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칼만필터를 이용한 선박 거동 예측에 관한 연구

A Study on the ship movement estimation by using Kalman filter

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요 약 : 본 연구에서는 레저선박 및 소형선박을 위한 지능형 충돌방지 시스템에 대한 언급하고 있다. 이 시스템의 기능은 선박으로부터 이동 물체까지의 거리와 속도를 추정하고 해당 물체와의 충돌을 회피하기 위한 제어신호를 발생하는 것이다. 본 논문에서는 칼만필터를 이용하여 대상물체의 위치와 속도를 추정하는 방법에 대해 소개한다. 실제 실험단계에서는 레이저센서를 이용하여 대상물체의 거리를 계측하고 계측된 신호에 필터링을 적용하여 대상물의 위치와 속도를 검출하게 된다. 제안한 기법의 유용성을 검증하기 위해 물체의 위치 및 속도추정에 대한 시뮬레이션을 수행하였다.

핵심용어 : 위치추정, 속도추정, 칼만필터, 선박궤적 추적, 레이저 센서

ABSTRACT : *In this research, intelligent protection system for laser boat is introduced. The function of system is to measure the distance and velocity of object from our boat and generate control signals to avoid collision with moving targets. A novel approach to estimate object's position from our ship is tackled on this paper. To do this laser sensors are used to measure distance from ship to targets. The ship position and velocity is estimated by th Kalman filter algorithm. In the real phase, the filtering method will be applied to process signal gathered by laser sensors. Simulation to estimate ship's position and velocity under noise are executed and the results are introduced to show the effectiveness of the algorithm.*

KEY WORDS : *position estimation, velocity estimation, Kalman filter, ship tracking, laser sensor*

1. Introduction

The accurate estimation and prediction of the trajectories of ship in navigation are important to improve maritime safety and security. Therefore, many ocean navigation systems and Vessel Traffic Management & Reporting Services are equipped with Radar facilities for this purpose. However, small boat and laser boats are hard to load these equipments because of its economic feasibility. Such ships are operated by experience of operator and attended by danger with collision. Hence, there is a need of develop the equivalent system. Laser sensors are proposed by recent studies (L.P.Perera, 2010) that will be important part of the target detection in close proximity.

In this research, a Kalman filter based estimation algorithm is developed to estimate relative position between ship and target. In the real phase, laser sensor will be applied to measure the signals. Developed system will give out information and alarm for ship sailing.

2. Estimation Algorithm

This algorithm will estimate distance from ship to target, relative velocity and acceleration of target to ship. In general, the target can be considered as a moving particle with unknown mass, m as shown in Fig. 1.

Assume that the target dynamic equation is described as

$$x(t) = x(0) + \dot{x}t + w(t) + \gamma(t) \quad (1)$$

where, x is distance from ship to target, $x(0)$ is initial distance. $\omega(t)$ is sensor noise - white noise, $\gamma(t)$ is process noise.

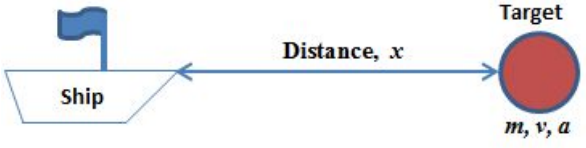

Fig. 1 Distance measurement

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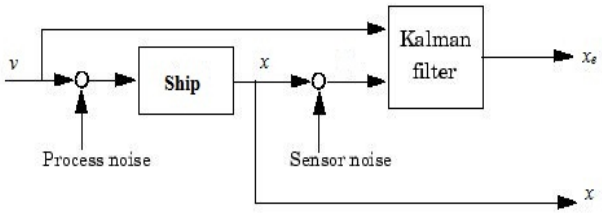

Fig. 2 Kalman filter for ship's position estimation

In next step, a Kalman filter based algorithm is applied to estimate ship's position as shown in Fig. 2. Kalman filtering is a 2 step process that is summarized in Fig. 3.

- Prediction

The filter predicts the next position and its estimated error based on the previous position and its estimated error.

- Update

The filter calculates the new position and its estimated error by updating the predicted position using distance measurements acquired during the ship moving.

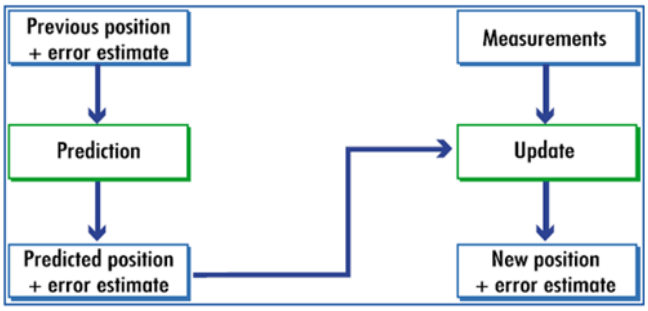

Fig. 3 Kalman filtering process

3. Simulation result

The estimation of target's position and velocity using Kalman filter is applied and its results are shown in Fig. 4 and Fig. 5.

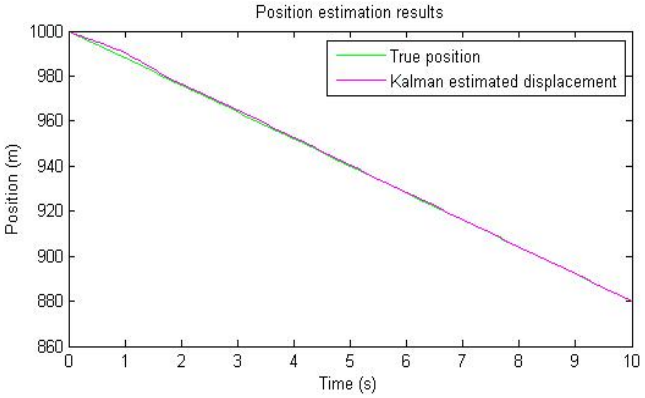

Fig. 4 Target's position Estimation

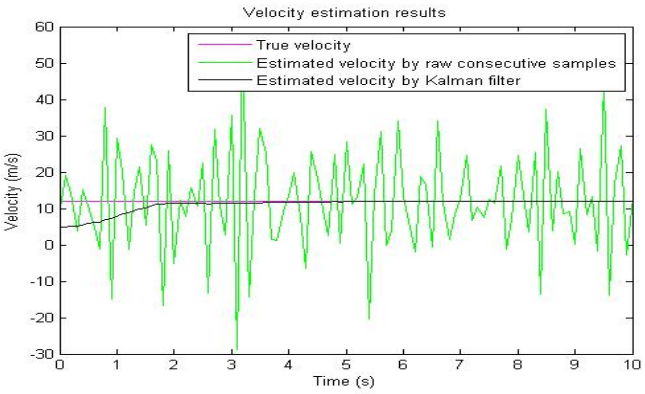

Fig. 5 Target's velocity estimation

For simulation, assuming that initial distance from ship to target is 1000 meters, ship's relative velocity to target is 12 m/s and, sensor noise is random Gaussian noise. Simulation result in Fig. 4 and Fig. 5 illustrates that position and velocity of ship are estimated with high accuracy.

4. Conclusion

In this study, an reliable approach for ship's position and velocity estimation based on Kalman filter theory was proposed. An simulation program based on Matlab is developed to verify the simulation results. In next step, a real system will be setup for experiment and developed estimation algorithm will be applied.

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References

[1] L. P. Perera and C. Guedes Soares, (2010) "Laser measurement system based maneuvering target tracking formulated by adaptive competitive neural networks," in In Proc. 2nd ADPTIVE, Lisbon, Portugal

[2] J. G. Balchen, N. A. Jenssen, and S. Sælid, (1976), "Dynamic positioning using Kalman filtering and optimal control theory," in Proc. IFAC/IFIP Symp. Au-tomation in Offshore Oil Field Operation, Bergen, Norway, pp. 183 - 186.

[3] T. I. FOSSEN and T.PEREZ, (2009), "Kalman Filtering for Positioning and Heading Control of Ships and Offshore Rigs" IEEE Control system Magazine.