Distributed Multi-sensor CPHD Filter using Pairwise Gossiping

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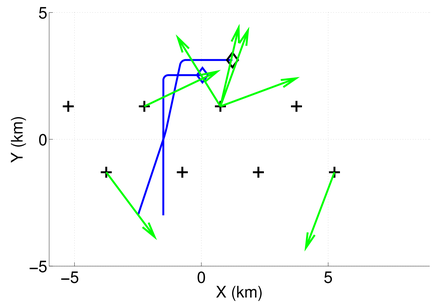
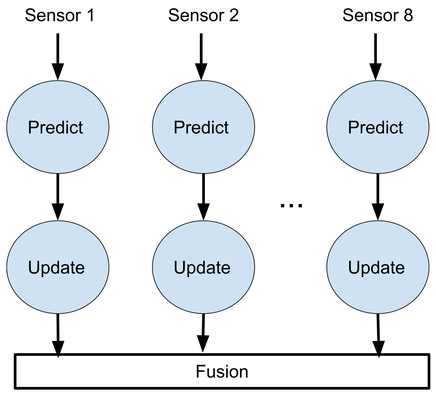
Introduction and motivation

- Multi-target tracking is an important building block in many applications, and prevalence of wireless sensors requires distributed solutions



- Consensus CPHD filter [1] requires sensors to fuse their local estimates; but missed detection by a single sensor can lead to track loss after fusion.



- We propose a new fusion algorithm which prevents track loss when not all sensors detect the target.

Fusion algorithm

Consider fusing local estimates $D^1(x)$ and $D^2(x)$

- Consensus CPHD uses Kullback-Leibler average [1]

$$D^{1,2}_{KL}(x) = \frac{\sqrt{D_1(x)D_2(x)}}{\int \sqrt{D_1(x)D_2(x)}dx}$$

- We propose using arithmetic average

$$D^{1,2}_{AA}(x) = \frac{D_1(x) + D_2(x)}{2}$$

- In case of missed detection by one sensor, we have $D^1(x) > 0$ and $D^2(x) \approx 0$. The two fusion algorithms yield $D^{1,2}_{KL}(x) \approx 0$ and $D^{1,2}_{AA}(x) > 0$ respectively.

Figure 1: Local estimate of sensor 1

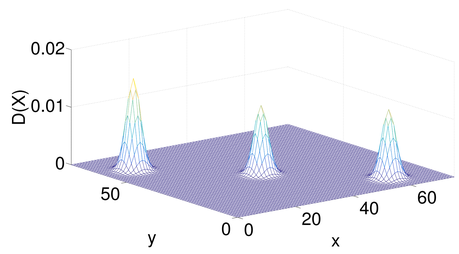


Figure 2: Local estimate of sensor 2

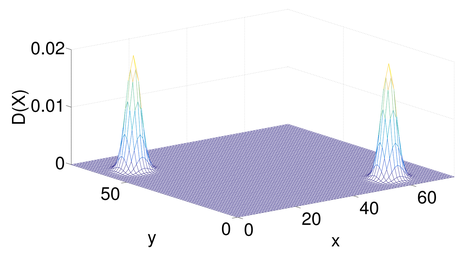


Figure 3: Fused estimate via Kullback-Leibler average

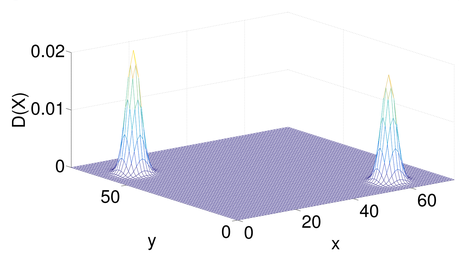
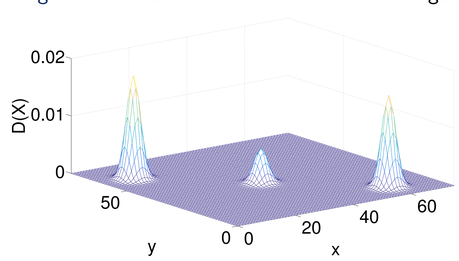
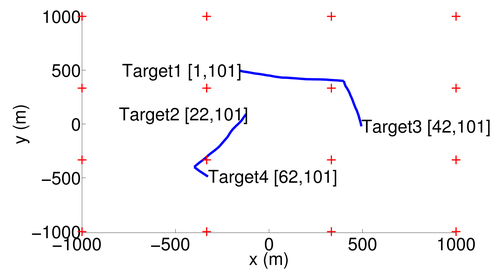


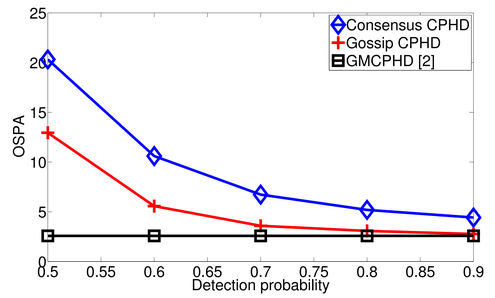
Figure 4: Fused estimate via arithmetic average

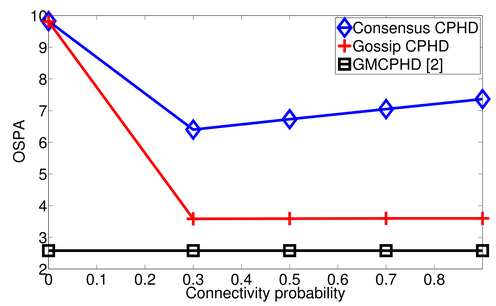


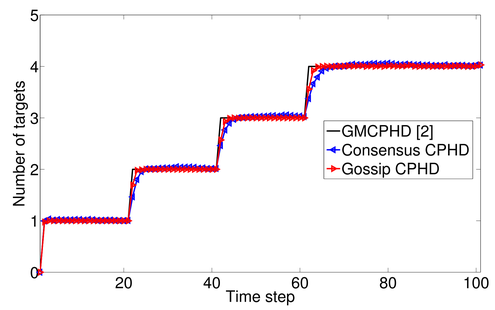
Simulations

- Sensors measure target positions with noise
- 10 clutter measurements per sensor on average
- OSPA error metric (cutoff $= 25$, order $= 1$)
- Three algorithms for comparison:
  - Distributed consensus CPHD [1]
  - Distributed gossip CPHD
  - Centralized general multi-sensor CPHD (GMCPHD) [2]





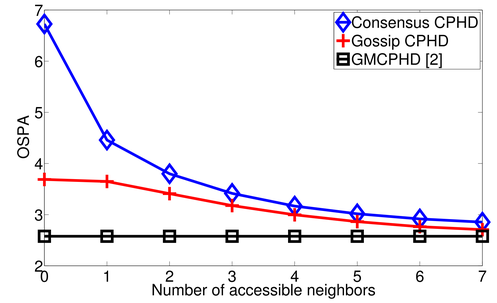




- The proposed fusion algorithm consistently outperforms existing fusion algorithm and leads to faster detection of new targets.

Proposed extension

- So far, each sensor only use its own measurements to compute local estimate.
- Allow neighboring nodes to exchange measurements.
- Compute local estimate via general multi-sensor CPHD prior to fusion.



- Exchanging measurement between neighboring sensors leads to significant improvement in tracking performance and the gain increases for larger neighborhood.

Conclusion

- We presented a new fusion rule for distributed CPHD filter.
- The arithmetic average fusion leads to improved tracking performance and faster detection of new targets.

References

[1] G. Battistelli, L. Chisci, C. Fantacci, A. Farina, and A. Graziano, "Consensus CPHD filter for distributed multitarget tracking,", *IEEE J. Sel. Topics Signal Process.*, 2013.

[2] S. Nannuru, S. Blouin, M. Coates, and M. Rabbat, "Multisensor CPHD filter,", preprint, available online at http://arxiv.org/abs/1504.06342, 2015.