Summary of Probabilistic Models with Uniformly Distributed Uncertainty

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Recursive estimation is an important part of the adaptive decision making tasks such as prediction and adaptive control. Adaptivity is based on the on-line learning of the underlying local model.

The system is often modelled by black-box, locally valid models. Autoregressive model with exogenous inputs (ARX) is an important representative of this model class. Uncertainty of the model is expressed by the noise that is white, zero mean and has time-invariant variance. Mostly, the noise is assumed to be normal. It induces least squares as the adequate estimation procedure. Light tails of the normal distribution imply that its unbounded support can often be accepted as a reasonable approximation of reality, which is mostly bounded.

To get more precise model, unobservable quantities (states) are to be considered. The system is then described by the state space model and the subtask of the state filtering arises. Considering normal noises in the model, Kalman filtering is the first-option method for its addressing.

In some case, however, the assumption of the noise normality is unrealistic or do not fit subsequent processing, for instance, robust control design. Then, techniques similar to those dealing with unknown-but-bounded equation errors are used. They often intentionally give up stochastic interpretation of the innovations and develop and analyze various algorithms of a min-max type. The resulting algorithms are definitely useful. But the related decision-making tasks are unnecessarily difficult because of the missing statistical tools. Thus, it makes sense to address the discussed estimation and filtering within the "classical" probabilistic setting.

The presentation summarizes results of the research of both ARX and state space models under the assumption that noises are bounded but stays within the standard, here Bayesian, estimation setup by assuming their uniform distribution. The proposed uniform models are compared with their normal counterparts.

References

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