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A DESIGN METHOD FOR ROBUST STABILIZING MODIFIED PID CONTROLLERS FOR TIME-DELAY PLANTS WITH UNCERTAINTY

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Abstract. *We examine a design method for robust stabilizing modified proportional–integral–derivative (PID) controllers for time-delay plants with uncertainty. The PID controller structure is very widely used in industrial applications. However, the plants to which the PID controller is applicable are restricted. Yamada, Hagiwara and Shimizu proposed a design method for robust stabilizing modified PID controllers for any plant with uncertainty. However, no method has been published to guarantee the robust stability of a PID control system for any time-delay plant with uncertainty. In this paper, we propose a design method for robust stabilizing modified PID controllers for any time-delay plant with uncertainty.*
Keywords: PID control, Time-delay plant, Uncertainty, Robust stability

1. **Introduction.** The proportional–integral–derivative (PID) controller is the most widely used controller structure in industrial applications [1]. Its structural simplicity and ability to solve many practical control problems have contributed to this wide acceptance. Several papers on tuning methods for PID parameters have been presented [2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14]. However, the methods in [2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14] do not guarantee the stability of the closed-loop system. Design methods for PID controllers that guarantee the stability of the closed-loop system were proposed in [15, 16, 17, 18, 19, 20]. However, the plants to which these methods can be applied are restricted. To stabilize any plant using a PID controller, Yamada and Hagiwara gave a design method for modified PID controllers to make the closed-loop system stable for any unstable plant [21].

When we apply a PID controller in a practical application, we must consider the influence of uncertainty in the plant. In some cases, even if a PID controller stabilizes the nominal plant, the uncertainty makes the closed-loop system unstable. The stability problem with uncertainty is known as the robust stability problem [32]. Because almost all practical plants include uncertainty, the problem of designing robust stabilizing modified PID controllers for any plant with uncertainty is important. Several papers on design methods for robust stabilizing PID controllers have been presented [22, 23, 24, 25, 26, 27, 28, 29]. However, no design method for modified PID controllers has been published to guarantee the robust stability of PID control system for any plant with uncertainty. To overcome this problem, Yamada, Hagiwara and Shimizu gave a design method for robust stabilizing modified PID controllers to make the closed-loop system stable for any plant with uncertainty [30]. However, their method cannot be applied to time-delay plants with