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Direct Filtering: A New Approach to Optimal Filter Design for Nonlinear Systems

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Abstract - Optimalfilters for nonlinear systems are in general difficult to derive or implement. The common approach is to use approximate solutions such as extended Kalmanfilters, ensemble filters or particlefilters. However, no optimality properties can be guaranteed by these approximations, and even the stability of the estimation error cannot often be ensured. Another relevant issue is that, in most practical situations, the system whose variables have to be estimated is not known, and a two-step procedure is adopted, based on model identification from data andfilter design from the identified model. However, the designedfilter may display large performance deteriorationsin the case of modeling errors. In this paper, a new approach overcoming these issues is proposed, allowing the design of optimal filters for nonlinear systemsinboth the cases of known and unknown system. The approach is based on the directfilter design from a set of data generated by the system. Either experimental or simulated data can be used for design. A bound on the number of data necessary to ensure a givenfilter accuracy is also provided, showing that the proposed approach is not affected by the curse of dimensionality.