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CONTROLLER DESIGN FOR A MARINE DIESEL ENGINE USING MEMBRANE COMPUTING

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Abstract. *This paper presents a method to design an optimal controller for marine diesel engines. First, the control system of marine engine is described. Second, the design is formulated as a special optimization problem. With the explicit weighting values, the optimization procedure searches the optimal shape of the closed-loop system responses to the external disturbance and to the step input. An optimal-tuning controller is designed by minimizing the settling time and the overshoot of the step disturbance response after the rising time and other corresponding criteria of the step input response are satisfied. Third, an optimization procedure based on the framework of membrane computing is investigated for solving the optimization problem. The optimization algorithm adopts the idea from standard membrane computing. Moreover, its objects and system structure are inspired by the structure of the DNA molecule. Simulation results are presented to demonstrate the performance and validity of the method. The controller is compared with other controllers according to the characteristics of the responses. The comparison result verifies that the new design method improves the specification of the controller.*
Keywords: Controller design, DNA computation, Marine diesel engine, Membrane computing (P systems), Optimization

1. **Introduction.** The diesel engine, due to its superior efficiency, is widely used for propulsion of marine vessels. It provides the major power source for marine transportation and contributes to the prosperity of the worldwide economy. However, the marine diesel engine is a very complicated system to control. Its controller is required to quickly reject the external load disturbance. In practice, this type of control systems fails to achieve satisfactory control performance with PID controllers. An actual engine installation used a sixth-order controller, which was carefully tuned to given acceptable time responses for load changes [1]. Due to poor damping, the closed-loop response to set point changes was oscillatory poorly. In order to improve the controller performance, membrane computing is applied in the design procedure.

As a branch of molecular computing, membrane computing (P systems) was introduced by G. Păun [2,3]. P systems are nondeterministic computer models, which are abstracted from the structure and functions of living cells in biological bodies. They learn the ideas, tools, techniques, and models from biological cells that can turn out to be useful (or at least interesting) for the purpose of computing [4,5]. Recently, variants of membrane computing have been applied to optimization problems [6,7]. The parameter optimization of a complex system and the optimal control are research areas of great interest [8-12]. In

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