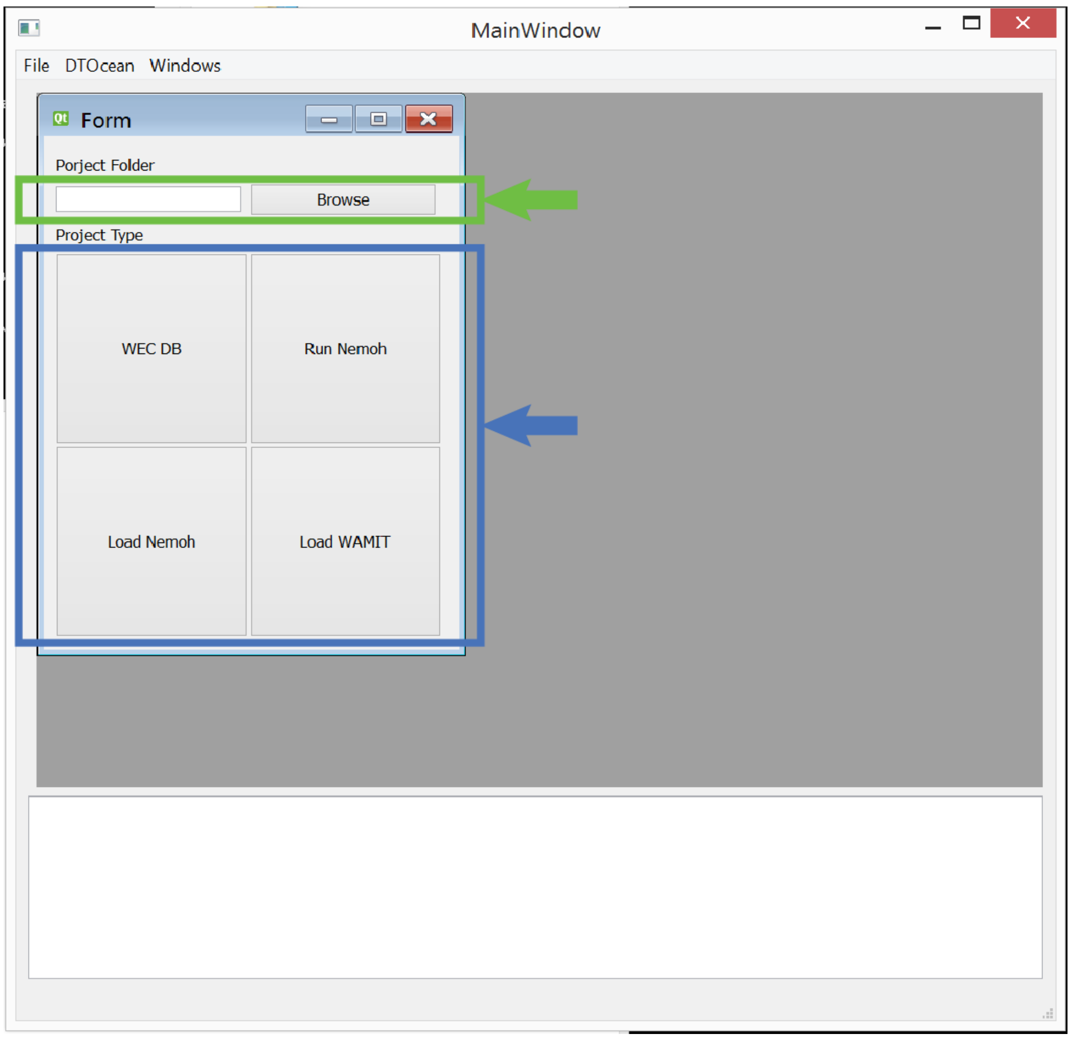

Figure 1.1: New project window

Address Information.
123 Main St. ☎ (777) 777-7777
City, State (777) 777-7777
ZIP tex.stackexchange.com

Chapter 2

Load an Existing Project

If a previous project has been created but not finished, or if the GUI crashed, it is possible to load the data saved using the Load Porject Option. The load project option will open a browse windows, and ask the user to select a folder with a valid project saved. The porject data is always saved in a file called FOLDER_NAME_data_collection.hdf5.

Tha data is stored in hdf5 format, and the FOLDER_NAME is the name of the containing folder. For example if the project is saved in the the folder:
C:\User\JohnDoe\Document\WEC1_ project

then the project data will be stored in the file:
WEC1_project_data_collection.hdf5

inside the project folder.

Address Information.
123 Main St. ☎ (777) 777-7777
City, State (777) 777-7777
ZIP tex.stackexchange.com

Chapter 3

Generate DTOcean Input Format

Once both the hydrodynamic and the performance fit module are completed, the user will have the chance to generate the DTOcean compatible format of the WEC model. This is true if and only if the array interaction matrixes have been calculated in the hydrodynamic module.

Address Information.
123 Main St. ☎ (777) 777-7777
City, State (777) 777-7777
ZIP tex.stackexchange.com

Chapter 4

Project Structure

Every project is made of three basic modules, Fig. 4.1 :

- Hydrodynamic
- Performance Fit
- Data Visualisation

The hydrodynamic module is the first module that need to be completed, the other two are deactivated at the beginning. The Data Visualisation module is deactivated for obviuos reasons, while the Performance Fit module relies on the hydrodynamic data to be run, therefore its utilisation is sequential with the hydrodynamic module.

The red box in the top-left side of Fig. 4.1 represents the model list view, and the colour represents the status of each module. The color map used is:

blue module ready to be used

green module completed

black module inactive

4.1 Hydrodynamic Module

The module is used to evaluate the hydrodynamic properties of the WEC. The hydrodynamic module is based on the linear theory and the solution is obtained by calculating the velocity potential in the domain using a BEM software.

The hydrodynamic module is subdivided in four types:

1. Load WEC database case-study
2. Run Nemoh BEM Software
3. Load Nemoh Solution
4. Load WAMIT Solution

Nemoh is used as the base solver for the hydrodynamic problem, but the user is allowed to solve the problem externally, using WAMIT or Nemoh and then bring the solution into the GUI. Additionaly, the user can select among a list of 10 precompiled cases, even though this use is mostly interesting in combination with the DTOcean tool. The different seciton are described in details hereafter.

Address Information.
123 Main St.
City, State
ZIP
(777) 777-7777
(777) 777-7777
tex.stackexchange.com

TEST REPORT

Prepared for: –prepared–
PO Reference: –PO–

Project Number: –project-number–
Test Report Number: –test-report-number–

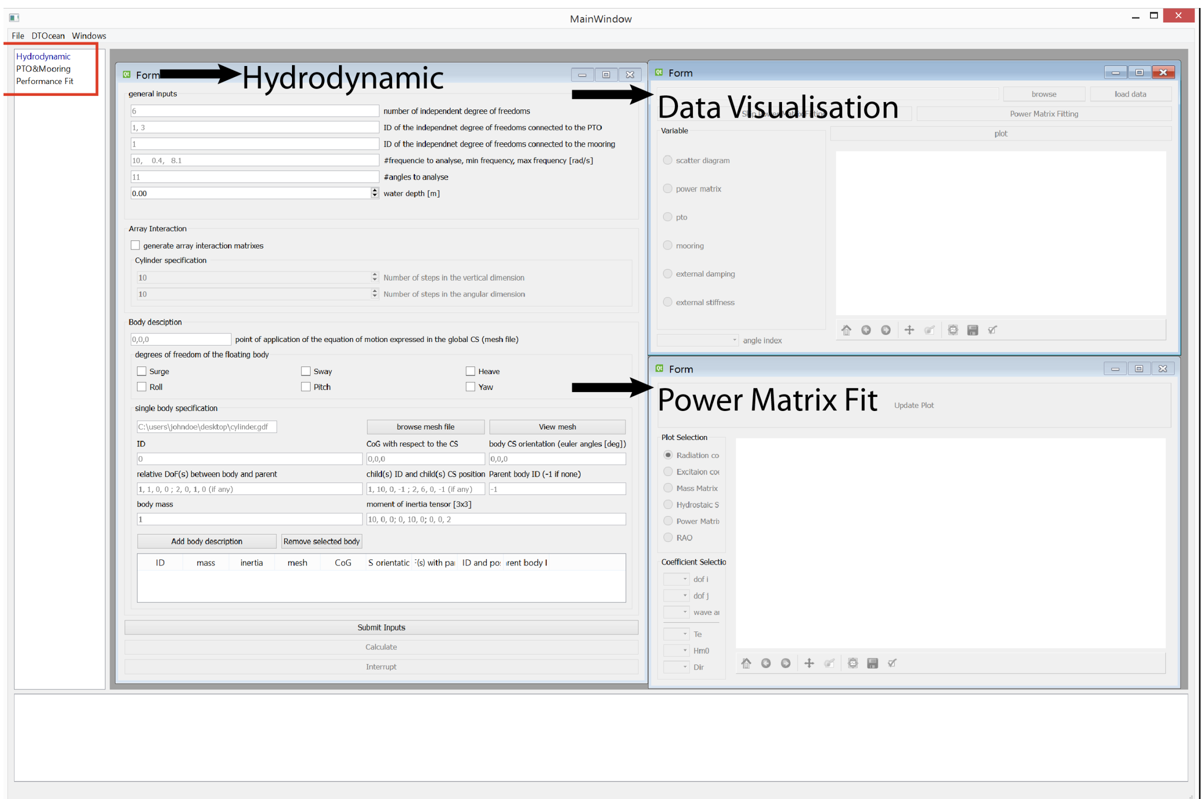

Figure 4.1: Project Overview

Address Information.
123 Main St.
City, State
ZIP
(777) 777-7777
(777) 777-7777
tex.stackexchange.com

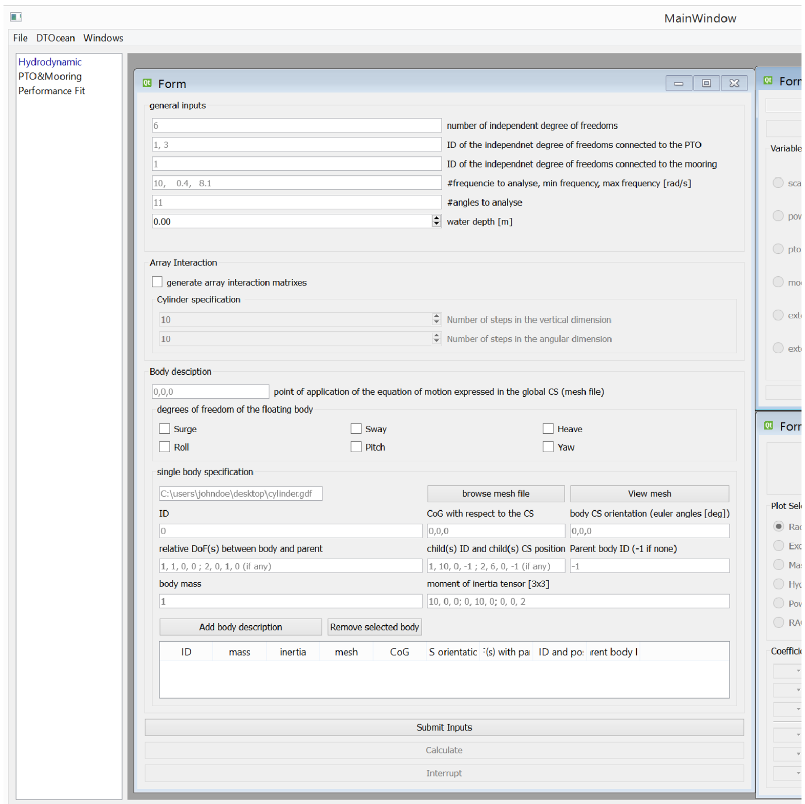

Figure 4.2: Hydrodynamic Module Interface

4.1.1 Load WEC database case-study

TO BE DONE

4.1.2 Run Nemoh BEM Software

In this module the user will run the BEM software Nemoh, which is shipped with the GUI. The module interface is shown in Fig. 4.2 . The hydrodynamic module is made of three groups:

- General Inputs
- Array Interaction
- Body Description

Each group is described in the following.

general inputs the general inputs are made of six different parameters:

1-number of independent degree of freedom The field describes the minimum set of independet degree of freedoms (dof) describing the WEC. For a single rigid body, the minimum set of dof has the size of six element, and it is given in the canonical form as Surge, Sway, Heave, Roll, Pitch, Yaw. The first three dofs describe the body translation from the equilibrium position, while the last three dofs describe the rotation around a user specified point. If the structure is constrained in any of the above mentioned dof, the minimum set can be smaller then six in size.

If the WEC is made of different bodies mechanically linked, the each body will have its own dofs, but the mecchanical link will combine/link some of them, reducing the number of linearly indepentent variable of the system. For example two hinged barges, with 6 dofs each, will have 12 dependent dofs and 7 independent dofs, (6 canonical plus the hing). This number is the input required.

2-ID of the independent dof connected to the PTO The field describes which dof is linked to the power take-off (PTO) system. For example a cylinder with 6 dofs, which extract energy with the vertical displacement will have the dof ID 3 connected to the PTO.

For the case of the two hinged barges, the dof ID will be 7, which identifies the hing dof. The user can input a list of dofs separated by a comma.

3-ID of the independent dof connected to the mooring Same has before but in this case the user need to specify the dof ID connected to the mooring system. The user can input a list of dofs separated by a comma.

4-frequency description The field describes the discretisation of the frequency domain that will be used by the BEM software. The field requires three values:

- number of frequency to be analysed; the minimum number of wave frequencies is one.
- minimum value of the frequency range in rad/s
- maximum value of the frequency range in rad/s

The minimum number of wave frequencies is one.

5-number of wave direction The field describes the discretisation of the angular domain that will be used by the BEM software. Since the GUI has been builted mainly to generate the array interaction matrixes, the base assumption is to solve the BEM problem for the whole circle around the WEC.

The field requires the number of wave angles to be analysed. The minimum number is one, which correspond to analyse only the 0 deg wave angle.

5- water depth The field gives the water depth at the WEC location. NOTE: 0m corresponds to infinite water depth. In this case the array interaction cannot be solved, with the actual implementation, therefore the array interaction group will be disabled.

array interaction The array interaction group indentifies the features needed to calculate the array interaction matrixes, which are then used in the direct matrix method to solve the array hydrodynamic interaction.

The array interaction is solved by substituting the actual structure, with a description of it mapped into a circumscribing cylinder. The cylinder radius is internally determined, while the user is asked to describe the number of element used to discretise the cylinder in the vertical axes and in the angular axes. This two values affect the quality of the mapping but also the computational time, and they should be decided as a trade-off between accuracy and cpu-time. In general 50 element in the vertical direciton and 60 element in the angular direction can be considered already enough, to obtian a reliable solution, but the user should perform a sensitivity analysis to ensure the quality of the results.

Address Information.
123 Main St. ☎ (777) 777-7777
City, State (777) 777-7777
ZIP tex.stackexchange.com

body description The group sums all the features of the structure. It is divided in two parts: The first part identifies the point of application of the equaiton of motion, with respect to the mesh coordiante system and the canonical dofs of the body(bodies).

The second part (single body specification group) describes the body(bodies) of the WEC. In particular:

mesh file describes the path-filename of the mesh that describe the submerged part of the body. Both WAMIT or Nemoh are accepted formats.

ID is the unique ID of the body. It is good practice to start from ID 0 and increase the number.

CoG with respect to the CS position vector of the centre of gravity of the body expressed in the body coordinate system.

local CS orientation are the three Euler angles which describe the orientation of the local coordiante system.

parent body ID for a single body WEC the parent body ID needs to be -1, while for a multi-body WEC the field describes the body closer to the root connected to the actual body.

body mass mass of the body, which need to match the submerged volume of the body times the water density.

moment of inertia it is the 3x3 tensor of the moment of inertia of the body.

(only multibody) relative dofs between body and parent each dof is a 4 element vector, made of: dof type (1 translation, 2 rotation), dof axes (x, y, z components of the unitary vector).

(only multibody) child position ID of the child connected to the body and position (x, y, z coordinates) of the child CS. The Position of the child is given wrt the local CS of the body.

4.1.3 Load Nemoh Solution

TO BE DONE

4.1.4 Load WAMIT Solution

TO BE DONE

4.2 Performance Fit Module

The Performance Fit module is an attempt to generate a numerical model of the WEC which resample as close as possible, in a linear sense, the user given power matrix.

In facts, if the certified power matrix is obtained via experiments or advanced numerical models there is a high chance that the internally generated linear numerical model is not capable to correctly represent the cetrified power matrix. Therefore, the module will minimise the difference between calculated and user given power matrix for each sea state. The minimisation algorithm acts on two parameters: a damping and a stiffness coefficient. The inputs of the module are the PTO and Mooring matrixes of the machine, together with the Certified Power Matrixes and the relative Scatter Diagram. Further, the user can specify an additional Damping and Stiffness matrixes to account for known linear effect.

The PTO, Mooring, Damping and Stiffness are square matrixes with the dimention of the number of independent dofs of the system, while the Power Matrix has the dimention of the Scatter Diagram. The inputs are given in separate csv files:

- performance_fit_pto.csv

Address Information.
123 Main St. ☎ (777) 777-7777
City, State (777) 777-7777
ZIP tex.stackexchange.com

- performance_fit_mooring.csv
- performance_fit_power_matrix.csv
- performance_fit_scatter_diagram.csv
- performance_fit_ext_damping.csv
- performance_fit_ext_stiffness.csv

The containing folder is passed to the module and if all the files are in the folder the Load button will be activated. Once clicked, the Load button will read the data and check for its consistency. If the process terminate successfully, the Skip Fitting and Fitting button will be active. Note that if the array interaction matrixes have not been calculated in the hydrodynamic module, the Performance Fit cannot be performed. Therefore, only the Skip Fitting button will be active.

The Skip Fitting button will generate the necessary matrixes with zero values, while if active the Fitting will generate the matrixes used to minimise the user and calculated Power Matrixes.

Depending on the number of dofs of the system and the number of sea states, the Performance Fit can require quite a long time to run (10 min). At the actual stage the threading of the module is not running and therefore the GUI will be freeze during the computation.

4.3 Data Visualisation

TO BE DONE