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An investigation of techniques for nonlinear state observation

McBride, Dean Christian Tait

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ABSTRACT

An investigation and analysis of a collection of different techniques, for estimating the states of nonlinear systems, was undertaken. It was found that most of the existing literature on the topic could be organized into several groups of nonlinear observer design techniques, of which each group follows a specific concept and slight variations thereof.

From out of this investigation it was discovered that a variation of the adaptive observer could be successfully applied to numerous nonlinear systems, given only limited output information. This particular technique formed the foundation on which a design procedure was developed in order to asymptotically estimate the states of nonlinear systems of a certain form, using only partial state information available. Lyapunov stability theory was used to prove the validity of this technique, given that certain conditions and assumptions are satisfied. A heuristic procedure was then developed to get a linearized model of the error transient behaviour that could form the upper bounds of the transient times of the observer.

The technique above, characterized by a design algorithm, was then applied to three well-known nonlinear systems; namely the Lorenz attractor, the Rössler attractor, and the Van Der Pol oscillator. The results, illustrated through numerical simulation, clearly indicate that the technique developed is successful, provided all assumptions and conditions are satisfied.