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REDUCED-ORDER MODELING BASED ON GENERALIZED HOLDS: APPLICATION TO DIGITAL PID CONTROL

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Abstract. *This paper explores the use of a discretization procedure based on multirate sampling called Generalized Sample-data Hold Function (GSHF) for modeling and control purposes. Within this framework, the designer is allowed to use the degrees of freedom provided by the GSHF to deliberately cause stable pole-zero cancellations and, thus, obtaining reduced-order discrete-time systems from linear continuous-time ones. This methodology is used for controller design purposes, concretely, Proportional-Integral-Derivative (PID) control. In this way, a continuous-time process that is not suitable for PID control is discretized by means of a GSHF allowing a double benefit: complex dynamics of the continuous-time plant are removed in order to make PID control adequate and, for the reason that the order of the model is reduced, more simple tuning procedures can be used. Simulation examples have shown the applicability of the proposed approach and its usefulness providing good asymptotic tracking and smooth inter-sample behavior both in the perfectly known system and under parametric uncertainty.*
Keywords: Model reduction, Generalized holds, PID control, Digital control

1. **Introduction.** As it is well-known, plant zeros play an important role in control systems design. For many control design procedures, (for instance, model-reference control schemes) it is necessary that the plant has all its zeros stable since they are based on its closed-loop cancellation.

Otherwise, unstable zeros would be transmitted to the closed-loop system. This basic limitation imposed by unstable zeros together with the contemporary tendency of implementing discrete-time controllers even for continuous-time systems [9], [10] have spoiled an active research work during the last decades in novel discretization procedures aimed at achieving an improved stability of the zeros of the discrete-time models which may lead to a more successful discrete-time controller design [15, 17].

In this way, Ishitobi and Liang present in [12] and [14] a discretization procedure based on multirate sampling called Generalized Sample-data Hold Function (GSHF). The most interesting conclusion of these works is that an appropriate selection of some free-design parameters appearing in the scheme may lead to a stable discrete numerator overcoming the above mentioned problems related to the presence of unstable zeros. Moreover, this feature has been recently used in [7] to design model-reference adaptive control laws removing the hypothesis of the unstable zeros of the plant being known as well as part of the reference model.