Dipoles Implementation in NEMOH Implementation Details

Revision History

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Deployment Instructions

This is not the deployment guide but a document describing the implementation which has been kept and updated for reference. The deployment guide is "Dipoles Implementation in NEMOH.doc"

1. Nemoh Goal

The goal of Nemoh is to solve the seakeeping problem. The seakeeping problem is the problem of 3 dimensional bodies, floating (partially immersed) or immersed in a fluid (water) of infinite or constant finite depth. The bodies could be subjected or not to sinusoidal waves from the fluid. The objective is to evaluate the unsteady hydrodynamic pressure, loads and motions of the body, as well as the pressure and velocity in the fluid domain. This is one of the main problems in hydrodynamics.

Nemoh is solving it by using the Boundary Elements Methods or BEM with a low order panel method.

In this method:

1- The potential is represented either by a source distribution of unknown strength over the body surface (the 'source formulation'), or by Green's theorem where the source strength is known and the dipole moment is equal to the unknown potential (the 'potential formulation');

2- The body surface is approximated by a large number N of small quadrilateral panels;

3- The source strength and dipole moment are assumed constant on each panel, giving a total of N unknowns;

4- In the source formulation the normal derivative of the potential is evaluated at the centroid of each panel, and set equal to the normal velocity at that point (in the potential formulation the potential itself is evaluated directly at the same points) giving a total of N linear equations for the unknown source strengths (or potentials);

5 This system of equations is solved by standard methods of linear algebra;

6- From this potential the pressure on each panel is evaluated, and integrated to compute the required forces and moments.

This is at a high level what Nemoh is currently doing

2. Contest Problem Statement

This contest asks us to implement the dipoles formulation of BEM.

This is because currently, Nemoh is using the Green theorem for representing the mathematical formulation of the problem but all integral are solved using a source formulation.

The problem with the source formulation is that it is not too appropriate for body with thin elements.

3. Mathematical Model of the Dipoles Implementation

The mathematical model of the dipoles implementation is described by equations (15.46) and (15.47) of reference R2, whereas the old Nemoh code is solving equations (15.24) and (15.25) of reference R2.

In equation (15.46) and (15.47) of reference R2, G is called the Green Function and its expression is given by equations (15.14) and (15.17) of reference R2 respectively for the infinite depth (water) and finite depth.

Equations (15.46) or (15.47) of reference R2 are both solved using the collocation method (http://en.wikipedia.org/wiki/Collocation_method)

In this method, you compute the integral for N known points giving a system of N linear equations and we choose for answer the solution to this equation. This process is called the discretization of the integral equations.

For equations (15.46) and (15.47) of reference R2, N points corresponding to the (discretized N panels of the body) are chosen. Each point corresponds to the center of gravity of the panel. This leads to equations similar to (15.20) and (15.21) of reference R2. As you can see, these equations lead to a linear system of the form Ax=b and the key to find the Matrix A is to find the coefficients.

To compute those coefficients, the green function and its derivative is needed. Those are computed by following and extending previous routines written in Nemoh.

Once all of these are done and taking into account that the right hand side of equation we have the complete system of linear equations (Ax=b) which is solved using GAUSS.

4. Implementation Details

Previous Nemoh used 4 (Solver/Core/SOLVE_BEM_FD_DIRECT.f90 Solver/Core/SOLVE_BEM_INFD_DIRECT.f90 ...) files to compute the coefficient of the Matrix (in its previous formulation) and solve it.

To compute the dipoles implementation, we used a single file "Solver/Core/SOLVE_BEM_DIPOLES_THIN.f90" for both the finite and infinite case.

The main subroutine is SOLVE_POTENTIAL_DIPOLES_THIN. In this subroutine we created a double loop through the number of panels (as it is done currently). The goal will be to compute the matrix A and solve it (In previous code matrix ZIJ is created).

For the first loop we will take the centroid of the corresponding panel (x, y, z).

For the second loop we will consider the coordinate of the quadrilateral of the corresponding panel.

Most of the inputs we used to compute the Matrix as described in section 3 are already computed in the file Solver/Core/PREPARE_MESH.f90.

For example, the area of a panel is already available in the variable AIRE.

The centroid of a panel is available in XG, YG, ZG for each component of the centroid and per panel.

The wavenumber, period, the number K are all already computed in Solver/Core/SOLVE_BEM.f90.

With these inputs already available, the implementation is a straight computation of the formula referenced in section 3.

Finally we will modify Solver/Core/SOLVE_BEM.f90 to call our newly added routines according to a flag.

5. Starting

Not Applicable

6. References

R1 **A Rankine panel method as a tool for the hydrodynamic design of complex**

marine vehicles.
http://dspace.mit.edu/bitstream/handle/1721.1/50364/39696248.pdf?sequence=1

R2. **Wamit User Manual** http://www.wamit.com/manualupdate/V70_manual.pdf

7. Resource Contact List

Name	Resource Email
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