INTELLIGENT CONTROL STRATEGIES USED IN FAST TIME SHIP MANOEUVRING SIMULATIONS

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***Abstract*:** Fast time simulations are an efficient method to assess and analyze ship manoeuvring behaviour in confined water. The track-controller plays an important role in controlling the ship trajectory in these fast time simulations. In order to improve track-controller accuracy and adaptability in different nautical environments, different intelligent control strategies are considered to be used in the simulation. The principle and characteristics of the track-controller as used at Flanders Hydraulics Research (FHR) and Ghent University are firstly described, then advanced and smart control methods depending on its characteristics are reviewed and compared. Finally, the grey relational decision-making approach is applied in selecting the proper control strategy for the track-controller. Based upon the results from comparison, the fuzzy logic control algorithm is the most suitable for track-controller designing due to its simple control structure and good adaptability.

Keywords: Fast time simulation; Track-controller; Intelligent control strategies; Autopilot; Ship manoeuvring

1. Introduction

Fast time ship manoeuvring simulation is a common technique for checking new navigation areas, for assessing channel safety, and for analyzing confined and shallow water effects on ships. The simulation offers a cost-effective and efficient approach for identifying potential risks when designing a fairway. In a fast time simulation, the human input is eliminated and replaced by a control algorithm, here named “track-controller”. Track-controller is preferred over “autopilot” in order to avoid confusion with the on-board device with the same name. The track-controller is a control model used in the fast time simulation system, which was initially developed for track-keeping (within restricted deviations) in a confined channel. This algorithm does not only provide new control actions (rudder deflection) at discrete time intervals with the help of a prediction model, which can deal with complex, highly non-linear ship behaviour, but also controls the engine speed thus setting the propeller rate.

The track-controller, developed and in use at Flanders Hydraulics Research (FHR) and Ghent University(UGent), is taken as a case study. It is rather advanced, although the performance of this control system does not always lead to a satisfactory result. In order to optimize the present model, intelligent and advanced control strategies need to be taken into account. Apart from the classic PID control theory, fast time simulation track controllers can be based on fuzzy adaptive logic control, neural network control, and other more advanced or sophisticated tracking control algorithms.

The present paper intends to review and highlight the special requirements for fast time simulation systems with the focus on advanced and intelligent control algorithms. This paper will start with an overview of the development of control algorithms in fast time simulations, then existing intelligent control strategies are outlined and classified according to their functions, methodologies and applications. Six different control strategies are compared based on eight predefined properties.