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Energy-efficient localization and target tracking via underwater mobile sensor networks

Key words: Underwater mobile sensor networks; Energy-efficient; Sensor localization; Target tracking

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Motivations

Underwater mobile sensor networks (UMSNs) with free-floating sensors are more suitable for under-standing the immense underwater environment. Target tracking, whose performance depends on sensor localization accuracy, is one of the broad applications of UMSNs. However, in UMSNs, sensors move with environmental forces and thus their positions continuously change, which poses a challenge on the accuracy of sensor localization and target tracking.

Main ideas

1. We propose a high-accuracy localization with mobility prediction (HLMP) algorithm to acquire relatively accurate sensor location estimates. HLMP algorithm exploits sensor mobility characteristics and a multi-step Levinson-Durbin algorithm to predict future positions.

2. Furthermore, we present a simultaneous localization and target tracking (SLAT) algorithm to update sensor locations based on measurements during the process of target tracking.

Methods

Simulation results demonstrate that the HLMP algorithm can significantly improve localization accuracy with low energy consumption and the SLAT algorithm can further decrease the sensor localization error. In addition, results prove that a better localization accuracy will synchronously improve the target tracking performance.

Localization and Target tracking Performance

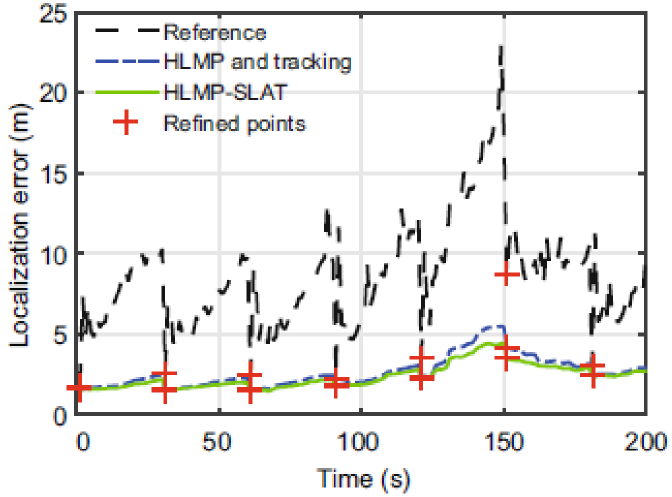

Fig. 6 Localization errors of the three schemes

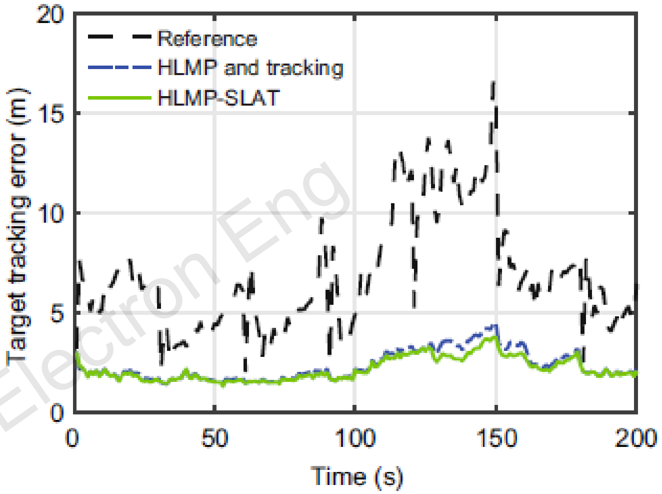

Fig. 7 Target tracking errors of the three schemes

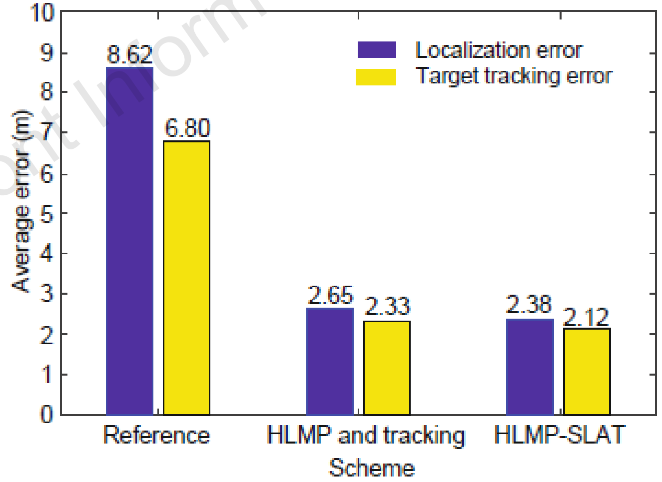

Fig. 8 Average localization errors and target tracking errors of the three schemes

Energy-efficiency

Table 2 Performances of the Reference (under different threshold D) and HLMP-SLAT schemes

Scheme	Localization error (m)	Broadcast times
Reference ($D = 10$)	6.59	769
Reference ($D = 7$)	5.11	816
Reference ($D = 4$)	3.73	878
Reference ($D = 2$)	2.76	989
HLMP-SLAT	2.62	192

Impacts of Parameters

Table 3 Average localization errors and target tracking errors under different prediction window length *H*

H	Localization error (m)		Target tracking error (m)	
	HLMP	HLMP-SLAT	HLMP	HLMP-SLAT
10	2.03	1.85	1.99	1.89
20	2.30	2.07	2.15	2.01
30	2.65	2.38	2.33	2.12
40	2.84	2.55	2.44	2.26
50	2.92	2.62	2.50	2.31

Table 4 Performances of HLMP-SLAT under different data sequence length *N*

N	Localization error (m)	Tracking error (m)
30	2.57	2.27
50	2.38	2.12
70	2.10	2.00
90	1.88	1.86
110	1.78	1.79

Table 5 Performances of HLMP-SLAT under different model order *l*

l	Localization error (m)	Tracking error (m)
2	1.69	1.79
3	1.58	1.70
4	1.68	1.74
7	2.05	2.00
10	2.38	2.12

Conclusions and future work

1. We have presented an HLMPSLAT scheme to solve the target tracking problem for UMSNs. Our HLMP-SLAT scheme contains two parts: HLMP algorithm and SLAT algorithm.

2. Simulation results showed that our HLMP-SLAT scheme can fulfill the target tracking mission in UMSNs with higher localization and target tracking accuracies and save more energy than the schemes for reference. Besides, we have analyzed the influence of different parameters by carrying out more simulations, certifying the superiority of our HLMP-SLAT scheme ulteriorly.

3. Future work will focus on the target tracking issue of UMSN with AUV.