Gluing KKL observer for hybrid systems with unknown jump times

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Résumé

This work proposes an observer design for general hybrid systems, whose outputs are continuous at jumps, and whose jump times are unknown. Inspired by the gluing approach and the Kravaris-Kazantzis/Luenberger (KKL) paradigm, we present conditions under which the hybrid dynamics can be transformed into continuous-time dynamics, that take the form of a filter of the output and for which an observer is readily designed. The possibility of recovering the estimate in the original coordinates is guaranteed outside of the jump times, under a mild backward distinguishability condition that ensures injectivity away from the jump set, assuming sufficient regularity of the transformation. Contrary to previous gluing results, the design of the gluing transformation and observer is systematic with a well-identified target form of dynamics. While the theoretical conditions are validated on an academic bouncing ball system, we illustrate our method on the application of dry friction parameter estimation in presence of stick-slip, via the use of neural networks to learn a numerical model of the transformation.

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