Optimal Control Theory Applied to Ship Maneuvering in Restricted Waters

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Ship drivers have long understood that powerful interaction forces exist when ships operate in close proximity to rigid boundaries or other vessels. Controlling the effects of these forces has been traditionally handled by experienced helmsmen. The purpose of this research is to apply modern optimal control theory to these maneuvering scenarios in order to show that helmsman may some day be replaced by modern controllers. The maneuvering equations of motion are cast in a linear state space framework, permitting the design of a linear quadratic controller. In addition, the hydrodynamic effects are modeled using potential flow theory in order to simulate the interaction forces and test the efficacy of the controller. This research demonstrates that the linear quadratic regulator effectively controls ship motions due to the presence of a boundary or other vessel over a broad range of speeds and separation distances. Furthermore, the method proposed provides stable control in the presence of additional stochastic disturbances.