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Research on Maritime Target Tracking for High Frequency Over-The-Horizon Radar

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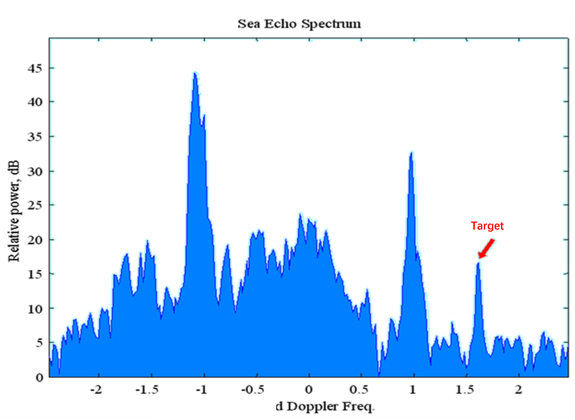
INTRODUCTION

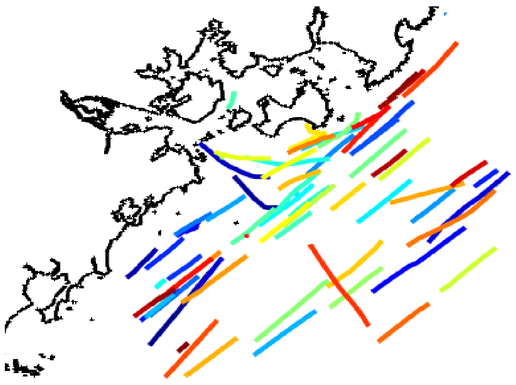
- High frequency over-the-horizon radar(HFOTHR) is an effective method to detect targets below the horizon without the limitation of earth curvature. Thus, it is of great significance for all-weather, wide-range surveillance of sea-surface targets in the exclusive economic zone.

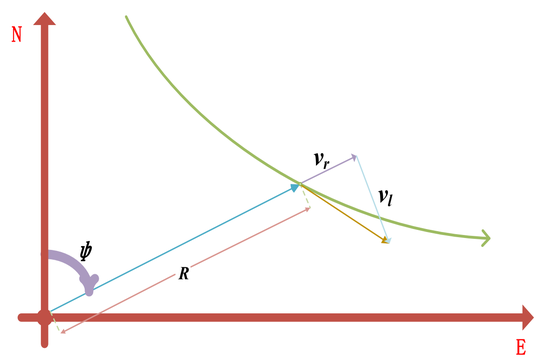


- With the increasing application of HFOTHR, the detection environment is more complicated and the real-time requirement becomes more urgent.

THEORY AND METHODS

- Before the tracking filter carried out, the system model consistent with the actual system needs to be established. The system model includes the dynamic model for target law of motion and the measurement model for modeling the process of radar observation.

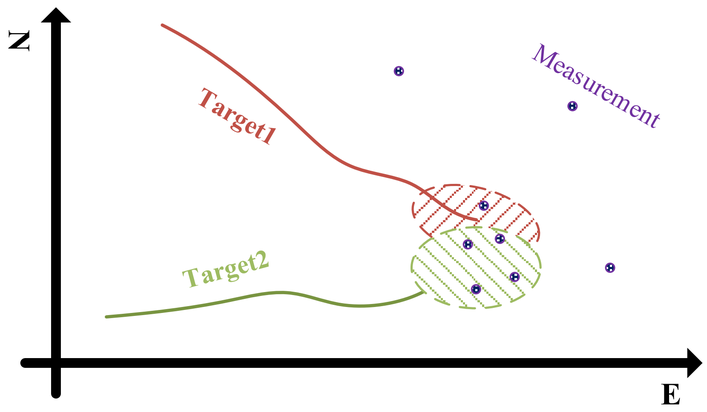




- In actual scenarios, the acquired AIS trajectory map strongly show that constant velocity (CV) model is suitable dynamic model in most cases. And, HFOTHR usually measures the target in polar coordinate system for its range, azimuth, radial velocity and lateral velocity. Therefore, the observation equations are nonlinear.

$$\begin{cases} R = \sqrt{x^2 + y^2} \\ \psi = \arctan(\frac{y}{x}) \end{cases} \qquad \begin{cases} v_r = \dfrac{xv_x + yv_y}{\sqrt{x^2 + y^2}} \\ v_l = \dfrac{xv_y - yv_x}{\sqrt{x^2 + y^2}} \end{cases}$$

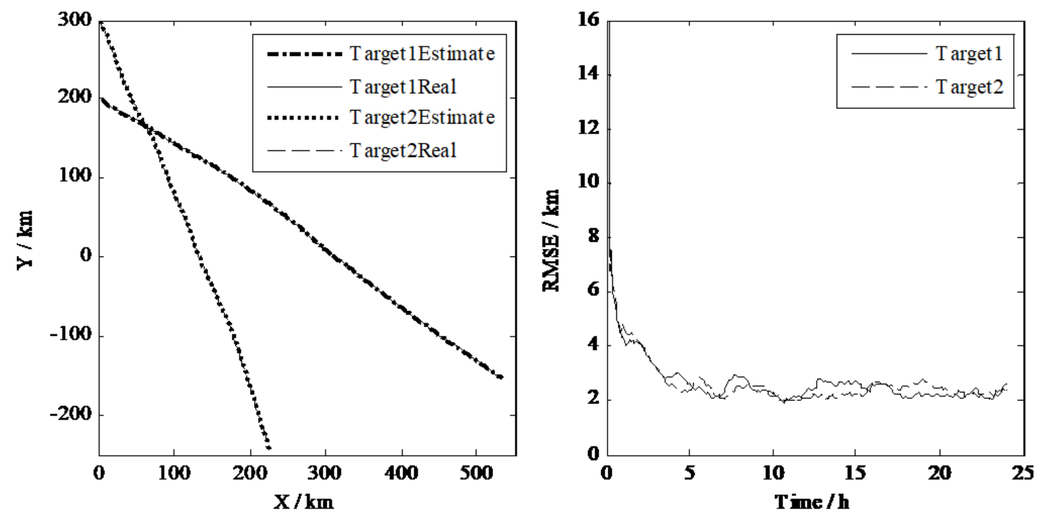
- In order to basically utilize the standard Kalman algorithm framework to track one target, the first-order approximation for the nonlinear equations is adopted. Actually, there may be plenty of targets being detected and tracked. Thus, many-to-many relationship between measurements and tracks will be established.



- For the matching problem, correlation gate for data association is performed. Then, the joint probabilistic data association (JDPA) is used for updating states of each target.
- With the increasing numbers of target, the computation complexity increases sharply for JPDA. So, PDA for targets without intersection at present time is utilized.

RESULTS AND CONCLUTION

- Two cross motion targets with different states are tracked continuously for 24 hours at interval of five minutes. The simulation results are show here.



Target number	3	4	5	6	7	8	9
original algorithm	0.50	0.85	1.60	6.50	12.0	17.5	45.0
Improved Algorithm	0.40	0.55	0.80	0.95	1.20	1.50	1.65

- Tracking trajectory is consistent with real motion trajectory and the RMSE is less than 2km that is better than the radar resolution of 5km. the average time of the improved algorithm increases linearly while JPDA increases exponentially.