REAL TIME VESSEL SIMULATION INCORPORATING COASTAL NUMERICAL MODELING

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INTRODUCTION

Real time vessel simulation has become an integral part of design of navigation channels, harbor geometries, and marine terminals. Generalized guidance for channel width, bend radii, and turning basin dimensions is documented in numerous sources (e.g. PIANC, ASCE) based on typical environmental parameters of current magnitude, wind speed, and wave height. Common to all the guidance is to confirm and finalize geometry and operability based on vessel simulation studies.

A real time vessel simulator incorporates various data to represent the response of a vessel to helm controls of the pilot such as water depth, currents, waves, winds, drag, rudder force, and tug boat power. A key component of the simulation is that the computations occur in real time such that the pilot does not notice any lag due to computer processing. As such the fidelity of environmental input to the simulation has often been limited to avoid congestion. Furthermore, vessel simulation software was designed for quick modification in training simulations with simple parameters to apply the conditions uniformly over the model domain.

As a result, the implementation of metocean conditions in real time simulation is often truncated based on a simple characterization of sea state and currents to a snap shot of time, represented by a static current field representing peak and ebb or flood tide or by simple representative vectors. However, there are aspects of assessing channel design which benefit from simulating the changing of metocean conditions simultaneously with vessel maneuvering. With improving processing power of simulators, it is possible to incorporate time-varying numerical modeling results directly with fine resolution.

This paper presents applications of coastal engineering tools and techniques for real time vessel simulation in conjunction with high resolution coastal hydrodynamic modeling for waterway design.

Figure 1 - Real Time Tanker Simulation

TIDAL CURRENT PHASE

For longer channels where transits may span hours, the change of tidal phase may impact vessel maneuverability (Figure 2). Incorporation of the changing current vectors will more accurately represent the performance of the channel design, the challenges pilots may encounter and operational restrictions that may be implemented.

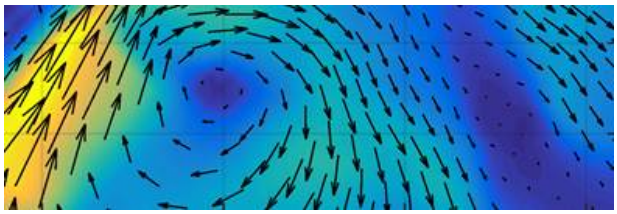

Figure 2 - Eddy Formation During Changing Tidal Phase

SPECTRAL WAVE FIELDS

Time and spatially varying wave fields present a particular challenge for real time vessel simulation. Representation of waves in real time simulators is often focused on the visually representation of the wave field for the pilot with wave forces in the simulator based on a simplified spectrum or monochromatic wave fields. The authors have implemented methods for building up frequency and directional spectra from components to represent a random wave field based on spectral wave models rather than wave definitions in the simulator software.

EXTREME EVENTS

Near shore marine terminal concepts which incorporate long-term vessel moorings may incorporate design criteria which require evacuation during extreme events such as tsunamis. Representation of time varying currents is a necessary component of assessing the feasibility of maneuvering during tsunami events. An example of incorporating tsunami current development and navigation will be discussed.

With the increasing processing capabilities of vessel simulator systems, it is possible to combine detailed, time varying numerical coastal engineering model results into real time simulators, thereby improving the fidelity and realism of the simulation.

REFERENCES

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