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Regular article

Infrared dim target detection technology based on background estimate

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HIGHLIGHTS

- Basic principles and the implementing flow charts of infrared dim target detection algorithms.
- Dim target detection experiments for IR images.
- Subjective and objective evaluation method for infrared dim target detection algorithms.

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ABSTRACT

Accurate and fast detection of infrared (IR) dim target has very important meaning for infrared precise guidance, early warning, video surveillance, etc. In this paper, two new algorithms – background estimate and frame difference fusion method, and building background with neighborhood mean method are presented. The basic principles and the implementing procedure of these algorithms for target detection are described. Using these algorithms, the experiments on some real-life IR images are performed. The whole algorithm implementing processes and results are analyzed, and those algorithms for detection targets are evaluated from the two aspects of subjective view and objective view. The results prove that the proposed method has satisfying detection effectiveness and robustness. Meanwhile, it has high detection efficiency and can be used for real-time detection.

1. Introduction

The main thought on infrared detection and tracking technology is as follows: Extracting target from pre-given infrared frame for operators, meanwhile, tracking object and predicting next position according to actual movement orbit. Presently, the operating principle of infrared object detection system is that infrared sensor receives infrared radiation from both object and background, and then generates real-time infrared image with different temperature distribution in terms of physics characteristics of target and background. As there are all kinds of disruptive factors triggered by system or environments, we have to revise real-time images before the image pro-processing to improve signal to noise ratio so as to realize target detection by using the correspondent detection algorithms one by one. It needs to make a correlation with current detected target and previous detection result as there may be false-target existing in the detection process. We can build up the movement orbit of correct result for the follow-up processing. Finally, we can realize detection and tracking with effective algorithm [1–5].

In this paper, the infrared target detection algorithms are discussed, namely, background estimate and frame difference fusion method, and building background method with neighborhood mean. Then we do some experiments by using this software platform. The implementing processes and results are analyzed. The experimental results show that these methods are efficient for the detection of the infrared targets. It has the great significance practical for the application.

2. The detection algorithm principle

2.1. Background estimate and frame difference fusion method

First of all, one frame is considered as the background frame in background estimate method, after that, a new background is attained by background update mechanism, at the moment, we can get target information by subtraction between current frame and corresponding background frame. Although this method is simple and easy for hardware implementation and it is able to extract the characteristic information of targets. However, the background

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estimate method is sensitive to the natural conditions, once the intensity of natural light changes quickly or there are cloud shelters, it will have great influence on the testing results. This is a deadly deficiency which is hard to overcome for the algorithm, at the same time, this method is very dependent on efficient background model and its update mechanism. Secondly, the traditional frame difference method mentioned has its own shortage, it is easy to produce "cavity area" or "double image", so we would rather combined with the advantages of the two algorithms in the subject, so that it can get better experimental effect. After the experiment, it is proved that this algorithm can adapt to a variety of environment, and to some extent, it is superior to traditional two frame difference method and background estimate method [6–7].

The process of background estimate and frame difference fusion method is introduced as following: Firstly, setting a frame as the initialized background image $B_i(x, y)$, then the current frame Ii subtracts the background image B_i, so we will get a difference image $DB_i(x, y)$, then we compare each gray value in the difference image with the threshold T, which can be expressed by the mathematical formula (1):

$$d = |I_i(x, y) - B_i(x, y)| \tag{1}$$

$I_i(x, y)$ means the gray levels of pixels in current frame, $B_i(x, y)$ means the gray levels of pixels in background frame, d means difference image.

Thresholding on formula (1):

$$DB_i(x, y) = \begin{cases} 1, d \geqslant T \\ 0, d < T \end{cases} \tag{2}$$

$DB_i(x, y)$ means the pixel gray scale value after binaryzation, T is judging threshold.

Now combining the binary images obtained by background difference method and the binary image obtained by improved three frames difference method, using mathematical expression to show as follows:

$$C_i(x, y) = \begin{cases} 1, DB_i(x, y) \cup B_i(x, y) = 1 \\ 0, DB_i(x, y) \cup B_i(x, y) \neq 1 \end{cases} \tag{3}$$

$B_i(x, y)$ means the three frames difference result, $DB_i(x, y)$ means the background difference result, $C_i(x, y)$ means the infrared target finally extracted from the image. The whole operation process can be shown in flow chart Fig. 1.

From Fig. 1, we can see that in the process by using the background estimated method and frame difference method to detect target, first of all, the original video is decomposed into frames sequence, and changed it into gray image; and then the first frame gray image is considered as the initial background frame, and we do subtraction operation between the current frame gray image and the corresponding background frame, then threshold on the difference results and do logical "and" operation for the binary image of background difference method and the binary image of improved three frames difference method, if the result is "1", it is set as a foreground pixel, otherwise it is set as a background pixel, after that we need to update the background image.

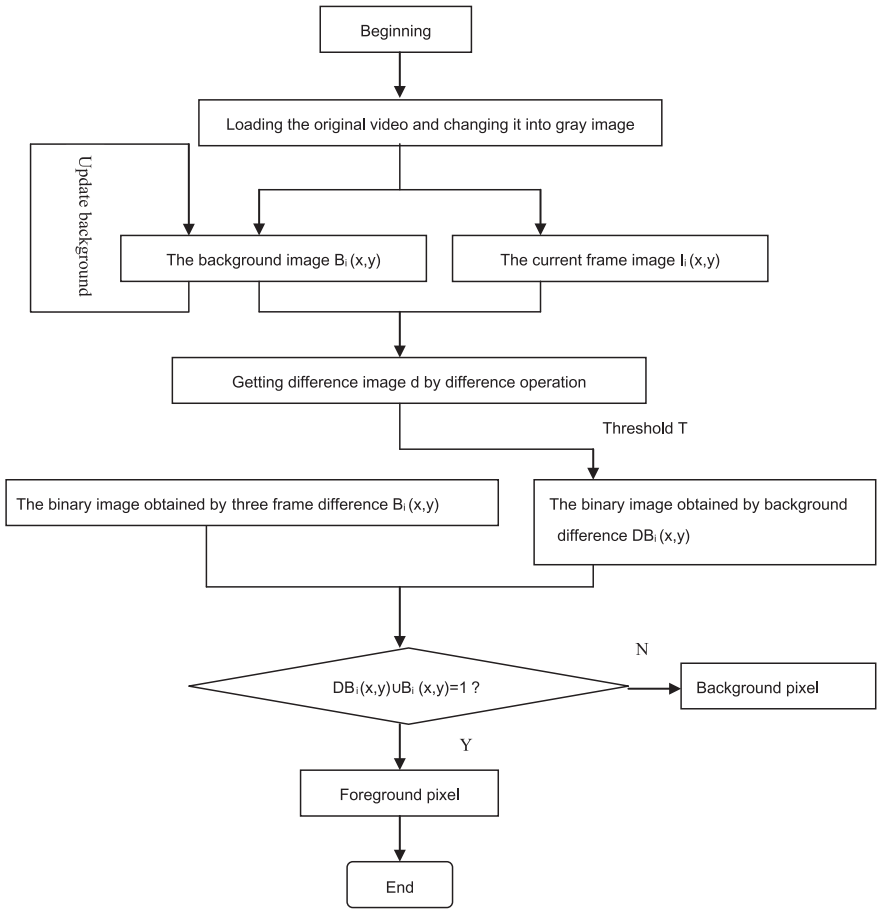

Fig. 1. The flow chart of background estimate and frame difference fusion method.