Chapter 1 : Introduction

February 27, 2013

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1 Ocean Wave Basics

The approach for creating a wave absorbing boundary condition used here rests on a technique of domain decomposition. The entire fluid domain is split into an "inner" region encompassing the domain of the fluid near the body of interest, and an "outer" region encompassing the remainder of the fluid domain which is usually infinite in lateral extent. With this decomposition, the flow in the outer region can be considered independently of the interior flow and a matching at the interface performed. If a general solution to this outer flow is found, matching the general outer solution to a particular interior flow effectively provides an outer boundary condition for the flow in the inner region.

2 Thesis Outline

In summary, the aim of this thesis is to develop a general solution of the linearized free-surface external potential flow problem and apply it as an outer boundary condition to inviscid and viscous interior flows. Chapter 2 develops the general "shell-function" solution of the linear flow in the exterior region. This solution is obtained utilizing a new spectral collocation technique to solve an integral equation representing the outer flow; this is done in a general way so that the solution can be computed once and applied to a variety of interior problems. Chapter 3 applies the outer shell-function solution as an outer boundary condition for several interior region solution techniques for solving inviscid flow problems. A new matching technique is developed that allows the shell-function formulation to be applied to field discretization methods for solving the interior inviscid flow problem. Chapter 4 examines the mathematical description of a viscous-inviscid fluid interface in the presence of a free-surface with waves. The boundary conditions developed in chapter 4 form the basis of the numerical viscous-inviscid matching technique developed in chapter 5. Chapter 5 applies the shell-function outer solution as an outer boundary condition to an interior solution of a viscous-flow problem. Two matching techniques for the viscous-inviscid case are explored, the first is an extension of work appearing in the literature and the second is a newly developed technique based upon the results of chapter 4. Numerical results are presented and the promises and limitations of the technique are explored. A concluding chapter summarizes the work and outlines promising extensions of the techniques developed in this thesis. Several appendixes present details of the computational scheme and particularly the Green function computation, storage, and recall techniques which allows the computations associated with the outer solution to be re-used for any problem in the interior domain.

PowerBuoy PTO diagram - 03/15/2012

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