Verifying Fragility in Digital Systems with Uncertainties using DSVerifier $v2.0$

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Abstract

Control system robustness verification with respect to implementation aspects lacks verification tools to check stability and performance of uncertain control systems, considering finite word-length (FWL) effects. In this paper, we present a bounded model checking tool for digital systems with uncertainties, named DSVerifier $v2.0$, which is able to check robust stability of closed-loop control systems, by taking into account FWL effects. In particular, the present work describes verification procedures and experiments related to limit-cycle oscillations (LCO), quantization error, and robust non-fragile stability on common closed-loop associations of digital control systems (*i.e.*, series and feedback). DSVerifier $v2.0$ extends previous properties of closed-loop systems (*e.g.*, LCO) and verifies stability and quantization errors for uncertain plant models, considering unknown parameters and FWL effects. Experimental results show that 35%, 34%, and 41% success verification can be reached for stability, LCO, and quantization error, respectively, for a set of 396 closed-loop control system implementations and realizations.

Keywords: fixed-point digital controllers, formal methods, bounded model checking, system reliability, uncertainty