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# Distributed multi-target tracking with labeled multi-Bernoulli filter considering efficient label matching

**Key words:** Distributed multi-sensor multi-target tracking; Labeled multi-Bernoulli filter; Arithmetic average fusion; Label matching

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# Motivation

- Conventional distributed labeled multi-Bernoulli (LMB) filter fusion has the premise that the labels among local densities have already been matched. However, considering that the label space of each local posterior is independent, such a premise is not practical in many applications.

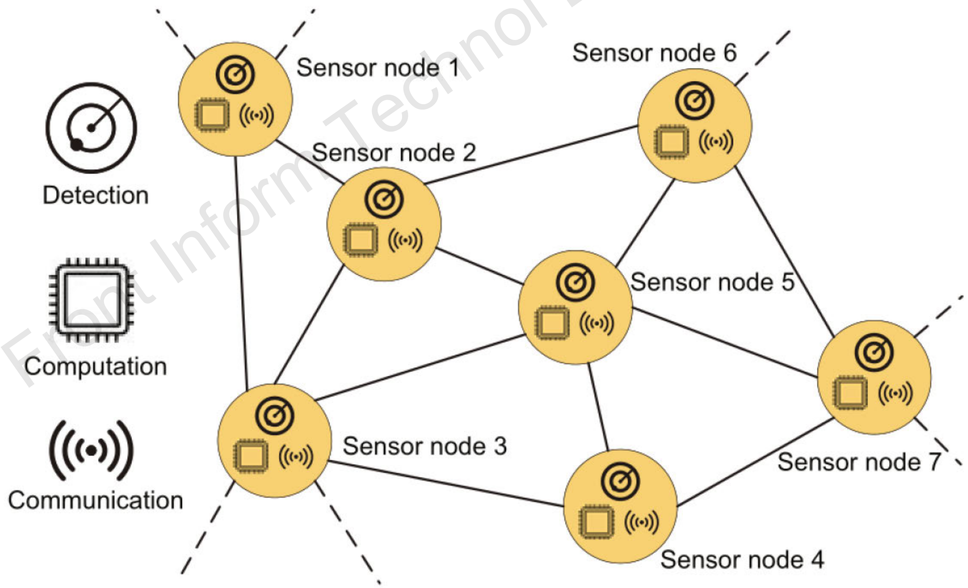


**Fig. 2** Schematic of the sensor network

# Main idea

- To achieve distributed fusion practically, we propose an efficient label matching method derived from the divergence of arithmetic average (AA) mechanism, and subsequently label-wise LMB filter fusion is performed according to the matching results.
- Moreover, to guarantee the consistency and completeness of the fusion outcome, the overall fusion procedure is designed into the following four stages: pre-fusion, label determination, posterior complement, and uniqueness check. The performance of the proposed label matching distributed LMB filter fusion is demonstrated in a challenging nonlinear bearings-only multi-target tracking (MTT) scenario.

# Method

Generalize AA divergence:

$$\begin{aligned}\tau^* &= \arg\min_{\tau} G(\Xi) \\ &= \arg\min_{\tau} \sum_{i\in\mathcal{N}} \omega_i D_{\mathrm{KL}}^{(\tau_i)} \left( \pi_i \| \sum_{j\in\mathcal{N}} \omega_j \pi_j \right).\end{aligned} \tag{33}$$

Derive the label matching cost function：

$$J(\tau) = \sum_{\ell\in\mathbb{L}_a} G(\ell, \tau(\ell)), \tag{34}$$

where

$$\begin{aligned}&G(\ell, \tau(\ell)) \\ =&\omega_a \left( D_{\mathrm{KL}} \left( r_a^{(\ell)} \| r^{(\ell)} \right) + r_a^{(\ell)} D_{\mathrm{KL}} \left( p_a^{(\ell)} \| p^{(\ell)} \right) \right) \\ &+ \omega_b \left( D_{\mathrm{KL}} \left( r_b^{(\tau(\ell))} \| r^{(\ell)} \right) + r_b^{(\tau(\ell))} D_{\mathrm{KL}} \left( p_b^{(\tau(\ell))} \| p^{(\ell)} \right) \right),\end{aligned} \tag{35}$$

# Method

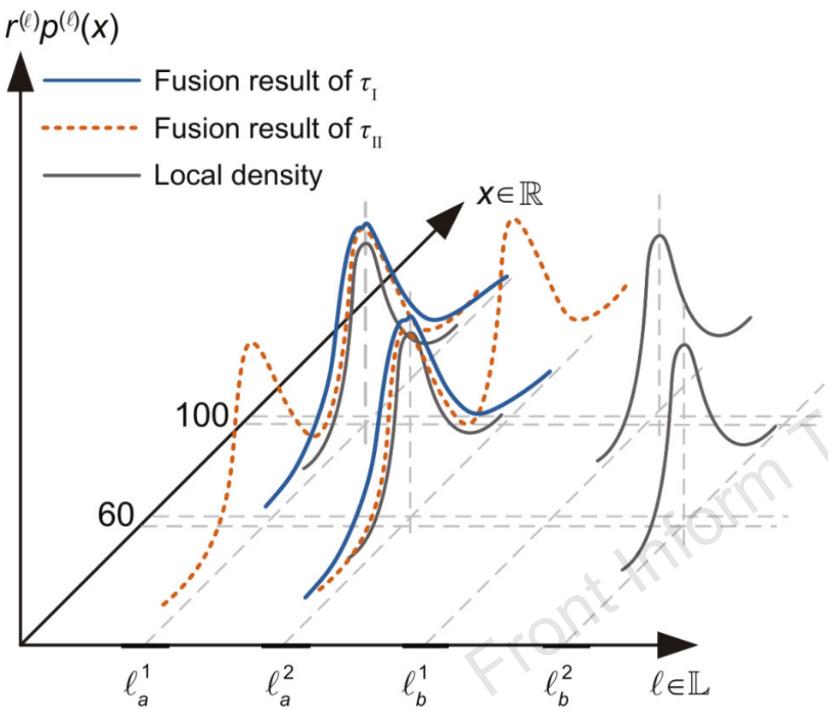


**Fig. 3 Different label matching results**

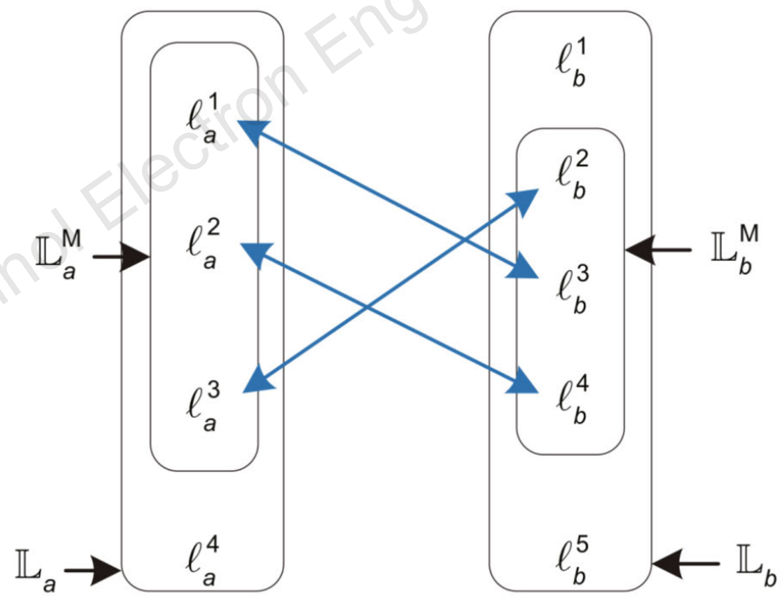


**Fig. 4 A label matching example (References to color refer to the online version of this figure)**

# Results

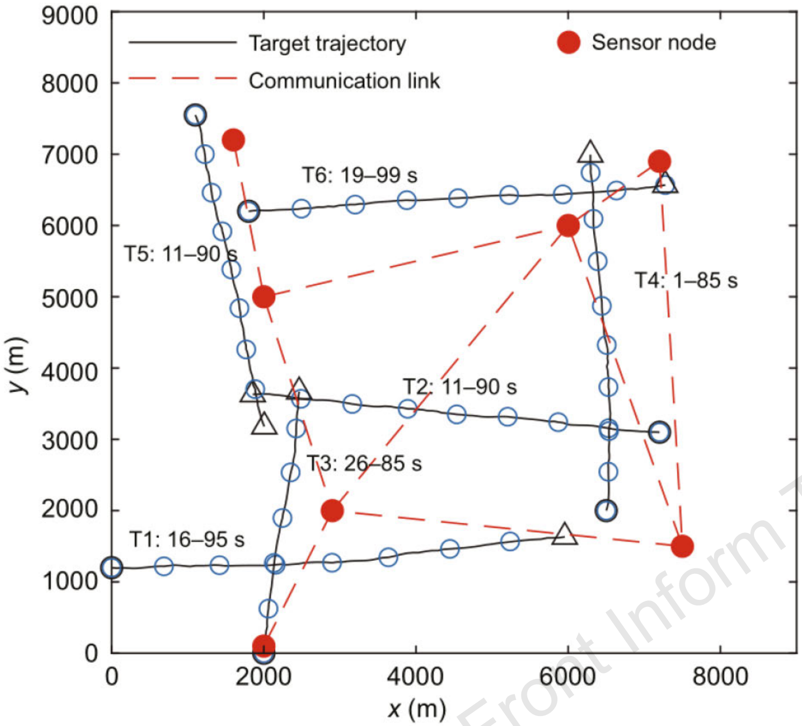


Fig. 5 A distributed network with seven bearings-only sensors and six targets, where black ∘ denotes the initial position, black △ denotes the end position, and blue ∘ denotes the position of the target every 10 s after birth. References to color refer to the online version of this figure

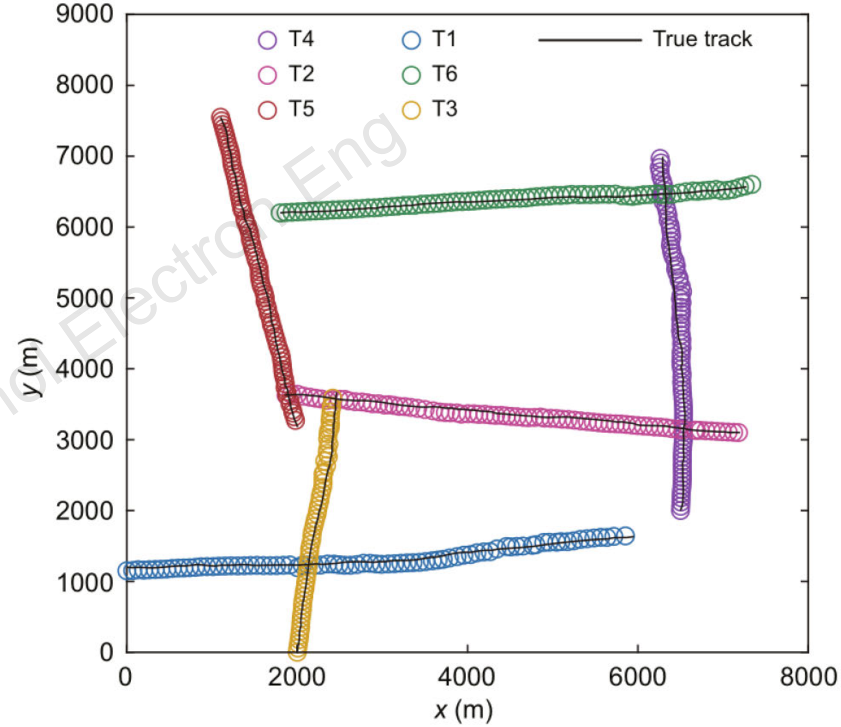


Fig. 6 Tracking results of AAF-AALM-K1 in one single run. References to color refer to the online version of this figure

# Results

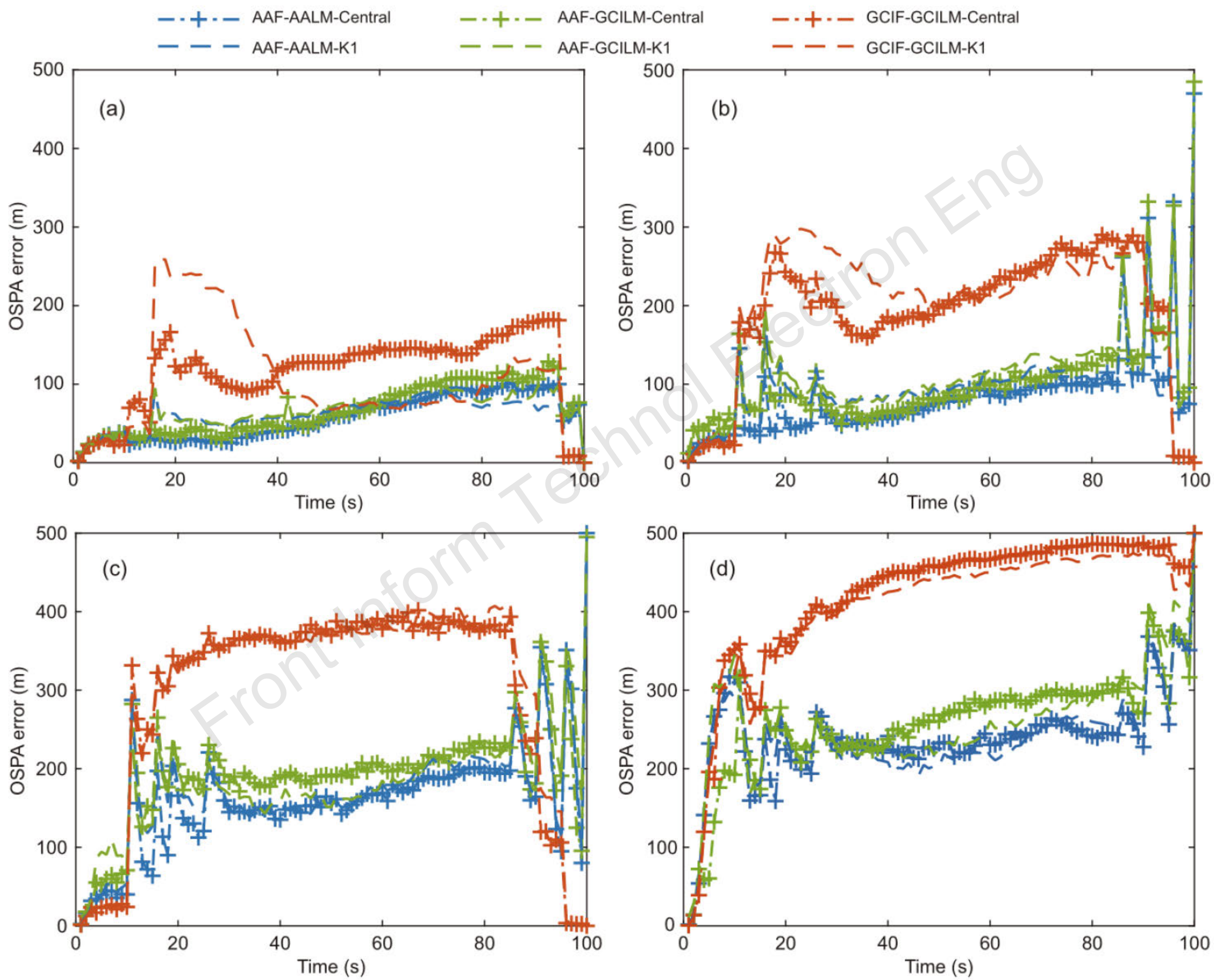


Fig. 7 OSPA errors under different detection probabilities: (a) 0.99; (b) 0.80; (c) 0.50; (d) 0.30

# Results

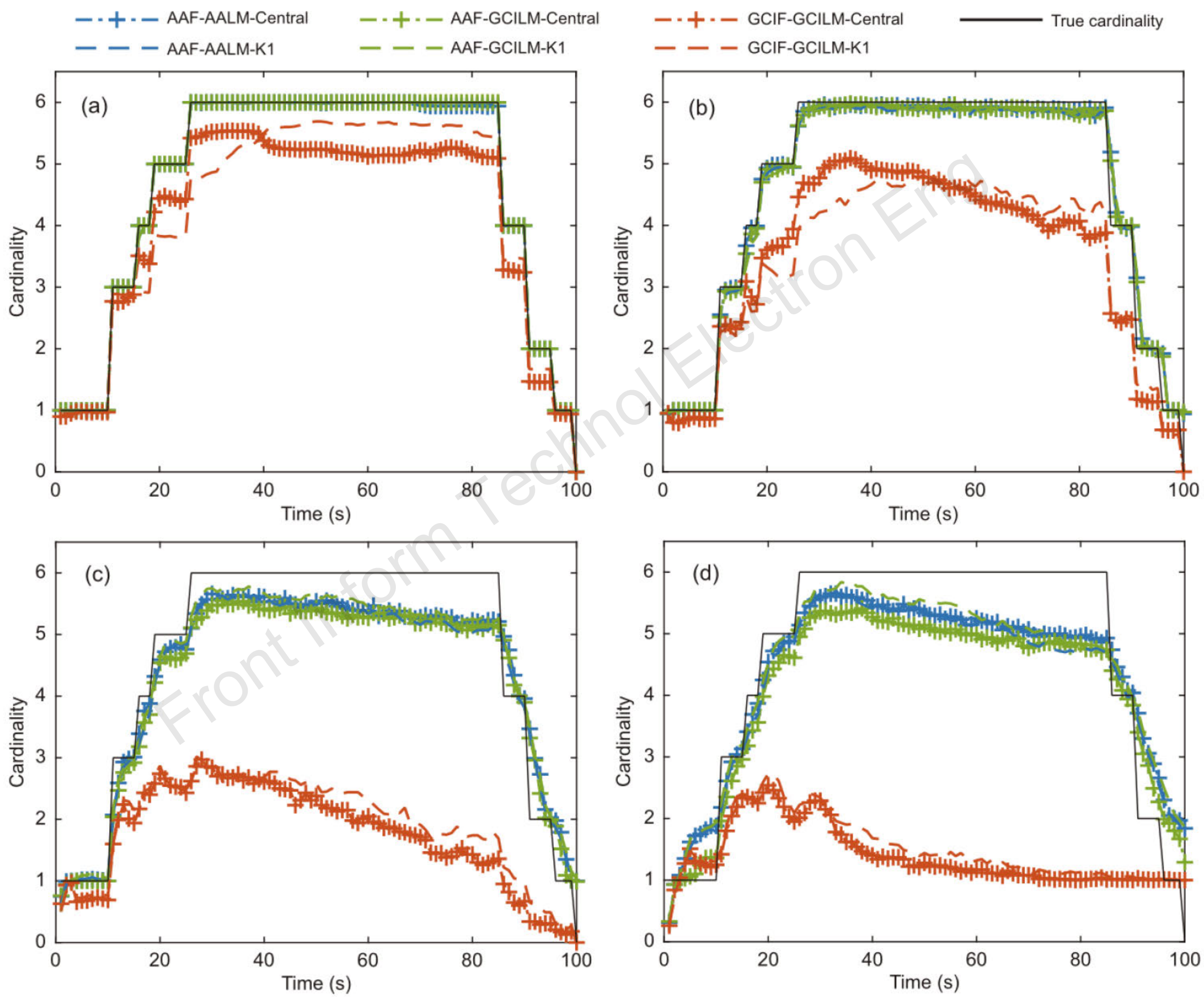


**Fig. 8** Target cardinality under different detection probabilities: (a) 0.99; (b) 0.80; (c) 0.50; (d) 0.30

# Conclusions

A distributed LMB filter with efficient label matching has been proposed in this paper. Considering the labels among local LMB densities that need to be consistent, this paper has proposed an efficient label matching method, called AALM.

This AALM first establishes a cost function which evaluates the discrepancy among local posteriors and converts label matching into a linear assignment problem. The proposed label matching method is able to guarantee high performance even in low detection probability scenarios.

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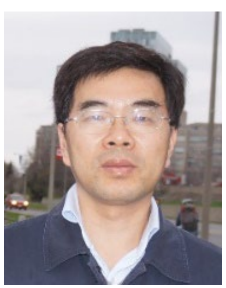

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