1 Introduction

OpenSEA is an open source software for numerical seakeeping analysis. The software suite is a series of softwares used individually or in combination.

1.1 Software Utility

Seakeeping analysis is a critical part of the design of marine structures. This includes everything from offshore oil platforms to the Washington State ferries to bulk cargo carriers. The basic intent of seakeeping analysis is to determine how a marine structure will respond to a given sea state. This can include calculation of vessel motions, sea loads imparted to the marine structure, and a host of other design characteristics.

2 User Demand

Marine design firms around the use seakeeping analysis in the design process. The problem is that marine design is a very small industry. It has a small user base to support new software development. Seakeeping software sells for costs on the order of $30,000 per license. This is prohibitively expensive for most marine design firms.

Many marine design firms bypass the use the seakeeping software and try to perform seakeeping analysis based on the performance of past vessel designs. The problem is that seakeeping performance is highly customized and specific to each marine structure. The industry has a need for advanced seakeeping software without high licensing costs. OpenSEA will be released as open source software to meet this demand.

3 Software Description

Most seakeeping software available today shares the same basic principles. One software calculates the interactions between a marine structure and ocean waves. Then a second software uses these interactions to predict vessel performance under a given set of wave conditions.

The software calculates wave interactions by discretizing a marine structure into a surface mesh composed of a series of panels. The equations of wave interaction are then solved for each discretized panel.

Solution requires efficient representation of each equation with complex numbers

(real and imaginary components) and computation of Bessel functions to form an interaction matrix. The software must then solve the interaction matrix, which is usually a size on the order of 1500x1500 entries. The software repeats this process 20 to 40 times for a given marine structure. Run times can range from 0.5 hr to 16 hr typically.

After calculation of the wave interactions, a second software solves for vessel motions. This involves a rigid body motion solver that includes the wave interaction effects, wave conditions, and any external body forces such as mooring lines. Program output can include a numerical time history of vessel motions, a visual video of vessel motions, a series of graphs showing the time history from any number of custom outputs, and statistical summaries of the time history.

3.1 Commercial Examples

The following two software are examples of commercial seakeeping software.

1. ANSYS AQWA (www.ansys.com/Products/Other+Products/ANSYS+AQWA)
2. WAMIT (www.wamit.com)

Both software are used by professional marine designers and have very high license costs associated with them.

4 Project Overview

The following details provide a general overview of the software scope. An individual development project may include only a small portion of the complete project.

4.1 Project Organization

The project plans the following software structure. Each item in this structure can be easily developed as an independent application. Minimal descriptions are provided; more information is available for each item and potential discussion for development strategies.

1. **oHydro** – Calculates wave interactions
    1. Solver development (Matrix inversion)
2. **oFreq** – Calculates frequency based response of marine structures due to wave interactions and a given sea state
    1. Solver for frequency based responses (Matrix inversion)
    2. Solver for resonant frequency analysis (Eigen-value solver)
3. **oTime** – Calculates time based response of marine structures due to wave interactions and a given sea state. Includes non-linear force components
    1. Solver development
    2. Feature development for non-linear force models
4. **oFourier** – Calculates frequency based responses of marine structures from a given time history
    1. Solver development (fast Fourier transform)
5. **oBatch** – Automation software to perform multiple runs of all the above programs and alter program inputs. Also aggregates all results and generates summaries
6. Common Utilities
    1. **AQWA Import** – Utility to convert data files from AQWA format to native OpenSEA file format
    2. **Common GUI platform** – A base software with common appearance and functionality that can be expanded to use by all software programs.
    3. **Text-file based user interaction** – The most basic method of interaction may be text-file inputs. The format of text file inputs needs to be specified, along with text file structure
    4. **ParametricGen** – Utility that allows the user to generate custom database based on interpolation between individual files and user defined parameters.

4.2 Possible Focus Areas

Possible focus areas include the oTime or ParametricGen. The exact focus would require further discussion.

4.3 Operating System

The program will be initially designed for only one operating system. Windows or Linux operating systems are possible, with a preference for Linux based systems. The program should be designed for eventual expansion to cross platform support in Windows and Linux. The sponsor currently intends to use the Qt development environment to provide this capability for future development. Other options can be explored as part of the project.

4.4 Programming Language

Application coding will probably be in the C++ language due to a variety of features. However, other options can be evaluated as part of the project.

5 Sponsor Background

The sponsor is a private individual named Nicholas Barczak. Nicholas is a professional naval architect working in the maritime community. (Professional profile available online via linkedIn: www.linkedin.com/pub/nicholas-b/23/a52/73a/) Nicholas has some experience with basic C++ and VBA programs. His primary background is in engineering, with an emphasis on numerical analysis, advanced computing methods, and computer automation. This has afforded Nicholas an appreciation for the complexities of software development and a basic understanding of software development and program coding.

Any software produced by this project will be released as open source. The sponsor will host a website to provide access for the software and advertise its existence within the naval architecture community.