Design of observers for a class of nonlinear systems in associative observer form

Ülle Kotta (Tallinn, Estonia)

Conditions for the existence of an observer form for nonlinear discrete-time dynamic models are known to be restrictive, motivating various extensions (e.g., generalized observer forms) to enlarge the class of systems for which observers with linear error dynamics can be designed. This paper introduces an alternative approach, based on replacing the usual addition operation "+" with a more general binary operation "o" that is associative, continuous, and cancellative. These requirements lead to a simple representation for the operation "o" in terms of a continuous, strictly monotonic function $\varphi(\cdot)$. This form is called an associative observer form, and it is demonstrated that the known results for observer design extend easily to this class of nonlinear systems and yield linear error dynamics. A constructive algorithm is described that determines whether the original nonlinear system can be transformed into the associative observer form. The proposed approach is compared with the generalized observer approach involving both state and output transformations, and it is shown that both approaches yield identical results. On the other hand, our approach simplifies the computations of the output transformation, which are done in two independent steps and do not require the solution of a system of n differential equations, as the generalized observer approach does.