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Ship-Maneuvering Control System Design Based on the Root-Locus Technique

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Summary: The PID control theory is very often used in practice in the field of shipbuilding; it is not an exaggeration to say that the use of other control theories is rare. Even though the theory possesses a defect in that it is not able to rationally design a multivariable control system, it nevertheless offers many advantages.
In contrast, the optimal control theory has rarely been utilized for designing the ship-maneuvering control system. The main reason for this is that the relation between gains and responses in optimal control is not clear despite the many advantages provided by state-variable feedback; thus, it is very difficult to finely tune the gains. From the viewpoint of practical use, it is important that the relation between gains and responses is crystal clear.
In this paper, the feedback-gain setting for control of a single input-output system that operates the heading angle by the rudder is discussed on the basis of the root-locus technique. The system is attached to three state-variable feedback loops similar to the optimal regulator, and the relation between gains, response speeds and ship speeds can be derived. Consequently, it is now possible for the gains designed for a linear time-invariant system to be applied to a time-varying system.

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