DESIGN OPTIMAL CONTROL OF SHIP MANEUVER PATTERNS FOR COLLISION AVOIDANCE: A REVIEW

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ABSTRACT

Although there have been lots studies about vehicular maneuvers on land or sea, maneuvers within a small area that require direction changes have rarely been discussed. Many reports on the arrival or departure of ships from ports have revealed more about what are safe and effective turning maneuvers within a narrow area. Convenient navigation systems for ship maneuvering should allow quick avoidance of obstacles to find the shortest distance in the whole seaway is important. This study proposes a review model that will satisfy optimal turning maneuvering anywhere and be applicable to any type of ship. However, the water-based environment is more complex and there are many factors that will affect the formula. By using a nonlinear unified state-space model to discuss another model we can divide and conquer the problem. In recent studies some categories have been evaluated to determine where the main attention should be directed. In this review study we look at how to construct the optimal turning maneuver within a limited sea area.

I. INTRODUCTION

Water-based transportation is more complex than land-based transportation and there are various environmental factors and vessel characteristics that should be considered in the control of ships for maneuvers. There have been lots studies about structure control in the natural physics [2, 4, 13-67, 68-83, 97-103, 105, 108-111, 113-134, 136, 137]. Nevertheless, a unified numerical model for ship maneuvers is difficult to establish, because the factors affecting it (as described above) are normally nonlinear [157, 158, 197-231]. Ships are of various types designed according to their purpose. The ship's length, weight and even appearance, and the power of its rudders and thrusters, all have a significant effect on the characteristics of its maneuverability [159, 163-177, 179-187, 192, 193]. Due to these conditions, even if a numerical model can be established, it would be difficult to apply to all types of ships. In previous research studies it is common to give restrictions when discussing particular issues about a specific ship. However, it is still necessary to define the basic conditions of an objective ship type. Most models cannot be applied to all types of ships.

In this paper we will discuss several different levels that are related to the behavior of ships. These three levels introduce optimal ship maneuvering, for instance ship positioning, optimal path of ship maneuvering and inland ship maneuvering.

II. LITERATURE REVIEW

1. Ship Positioning

There are different ways to control a ship's yaw. The basic system uses a single rudder or twin rudders at the stern, operating in conjunction. Of course, there are more advanced system, for example, to use twin tunnel thrusters, one installed on the bow section and on the stern, which offers transversal thrust. A contemporary ship might use one or several systems operating in conjunction, for instance, the Glomar Explorer deep-sea mining ship in 1974 and the Glomar C. R. built Luigs drillship in 1999.

Obviously, from prior definition, the control system finds optimal control of ship maneuvers. Therefore, we focus on the basic system which is based on having a single rudder located at the stern to control the ship [140, 147, 148, 150]. Various methods for the study of ship maneuvering have been studied [5, 68, 107, 194]. For more details about ship control modeling see: Inoue, Hirano, Kijima and Takashima [104]; Barr...