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OPTIMAL COURSE HANDLING CONTROL FOR NONLINEAR SHIP MANEUVERING SYSTEMS

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Abstract. *Under the control constraint of rudder angle, an on-line optimal course handling control with a quadratic performance index is developed in this paper for the nonlinear continuous-time ship maneuvering systems with wave disturbances. The ship maneuvering systems are represented by a linear sequential model which is derived by using the orthogonal functions. This approach permits the linear feedback control law to be applied to the nonlinear continuous-time ship maneuvering systems. The proposed optimal controller can accommodate the effects caused by wave disturbances. The on-line optimal course-keeping handling control, course-tracking handling control and course-changing handling control for a ship maneuvering system with wave disturbance are presented to illustrate the considerable promise that the proposed method exhibits.*
Keywords: On-line, Optimal course handling control, System identification, Control constraint, Ship maneuvering system

1. **Introduction.** The optimal course handling control for nonlinear ship maneuvering systems, which are nonlinear continuous-time systems, has been considered by some researchers [1-10]. The dynamic characteristic of the nonlinear ship maneuvering system is usually given and the determination of the optimal control is pre-computed and stored. However, in many practical situations, the dynamics of the nonlinear ship maneuvering systems to be controlled are not given beforehand, or they vary in unpredictable ways due to the influence of complex external environment. Off-line determination of the control cannot be applied, and a method of on-line optimal course handling control is needed.

On the other hand, identification of dynamic models for a physical system is conducted in discrete time using the least square identification (LSI) method owing to the rapid development and the wide uses of digital computers. Hence, the discrete-time models have received more attention than the models in continuous time. However, since the systems considered in science and engineering usually are continuous in time, it may