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Mutual-information based weighted fusion for target tracking in under wireless sensor networks

Key words: Target tacking; Fusion weight; Mutual information; Node selection; Underwater wireless sensor networks

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Motivation

1. Underwater target tracking is an increasingly important issue in many civilian and military fields, and underwater wireless sensor networks (UWSNs) can provide a more reliable solution to underwater target tracking.

2. Energy consumption is a critical issue for target tracking in UWSNs. To extend the life of network, we need to make a good sensor selection algorithms to improve efficiency.

3. Information from different nodes varies due to node differences , it is important to consider the fusion weights of selected nodes for tracking, which can help us get more information with limited measurements.

Main idea

1. Based on mutual information between measurements and target, a novel scheme is proposed to design fusion weights, which can quantify information about the target by the node's measurement.

2. A novel multi-sensor weighted particle filter is presented. And we offer a more precise and energy efficient target-tracking solution in UWSNs.

Method

1. We formulate the problem of target tracking in UWSNs with a CV model, and use particle filter to get measurement likelihood and estimate target state.

2. We use Cramer-rao low bound as the metric of estimation accuracy, and design a node selection scheme to save energy.

3. We use mutual information to qualify information from all measurements and calculate fusion weights.

4. We carry out various experiments based on the proposed framework.

Major results

1. We derive mutual information between underwater sensor nodes and target, and use mutual information to calculate fusion weights and propose multisensory weighted particle filter.

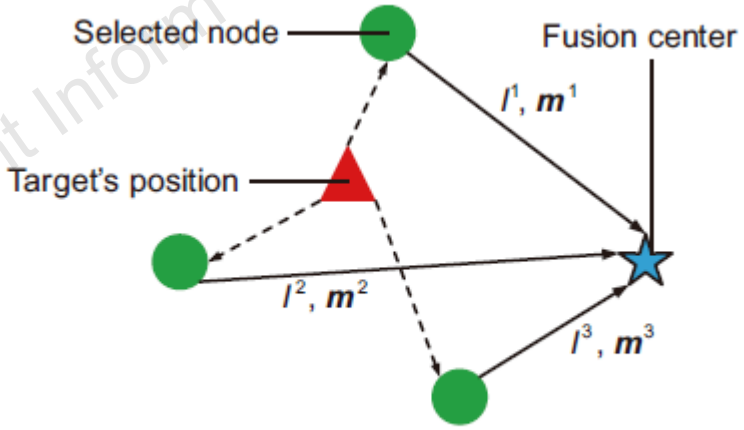

Fig. 2 Weighted fusion

Major results

2. Compared with equal weight (EW) and bad weight (BW) scheme, our proposed good weight (GW) scheme show the best tracking accuracy.

3. With proposed scheme, we can get a better performance with equal computation time and less sensors.

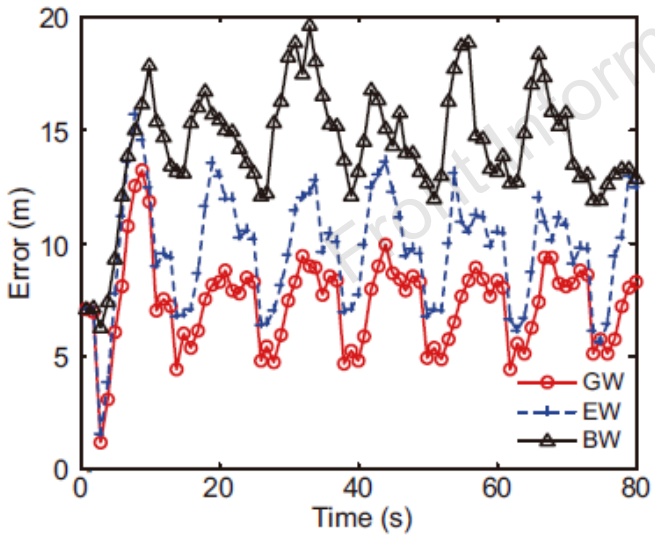

Fig. 6 2D scenario: tracking errors for the GW, EW, and BW schemes with $L = 6$ (over 100 MC runs)

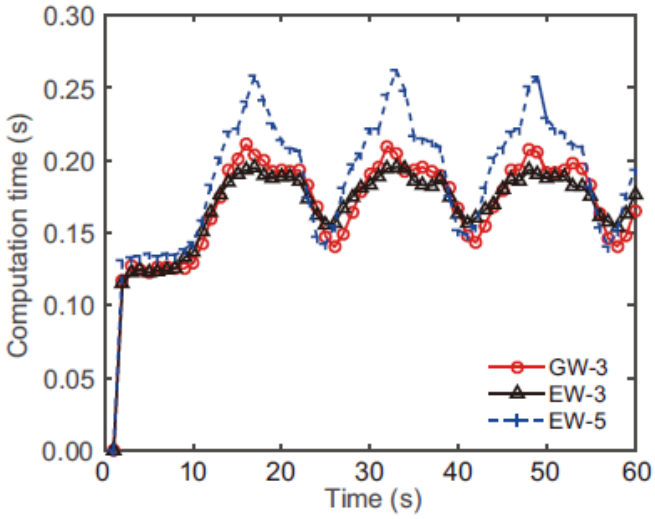

Fig. 16 3D scenario: average computation time for GW-3, EW-3, and EW-5 (over 100 MC runs)

Conclusions

1. We presented a novel multi-sensor weighted particle filter and combined with Cramer-rao low bound to design an energy efficient tracking scheme.

2. To find a proper solution to determine fusion weights, the mutual information between a node's measurement and target state was calculated.

3. The simulation results showed that with fusion weights determined by mutual information, our scheme achieved better tracking performance than existing schemes.