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Derivation of the multi-model generalized labeled multi-Bernoulli filter: a solution to multi-target hybrid systems

Key words: Multi-maneuvering-target tracking; Multi-model; Generalized labeled multi-Bernoulli filter; Multi-target hybrid systems

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Motivation

- 1. Multi-target hybrid systems have attracted considerable interest in the field of state estimation and control, because it can model complicated behaviors of various estimation and control systems.
- 2. Applications of the augmented state method to probability hypothesis density (PHD), cardinalized PHD (CPHD), and multi-Bernoulli (MB) filters are straightforward since the structures of these filters are relatively simple. However, the generalized labeled MB (GLMB) filter is more complex and involves a labeled multi-target state space.
- 3. It is unknown whether directly incorporating an augmented discrete state will change the closure property of the GLMB filter. This question has not been answered although the multi-model GLMB (MM-GLMB) filter was proposed.

Main idea

- 1. The continuous kinematic state is augmented with an additional discrete mode state, and the mode state evolves as a Markov process with constant mode transition probabilities independent of the continuous state.
- 2. By defining a new H-GLMB (a GLMB for hybrid systems) density, we will prove that the H-GLMB density is closed under the Chapman-Kolmogorov prediction and Bayes update for multi-target hybrid systems.

Method

- 1. An exact derivation of the MM-GLMB filter is provided, which consists of the Chapman-Kolmogorov prediction and Bayes update.
- 2. Using the extended inner product, vector integral, and set integral incorporating the mode variables, and by substituting the new H-GLMB density into the multi-target Bayesian filter, we prove that the H-GLMB density is closed for multi-target hybrid systems.

Conclusions

- 1. A solution of multi-target hybrid systems with a focus on the multi-maneuvering-target tracking system, i.e., the MM-GLMB filter, has been derived strictly.
- 2. The H-GLMB density is closed under the Chapman-Kolmogorov prediction and Bayes update for multi-target hybrid systems.



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