Computer Life (CPL) ISSN: 1819-4818
DELIVERING QUALITY SCIENCE TO THE WORLD

Analysis on the Principle of Maneuvering Target Tracking Technology

Zhishuai Zheng[1, a,*], Jiakang Dou[1], Yubo Zhang[1],Sizhu Ai[1] and Zheng Lai[1]

[1]School of International Education, Nanchang Hangkong University, Jiangxi, China

[a]1220363230@QQ.com

Abstract: Multi-target tracking is a very important technique in both modern defense and air traffic control systems. However, the multi-target tracking system is very complex, and the multi-target sensor tracking system is a huge system. The first thing that must be addressed is tracking a single target. Therefore, this paper first introduces the principle and basic model of mobile target tracking, reviews the commonly used system model and observation model, and lays a solid foundation for future research.
Keywords: Target Tracking, Principle, Model, Photoelectricity.

1. INTRODUCTION

Photoelectric theodolite is a photoelectric measuring equipment used in shooting range to test external trajectory tracking data and flight state. Tracking system is also an important part of it. With the development of science and technology, it is necessary to estimate the motion characteristics of maneuvering targets accurately in the fields of aviation, aerospace, military engineering and astronomical observation, which brings great challenges to the tracking of maneuvering targets. In order to achieve higher requirements, different new technologies have been continuously applied to target tracking. Mobile target tracking has become a very important research direction in the field of estimation[1].

Usually, the problem in maneuvering target tracking is the mismatch between the target model and the actual motion state of the target. Therefore, the establishment of a suitable target tracking model is one of the key points of maneuvering target tracking. After that, we need to design a filtering algorithm for target tracking. The most important thing in target tracking is to track the distance, velocity and acceleration of the target. Therefore, it is of great significance to study the principle of maneuvering target tracking technology for fast acquisition and precision tracking[2]-[3].

2. THE PRINCIPLE OF TARGET TRACKING

The process of target tracking can be defined as the process of filtering the current state of the target and predicting the state of the target at the future. The core problem of target tracking is state estimation. The state of the target includes various motion parameters and descriptive parameters, such as the position, velocity and acceleration of the target. We need to estimate the state of the target according to these parameters. State estimation is carried out in both cases, such as the uncertainty of the target model and the uncertainty of the measured value. Once the actual trajectory of the target motion is inconsistent with the established target motion model, there will be a lot of errors in the tracking. The uncertainty of measurement is due to the external influence in the measurement process, resulting in noise in the measured value[4].

2.1 Single maneuvering target tracking

With the development of various new technologies, especially in today's military surveillance environment, the mobility of the target can take place The change of the over-over-earth changes has led to an increase in uncertainty in the tracking target process. These uncertainties call for maneuvering targets. The tracking system must change with the change of the maneuver, make the corresponding correct judgment and decision. in order to eliminate that goal, These uncertainties must be estimated and predicted by filtering the state of the target motion[5].

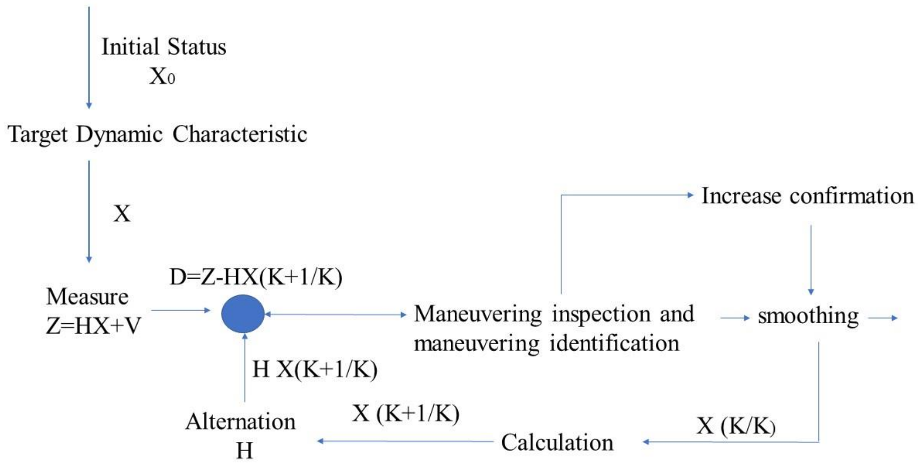

Fig. 1 Basic principle of single target tracking

From Fig.1， Firstly, the residual vector d is calculated, and then the maneuvering target is detected or identified according to the change of d. Secondly, the filtering gain is adjusted according to a certain criterion or principle, and the covariance matrix is also adjusted so that the maneuvering characteristics of the target can be identified in real time. Finally, the target estimation and prediction are obtained by the filtering recurrence algorithm, and the target tracking is realized.

2.2 Multi-target tracking principle

In the mid-1950s, since Wax first put forward the concept of multi-target tracking, multi-target tracking technology has made rapid development in theory and engineering application, and has become an important technique in military and civil fields[6].

The purpose of multi-target tracking is to divide the measured data received by the sensor into different observation sets or trajectories according to the different information sources. Once the target trajectory is formed and determined, the motion parameters such as position, velocity, acceleration and so on can be estimated correspondingly.

Multi-target tracking includes many aspects, including the formation of tracking gate, the association and maintenance of data, the beginning and termination of tracking, the underreporting and false alarm, and so on. Among them, data association is the most important and difficult problem in multi-target tracking technology.

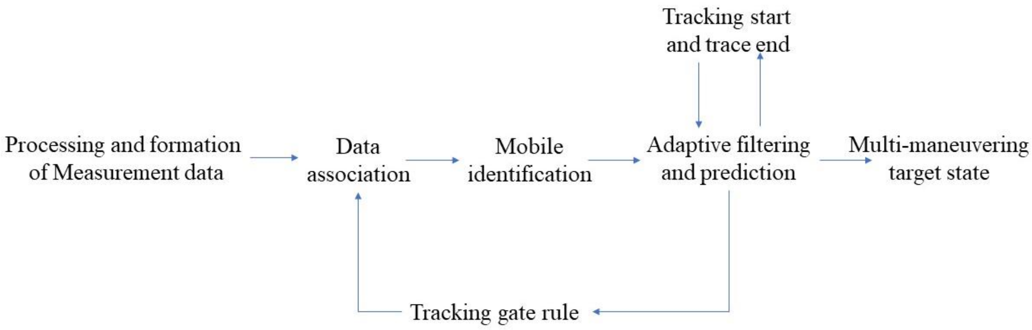

Fig. 2 Simple block diagram of multi - objective tracking.

Fig. 2 shows a simple block diagram of multi - objective tracking. assume that the whole process is recursive and that each trajectory of the target has been formed during the previous scan. by the detector the received data are first used to update the established target trajectory; the tracking gate is used to determine whether the observed trajectory is reasonable or accurate; the data association is used to determine the most reasonable observational trajectory pairing, and then according to the maintenance method package in the tracking including mobile target identification, adaptive filtering and prediction estimate the true state of each target trajectory. In the tracking area,Those observations or echoes that are not relevant to established target trajectories may come from new targets or false alarms, starting with tracking.The starting method can identify its authenticity and establish the information of these new targets accordingly; when certain targets leave the tracking area,The tracking end method eliminates these escape target information and reduces unnecessary computations.

Finally, the center of the tracking gate at the next moment can be determined by the predicted state of the target before the new observations arriveAnd size, and restart the next moment of circular recurrence.

3. SELECTION OF TRACKING COORDINATE SYSTEM AND STATE VARIABLES

In the design of tracking filter, it is affected by the following models to a large extent. (1) the measurement (observation) measured by the detector. (2) the motion of the target being followed. The establishment of these two models is affected by the coordinate system used. Therefore, it is the premise of establishing the mathematical model of the target to select a suitable coordinate system to ensure the fast and accurate tracking of the two contradictory requirements. There are two kinds of coordinate systems commonly used: one is Cartesian coordinate system, the other is polar coordinate system. For the stationary linear flight or navigation target, if the position of the target is processed in the Cartesian coordinate system, the best filtering effect can be obtained, but the measurement process of the photoelectric theodolite is completed in polar coordinates. If the filter is selected in rectangular coordinates, a large number of coordinate transformation needs to be made, which requires very high computing speed and increases the complexity of the system to a great extent. Therefore, the input parameters are obtained directly in the polar coordinate system by using polar coordinates, and the calculation amount is reduced without coordinate transformation. In addition, the observation matrix in polar coordinate system is also relatively simple. At the same time, the measurement covariance matrix is orthogonal, which can reduce the computational complexity to a great extent[7]-[9].

The general selection principle of state variables is to select a group of variables that can fully reflect the motion characteristics of the target, in order to reduce the huge amount of computation caused by the excessive dimension of state variables.

4. SELECTION OF TRACKING COORDINATE SYSTEM AND STATE VARIABLES

In order to realize the above functions, it is necessary to establish the model of target motion. The commonly used mathematical models of target motion are: uniform motion model (CV), uniform acceleration motion model (CA), time dependent model (Singer model), semi-Markov model, Noval statistical model, "current" statistical model and so on. The model is established based on the coordinate system used, so the appropriate coordinate system should be selected first.

4.1 Overview of maneuvering Target Model

From the dynamic point of view, the mathematical model of the target motion is divided into the maneuvering target model and the non-maneuvering target model. Class. The maneuvering target here refers to the sudden change of direction, speed change, turn, and so on when the target is sailing or flying. in general, The observation noise and the system dynamic system caused by random factors such as external environment interference can be more accurately described in advance. Meter characteristic noise. but typically the maneuver is random, sudden, and the size of the maneuver is not known, for example, This real-time model for establishing a maneuvering target is very difficult[10]. In the current estimation theory, the commonly used algorithm is the Kalman filter, which requires the mathematical model of the target to be used to describe state of movement of the target. A set of state variables with the least number of dimensions is selected to reflect the characteristics of the target motion. The establishment of the model is real It is the premise of the optimal tracking, and the accuracy of the tracking filtering is directly affected by the correctness of the model. in principle, the target motion model satisfies two conditions: one is to meet the actual maneuvering condition of the target, and the second is to be in favor of the mathematical treatment. non-motorized model of the target is easy to establish, and when the target is mobile, it is difficult to set up a suitable model.

In the process of establishing the target model, the modeler lacks the target motion due to the many unpredictable situations exact data, this is the state noise, needs to be introduced. if that target is move at a uniform speed, the acceleration is often regard as Is a random disturbance (state noise) and it is assumed that the noise is subjected to a gaussian distribution so that the kalman filter can be used.

However, when the target is highly mobile, such as rapid steering, the previous assumption that the acceleration is random noise is not reasonable, and the high speed of the target maneuver becomes an associated colored noise process. In this case, it is necessary to whiten the colored noise and increase the state vector.In thermal processing of residual materials with a various origin and predominantly for fire treatment of hazardous wastes rotary kiln are employed. In metallurgy they serve for heating of solid particles like oxide ores reduction, limestone calcination, cleaning of dwarfs from machine oil.

4.2 Common maneuvering target tracking model

The core problem of target tracking is state estimation.

$$X(t)=f[X(t)]+W(t)$$

The state vector X (t) usually contains the position, the speed, and sometimes the acceleration information, and the corresponding discrete measurement equation is:

$$Z(k)=h[X(k)]+V(k)$$

If the target moves at a uniform speed, the uniform model can be used. For aircraft tracking targets, uniform motion model can be used to represent the uniform acceleration motion model (CA model). If the target is moving uniformly (maneuvering), the uniform acceleration motion model can be used to represent the state model, and the state variable is a time dependent model.

The time correlation model can be divided into first-order time-dependent model and high-order time-dependent model. In 1970, Singh (Singer) regarded the sudden maneuvering of the target and the acceleration caused by atmospheric turbulence as a disturbance to the uniform moving target, and proposed a method to describe the maneuvering acceleration by using the first-order stationary correlation Markov process, which is described as the first-order time-dependent model, that is, the Singer model. If the maneuvering of the target is a long time and strong oscillation, it can be assumed that the time correlation function of the maneuvering acceleration is in the form of attenuated oscillation.

The mean acceleration of maneuvering target must be zero, which is the premise of establishing Singer model, which is not very appropriate to describe the moving characteristics of maneuvering target. Therefore, some scholars have proposed a Gaussian noise model with random switching mean value characteristics, and put forward the concept of semi-Markov model: a series of finite instructions described by semi-Markov process are used to show the maneuvering situation of the target. The transition probability of Markov process is used to determine the instruction that these transfer times are random variables. Kendrick et al described the normal acceleration of maneuvering targets as a time-dependent random pass of asymmetric distribution, and the asymmetry of probability density is represented by the following nonlinear functions.

5. CONCLUSION

In this paper, the tracking principle of the maneuvering target is studied, the tracking principle of the single object and the multi-objective is firstly analyzed, the coordinate system and the state variable are selected when the maneuvering target is tracked, and some common maneuvering target tracking models of the maneuvering target tracking are finally studied. The paper mainly introduces the "Current" statistical model of the maneuvering target, which lays the foundation for further research on the application of the target control technology in the field of photoelectric testing system and other fields.

ACKNOWLEDGEMENTS

This paper was supported by Nanchang Hangkong University “san xiao”project.

REFERENCES

[1] A. Traverso, R. Bertone and A. F. Massardo, “Transient Modeling of a Rotary-Kiln Hydrolyser”, Journal of Mechanical Engineering, 2007, Vol. 6 (12), p511-523

[2] Yongxiang Yang, Rob Boom, Brijan Irion, Derk-Jan van Heerden, Pieter Kuiper, and Hans de Wit, “Recycling of composite materials”, Chem. Eng. Process, Vol. 4 (2), p51-66

[3] D. Tsweleng, “Low-cement chrome-oxide-free cashable for use in iron making rotary kilns”, The Journal of the Southern African Institute of Mining and Metallurgy, Vol. 13 (8), p651-658

[4] Xu L, Li X R, Duan Z. Hybrid grid multiple-model estimation with application to maneuvering target tracking[J]. IEEE Transactions on Aerospace and Electronic Systems, 2016, 52(1): 122-136.

[5] Liu H, Wu W. Strong tracking spherical simplex-radial cubature Kalman filter for maneuvering target tracking[J]. Sensors, 2017, 17(4): 741.

[6] Li L Q, Xie W X, Liu Z X. Auxiliary truncated particle filtering with least-square method for bearings-only maneuvering target tracking[J]. IEEE Transactions on Aerospace and electronic systems, 2016, 52(5): 2562-2567.

[7] Fan Y, Lu F, Zhu W, et al. A hybrid model algorithm for hypersonic glide vehicle maneuver tracking based on the aerodynamic model[J]. Applied Sciences, 2017, 7(2): 159.

[8] Qian Y, Chen Y, Cao X, et al. An underwater bearing-only multi-target tracking approach based on enhanced Kalman filter[C]//2016 IEEE International Conference on Electronic Information and Communication Technology (ICEICT). IEEE, 2016: 203-207.

[9] Pradeep P D, Kumar D A, Sahu G. Estimating the target tracking using a set of range—Parameters for gain modification using kalman filters[J]. Int. J. Microw. Eng., 2016, 1(1): 1-8.

[10] Sun W, Yang Y. Adaptive maneuvering frequency method of current statistical model[J]. IEEE/CAA Journal of Automatica Sinica, 2016, 4(1): 154-160.