University of Victoria | Graduate Studies

Notice of the Final Oral Examination for the Degree of Master of Applied Science

of

WILLIAM ANTHONY LAWRENCE TRUELOVE

BEng (Royal Military College of Canada, 2011)

"A General Methodology for Generating Representative Load Cycles for Monohull Surface"

Department of Mechanical Engineering

Thursday, December 13, 2018
1:30 P.M.
Engineering Office Wing
Room 230

Supervisory Committee:
Dr. Zuomin Dong, Department of Mechanical Engineering, University of Victoria (Supervisor)
Dr. Peter Oshkai, Department of Mechanical Engineering, UVic (Member)
Dr. Andrew Rowe, Department of Mechanical Engineering, UVic (Member)

External Examiner:
Dr. Kevin McTaggart, Department of National Defence, Research and Development Canada

Chair of Oral Examination:
Dr. Michael Nowlin, Department of English, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

In this thesis, a general methodology for generating representative load cycles for arbitrary monohull surface vessels is developed. The proposed methodology takes a hull geometry and propeller placement, vessel loading condition, vessel mission, and weather data (wind, waves, currents) and, from that, generates the propeller states (torque, speed, power) and steering gear states (torque, speed, power) necessary to accomplish the given mission. The propeller states, together with the steering gear states, thus define the load cycle corresponding to the given inputs (vessel, mission, weather). Some key aspects of the proposed methodology include the use of a surge-sway-yaw model for vessel dynamics as well as the use of surrogate geometries for both the hull and propeller(s). What results is a methodology that is lean (that is, it requires only sparse input), fast, easy to generalize, and reasonably accurate. The proposed methodology is validated by way of two separate case studies, case A and case B (both involving distinct car-deck ferries), with case A being a more ideal case, and case B being a less ideal case given the methodology proposed. In both cases, the load cycle generation process completed in greater than real time, achieving time ratios (simulated time to execution time) of 3.3:1 and 12.8:1 for cases A and B respectively. The generated propeller and steering gear states were then compared to data collected either at sea or from the vessels' documentation. For case A, the propeller speed, torque, and power values generated were all accurate to within ±3%, ±7%, and ±10% of the true values, respectively, while cruising, and accurate to within ±14%, ±36%, and ±42% of the true values, respectively, while maneuvering. In addition, the steering gear powers generated in case A were consistent with the capabilities of the equipment actually installed on board. For case B, the propeller speed, torque, and power values generated were all accurate to within ±2%, ±8%, and ±9% of the true values, respectively, while cruising, and accurate to within ±28%, ±45%, and ±66% of the true values, respectively, while maneuvering. In case B, however, the steering gear powers generated were questionable. Considering the results of the validation, together with the rapid process runtimes achieved and sparse inputs given, one may conclude that the methodology proposed in this thesis shows promise in terms of being able to generate representative load cycles for arbitrary monohull surface vessels.