Recursive least-squares estimation in the case of interval observation data

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Abstract

In the engineering sciences, observation uncertainty often consists of two main types: random variability due to uncontrollable external effects and imprecision due to remaining systematic errors in the data. Interval mathematics is well-suited to treat this second type of uncertainty in, e.g., interval-mathematical extensions of the least-squares procedure if the set-theoretical overestimation is avoided (Schön and Kutterer, 2005). Overestimation means that the true range of parameter values representing imprecision is only quantified by rough, meaningless upper bounds. If recursively formulated estimation algorithms are used for better efficiency, for real-time applications or as the basic technique in state-space estimation, overestimation becomes a key problem. Hence, it has to be analyzed thoroughly to minimize its impact on the range of the estimated parameters. This paper is based on previous work (Kutterer and Neumann, 2008) which is extended regarding the modeling of interval uncertainty of the observations. Besides more naïve approaches, an observation imprecision model using physically meaningful influence parameters will be considered; see, e. g., Schön and Kutterer (2006). The impact of the particular models and of different recursion schemes on overestimation is studied in detail. Typical recursive estimation examples in Geodesy are presented to illustrate the theoretical results.

References

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