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MULTIPLE-MODEL BASED INTELLIGENT CONTROL TECHNIQUES FOR LTI SYSTEMS WITH UNKNOWN EXTERNAL DELAYS PART I: KNOWN RATIONAL COMPONENT

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Abstract. *In this two-set paper, an intelligent control framework which allows maintaining a conceptually simple control design methodology while simultaneously explicitly dealing with uncertainty in both rational component of the plant and delay is presented. This first part is devoted to the Smith Predictor (SP) based control of systems with known rational component and uncertain delay. Thus, as the mismatch between the actual delay of the plant and the nominal one used in the control structure increases, the closed-loop performance degrades accordingly, even potentially causing instability. In this paper, an intelligent frame to reduce the 'a priori' knowledge of the plant delay required in the design of SP controllers is proposed. The intelligent frame is composed of a set of different plant delay models running in parallel along with a high level supervision algorithm which selects the one that best describes the actual delay of the plant at each time interval to be used for control purposes. In this way, the designer can design the control of the system based on its delay-free part while the appropriate tuning of the delay of the Smith Predictor is performed by the intelligent supervisor. As a consequence, like simulation examples show, the closed-loop performance of the system is improved without the 'a priori' requirement of an accurate knowledge of the value for the time delay.*
Keywords: Intelligent control, Smith predictor, Performance assessment

1. **Introduction.** Delays between input and output variables (lag or transport delays) often appear in industrial processes as well as in biological, telecommunications, economic and social system models [1]. The presence of delays entails harmful effects in the closed-loop due to the reduction of the gain and phase margins of the system. Furthermore, the design of the control scheme becomes more difficult since the transfer function of the plant is no longer a rational function. These facts have spoiled an active research work in delayed systems during the last decades (see, for instance, the survey works [2,11]). When the delay is large and a fast closed-loop response is desired, it is usual to use a control structure aimed at compensating for the delay. The structure of the Smith Predictor (SP) is widely used in industrial applications due to its simplicity, [4,16]. In particular, it is well-known that SP offers satisfactory closed-loop behaviour when accurate information on the plant model (including delay and rational component) is available, [19,20]. However, due to modelling errors or linearization approximation, it is almost impossible to obtain