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Contraction-Theoretic Observers for Lorenz-95 systems

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This work presents analysis and design of nonlinear observers for the Lorenz-95 chaos model by employing contraction theory. Contraction theory has been an emerging theoretical framework to analyze the stability of nonlinear systems, and especially, synchronization of networked dynamical systems. This study designs hybrid observers that account for asymmetry in the topology of observation networks: continuous measurements are taken for some subset of the state space, while only (periodic) discrete measurements are available for the other subset of the state space. This hybrid architecture models the adaptive sampling problem in the context of numerical weather prediction, which determines supplementary sensing locations to aid the routine observation network. Contraction-theoretic analysis of the presented observers identies observability characteristics of the Lorenz-95 model.
KeyWords: Contraction theory, Network synchronization, Lorenz-95 model, Hybrid observer.