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Research on target photoelectricity track method and improved image processing arithmetic in dynamic targets detection system

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ABSTRACT

To solve the problem that the complexity background affects the dynamic target detection performance, which causes detection performance instability in dynamic target track system, this paper is to study target photoelectricity track method based on revolving image sensor, analyze dynamic targets track principle and track geometry relation on optical image track instrument, put forward the improved Mean Shift target track arithmetic and the improved difference image processing arithmetic to eliminate the background effect; research the positive and negative difference image processing algorithm and image target region extraction, analyze the flow of image processing arithmetic and derivate their calculation method by gathering target image in track detection system. Through experimentation gathering and processing target sequence image, the results show the target track method and processing arithmetic are accurate and feasible.

1. Introduction

Dynamic target detection is an important part in aviation, aerospace, weapons guidance and control system, precise target location and detection will effectively improve the efficiency of the intelligent control system [1]. In dynamic target detection system, detection control platform is mainly to control core, which consists of synchronized control, target detection and recognition processing, and so on [2].

Due to environmental variability, target diversity that makes all kinds of dynamic target detection is not one and only, there are unpredictable factors, especially, when the target dynamic parameter changes in long-distance outside ballistic trajectory, it exists target motion acceleration, deceleration, the background environment variety, the loading platform inconsistency, which makes remote track type target detection also brings certain difficulty [3,4]. To make track target accurate in test system, the target image processing is very important, but, conventional processing algorithms have many shortcomings, for example, track system is instable, to solve those problems, this paper researched a new dynamic targets track detection system and improved image processing algorithm.

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2. The dynamic targets photoelectricity track detection system and its track arithmetic

2.1. Dynamic targets track principle

The dynamic targets track principle can be shown by Fig. 1. A_n denotes n optical image track detection instrument that forms continuum track view in scheduled orbit.

In dynamic targets track detection system, every optical image track detection instrument has its own detection view, when the flying target enters their detection view, we use computer to gather and process targets image in order to achieve synchronization track target in scheduled orbit.

2.2. The track photoelectricity geometry relation of optical image track instrument in its detection view

In dynamic targets track detection system, when the target is moving, the image sensor will revolve according to target displacement variety in orbit, their geometry relation can be shown by Fig. 2.

Suppose, O_1O_2 is scheduled orbit in an optical image track instrument. H is the vertical distance between optical image track detection instrument and O_1O_2, OO_1 and OO_2 are their view sides, d_1 and d_2 are side length, θ_i and θ_{i+1} are revolving unit angles under even S_i and S_{i+1}, here, we make $S_{i+1} = S_i$ when target moving in orbit, β is the angle between OO_1 and O_1O_2, the revolving angle

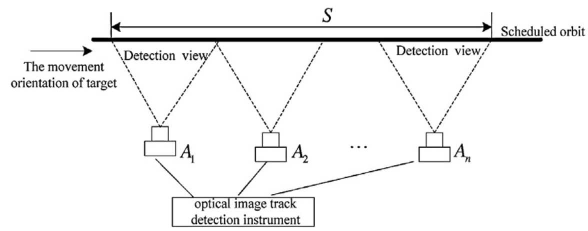

Fig. 1. The sketch map of dynamic targets track system.

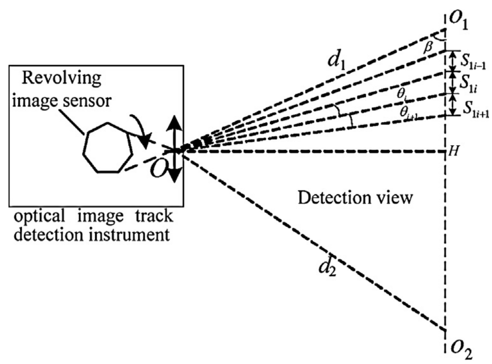

Fig. 2. The geometry relation on optical image track instrument.

is controlled by displacement variety in orbit, its moving range is decided by S, according to their geometry relation, when the moving target velocity is v, we can gain the expression (1) and (2)

$$S = \sum_{i=1}^{n} S_i \tag{1}$$

$$\theta_i = \arctan \frac{\sin\ \beta}{(d_1/\sum_{k=1}^{i} S_k) - \cos\ \beta} - \sum_{n=0}^{i-1} \theta_n \tag{2}$$

S is whole track distance in scheduled orbit, i is unit in S_1, the every image view in optical image track instrument is sum of every θ_i.

To realize synchronization real track in dynamic targets track detection system, we can gain the need control time t_i, $t_i = S_i/v$, when we know t_i, the revolving image sensor may be controlled accurately, and we can realize synchronization of real track target by combining the track arithmetic and image processing technology. Image processing technology is to look for target central point based on track arithmetic. In this paper, we research the improved Mean Shift target track arithmetic and the improved different image algorithm.

2.3. The improved Mean Shift target track arithmetic

Based on the dynamic targets track detection system, we use the improved *Mean Shift* arithmetic to realize track target in every optical image track detection instrument [5]. The target model is probability density function on gray value and part standard difference, we use nucleus density to estimate and select *Epanechnikov* nucleus function to form multi-nucleus function, which can be expressed by formula (3) and (4)

$$K_1(x) = \begin{cases} 3(h^2 - x^2)/(4h^3), & x\langle h \\ 0, & \text{else} \end{cases} \tag{3}$$

$$K_2(x) = \begin{cases} 2(h^2 - x^T x)/(\pi h^3), & x^T x\langle h^2 \\ 0, & \text{else} \end{cases} \tag{4}$$

The characteristic of the first nucleus function is the gene summation, and the second nucleus function is ensured by spatial location and target center. We use nucleus function method to set up target characteristic probability density distributing. Suppose, u is denoted the eigenvalue probability density function in target search window, we use $\hat{q}$ to denote their functions

$$\hat{q} = C \sum_{i=1}^{n} k \left(||\frac{x_0 - x_i}{h}||^2 \right) \delta[b(x_i) - u] \tag{5}$$

In (5), x_0 is central pixel coordinate in search window, x_i is the number i pixel coordinate, $k(||x||^2)$ is nucleus function, h is bandwidth of nucleus function, namely, the target radius, $b(x_i)$ is characteristic value, and δ is standard equation, C is unitary function [6].

In scheduled orbit dynamic targets track detection image system, the dynamic target image is sequence image, we may use the common characteristic in two neighborhood images to analyze their sequence image and ensure central position, suppose, y is central coordinate and nucleus function central position, $\{x_i\}_{i=1,\ldots,n_j}$ denotes the number i pixel and u is their characteristic value, and then, its probability density function of pre-election target is

$$\hat{p}_u(y) = C \sum_{i=1}^{n} k \left(||\frac{y - x_i}{h}||^2 \right) \delta[b(x_i) - u] \tag{6}$$

We use similar function to ensure image target by comparing with preelection target function, if the two functions are similar, and then, we may ensure the dynamic target positioning track system. Here, we use *Bhattacharyya* coefficient as similar function, it can be expressed by formula (7)

$$\hat{\rho}(y) \equiv \rho(\hat{p}(y), \hat{q}) = \sum_{u=1}^{m} \sqrt{\hat{p}_u(y) \cdot \hat{q}_u} \tag{7}$$

The value of $\hat{\rho}(y)$ is between 0 and 1, if the $\hat{\rho}(y)$ is higher, the degree on $\hat{\rho}(y)$ and $\hat{P}_u(y)$ will more similar, which ensures track credibility.

To make the $\hat{\rho}(y)$ most, when we select y_0 as previous frame image central coordinate, from this frame to look for the most matching target image, and then, we calculate beforehand choice model and carry thaler formula expanded in $\hat{\rho}(y_0)$, and gain the most value of $\hat{\rho}(y)$, the position is target.

Because dynamic targets track detection system adopts side track method, the moved target has start, accelerate and decelerate state in the whole orbit, we use *Mean Shift* track method to gain image target central coordinate to reach dynamic track availably.

3. Target image processing algorithm

3.1. The basic principle of difference image

In target detection system, if we need accurate synchronization track target, it is necessary to select moving target image feature. The previous frame and rear frame image will have obvious differences in target image, difference image is the premise that the dynamic target feature extract, the image on motion target was represented as previous and rear image intensity gray variation characteristics in whole integral time [7], we can identify motion target image gray feature changes on the basis of the image moving target characteristics, which can be described by adjacent serial image gray variation, suppose, dynamic target image was defined by formula (8)

$$f(x, t_1, t_2) = f_2(x, t_2) - f_1(x, t_1) \tag{8}$$