INITIALIZATION OF SEQUENTIAL ESTIMATION FOR UNOBSERVABLE DYNAMICAL SYSTEMS USING PARTIAL INFORMATION IN THE PRESENCE OF SYSTEMIC UNCERTAINTY

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Space Situational Awareness (SSA) is defined the ability to characterize as fully as possible the space environment. Short, unobservable measurement sequences pose a challenge for traditional state estimation methodologies and instead admissible region based methods are used. The primary question addressed in this work is how to best initialize a sequential estimation scheme given an uncertain admissible region. First, an approximate analytic probability of set membership function is defined which takes into account systemic uncertainties when assigning set membership for the admissible region. The resulting uncertain admissible region fuzzy set may then be used as a bootstrap method to initialize sequential estimation schemes. Then, the uncertain admissible region is proven to be an uninformative prior and the necessary conditions for the uncertain admissible region to be treated as a PDF are defined based on observability in the system. However, the treatment of the uncertain admissible region as an uninformative prior still requires an assumption on the a priori distribution. An evidential reasoning based sequential estimator is then developed which removes entirely the need to make assumptions on the a priori distribution of the uncertain admissible region by utilizing plausibility and belief functions. Finally a methodology is presented which enables a probabilistic association of a set of disparate sequences of unobservable measurements. This association methods uses an optimization based approach which enables a direct approximation of the PDF accompanying the state estimate in a computationally efficient way given the system is observable. The developed methodologies are tested and validated with both simulated observation data as well as experimental observation data collected with the Raven class Georgia Tech Space Object Research Telescope.