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INPUT-TO-STATE STABILITY ANALYSIS VIA AVERAGING FOR PARAMETERIZED DISCRETE-TIME SYSTEMS

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Abstract. The paper studies semi-global practical input-to-state stability (SGP-ISS) of a parameterized family of discrete-time systems that may arise when an approximate discrete-time model of a sampled-data system with disturbances is used for controller design. It is shown under appropriate conditions that if the solutions of the time varying family of discrete-time systems with disturbances converge uniformly on compact time intervals to the solutions of the average family of discrete-time systems, then ISS of the average family of systems implies SGP-ISS of the original family of systems. A trajectory based approach is utilized to establish the main result.

Keywords. ISS; averaging; sampled-data systems; approximate discrete-time model; strong average; weak average.

1 Introduction

Sampled-data systems currently attract a lot of attention in the literature (see [1, 2, 4]). The presence of a sampler in the closed loop makes sampled-data systems time-varying even if the plant and controller are time invariant. This complicates the analysis of sampled-data systems, especially when the plant is nonlinear.

Recently, a prescriptive framework for stabilization of sampled-data nonlinear systems via their approximate discrete-time models was proposed in [9]. Within the above framework, one typically needs to verify uniform stability properties of a family of approximate discrete-time models that are parameterized with a sampling period. For instance, it was shown in [9] that if a family of approximate discrete-time models is uniformly globally asymptotically stable and a certain consistency condition holds, then the family of exact discrete-time models is semi-globally practically stable in the sampling period. Semi-global practical stability of the exact discrete-time models implies under weak conditions the same property for the actual sampled-data system, see [10]. Similar results were presented in [7] to provide conditions for semi-global practical input-to-state stability of sampled-data nonlinear systems.