openDynamics Developer's Manual

https://github.com/TimB-QNA/openDynamics

Tim Brocklehurst

January 31, 2016

Contents

Chapter 1

Introduction

openDynamics was initially the formalisation of some quite simple ideas for the balancing of hydrostatics problems. In a hydrostatics problem, it is normal to hold one variable constant, and change another to minimise a certain derived quantity. For example, to work out righting moment, roll angle would be fixed, and heave would be changed to minimise the difference between buoyancy and weight; pitch can also be varied to reduce pitching moment. From this premise, it was a straightforward step to use a basic 2DOF dynamics solution instead of using a control mechanism. The generic 2nd order differential equation is described in 1.1. This can be solved numerically for two degrees of freedom (heave and pitch) reasonably easily, and for a hydrostatic solution, the degrees of freedom can be decoupled; with limited coupling derived from the geometry and associated motion.

$$M\frac{d_x^2}{dt^2} + A\frac{dx}{dt} + Cx = 0 \tag{1.1}$$

Hydrostatic solutions, while extemely useful only have limited applicability when considering more dynamic situations. For more dynamic scenarios like a yacht sailing through waves, or mooring loads, the solution needs to take into account the full 6DOF problem with the correct cross-coupling terms. openDynamics uses the Open Dynamics Engine library [1] for this purpose. ODE is a general 6DOF dynamics engine, which works by applying user-defined forces to bodies. ODE is also capable of modelling articuated bodies, though this is not extensively used in openDynamics.

Chapter 2

Documentation

The openDynamics documentation is written in LaTeX. For scientific documentation which contains many references and equations this is by far the easiest environment, and benefits over MS Word and OpenOffice in it's ability to be version controlled and handle references in particular. The documentation is based on a template document and a bibtex library.

New documents can be produced by copying the document.tex and Makefile files from the template directory into a document directory. All references should be added to the common bibtex library (library.bib).

Chapter 3

System Architecture

3.1 The input XML file

The input XML file is critical. It defines the parameters of the simulation and the properties of the vessel(s), moorings etc.

3.2 Basic Concepts

openDynamics has a "world" wherein all dynamics simulation happens. The odWorld class implements this "world" and loads the dynamics objects from the input XML file. Each object within the simulation (whether a physical or not) inherits odObject. odObject allows significant simplification in the software, and provides a common interface to everything in the simulation. Objects can interact with each other either by velocity influence, water surface displacement or direct application of forces (e.g. moorings).

Chapter 4

Objects

A variety of object types are available to use in the simulation.

4.1 odCable

4.2 odCurrent

4.3 odFoil

4.3.1 odFoilPanel

4.3.2 odFoilSection

4.4 odHull

4.4.1 odHullResistance

DELFT Resistance Model

4.5 odMass

4.6 odPropeller

4.7 odSail

4.8 odSpring

4.9 odWaves

Chapter 5

Bibliography

[1] Russell Smith. Open dynamics engine (www.ode.org). 5