Research on Infrared Multi-target Detection Method based on Laser Visual Recognition

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Abstract: In recent years, significant research has been successfully applied in many fields such as target detection, recognition, and image compression. These fields include infrared small target detection. As a key technology in the field of infrared self-seeking guidance, search tracking and early warning, infrared small target detection, especially the air target under complex cloud interference, infrared small target of sea and sky background under sea clutter and cloud interference, and complex Small target detection in the ground background is still the current research hotspot and difficulty. On the basis of comprehensively summarizing the work of the predecessors, this paper has carried out in-depth research on the feature extraction of infrared small target images and the construction of visual saliency models under complex background.

1. Introduction

In recent years, significant detection has been successfully applied in many fields, and the infrared small target automatic identification system is a specific application field. With the continuous development of infrared technology, infrared imaging systems have been widely used in military or civilian fields such as precision guidance, target detection and fire control, optical remote sensing and night navigation. The advantages of good concealment, strong interference performance, long distance of action and day and night work make infrared technology play a crucial role in these fields, and infrared small target detection is the key technology in this system. It is still the current research hotspot and difficulty, especially in the case of interference with clutter and complex background, the detection method has been difficult to break through. Applying the saliency detection model to the infrared target recognition system provides a new idea and method for infrared small target detection.

2. Infrared spectral characteristics analysis

The image of the object point on the focal plane of the imaging detector is not an ideal geometric point, but a diffuse circular spot, commonly referred to as a diffuse plaque. It is generally believed that the infrared imaging system obeys the Gaussian distribution. Therefore, when describing the point target image, it is assumed that the energy probability density obeys the Gaussian distribution, and the size of the image is affected by the image quality of the optical system, the blur caused by the line of sight jitter, the atmospheric and the target angular diameter, respectively. θ like O, θ like J, θ like A, θ like T denotes the contribution of the optical system, line of sight jitter, atmospheric and target angular diameter to the image size, and the target image point angle diameter.

The overall infrared radiation intensity of the aircraft comes from aircraft skins, engine hot parts, and wakes. Aircraft skin (body) radiation can be subdivided into skin radiation, skin reflections from direct sunlight, and skin reflections on background radiation. The exhaust wake radiation (tail nozzle) is mainly derived from the radiation generated by H2O, CO2, C particles, etc. during molecular combustion in the wake. Factors such as the flying state of the aircraft, the angle of observation, etc. all have an effect on the intensity of the radiation. The infrared spectrum of the bait is similar to the target infrared spectrum. Most of the bait is a chemical heat source. It is usually composed of a combustion agent, an oxidant or a binder. It is irradiated with black or gray body characteristics, such as magnesium-polytetrafluoroethylene (Mg PTFE). . Shorter light-off times,

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longer periods of operation and a reliable separation speed will maximize the deceptive effect of the bait.

3. Infrared small target detection method based on spectral residual

Infrared small target detection plays an important role in automatic target recognition systems such as remote infrared detection, infrared guidance and infrared warning. Since the infrared target detection based on single-frame image requires few imaging resources and high processing efficiency, it has a wider application than multi-frame based infrared target detection. In most cases, it is even more the basis of frame image detection. Generally, the difficulty of infrared small target detection under single frame conditions mainly comes from background clutter, noise interference, and changes in target characteristics, which leads to a high false alarm rate while ensuring the detection rate. In addition, many traditional methods focus on target detection in fixed scenarios, and cannot meet the needs of use under a variety of background conditions. In view of the above problems, this chapter proposes an improved infrared small target detection method based on spectral residuals based on the visual attention mechanism of human eyes. Research shows that after the image is transformed by frequency domain, the spectrum information contains a lot of information related to saliency, while the traditional method based on high-pass filter is not suitable for single-frame infrared small target detection. In this chapter, according to the imaging characteristics of the target, that is, the local highlight of the small target and the Gaussian shape, the image is divided into two directional feature channels. In these two channels, the SR method is used to generate the saliency map of the corresponding direction. Finally, the saliency maps of the two feature channels are fused to enhance the target. The acquisition of the two directional features uses a stepwise operator of Sobel. This method can better overcome the influence of infrared image noise compared with the traditional spectral residual method. The experimental results on real shots of several small infrared target images show that the proposed method is more advantageous than the original SR infrared target detection.

The basis of spatial and frequency domain linear filtering is the convolution theorem, which can be written as: f (x, y) = h(x, y) *H (u , v) F (u , v)

Among them, the symbol "*" represents the convolution of two functions, and the expressions on both sides of the double arrow constitute the Fourier transform pair. This expression indicates that the convolution of two spatial functions can be obtained by computing the inverse of the product of two Fourier transform functions. Conversely, the Fourier transform of the convolution of two spatial functions is exactly equal to the product of the Fourier transform of the two functions. The filtering in the spatial domain consists of the image f (x, y) and the filtering mask h(x, y). According to the convolution theorem, we can get the same result by multiplying F (u , v) by H (u , v) in the frequency domain, that is, the Fourier transform of spatial filtering. We usually refer to H (u , v) as the filter transfer function. Basically, the purpose of frequency domain filtering is to select a filter transfer function to modify F (u , v) in the specified way. After multiplying by a centered function F (u , v), the transfer function attenuates the high frequency components of F (u , v) while leaving the low frequency components relatively unchanged. A filter with this characteristic is called a low-pass filter, and the effect of the low-pass filter is to blur (smooth) the image. The infrared small target usually corresponds to the high frequency part of the image, so as described above, the conventional high-pass filter is often used in the detection of small targets. Below we describe three classic frequency-domain high-pass filters: ideal high-pass filters, Butterworth high-pass filters, and Gaussian high-pass filters. The ideal high pass filter is a step filter. The filtering effect of the Butterworth high-pass filter is between the ideal high-pass filter and the Gaussian high-pass filter.

4. Infrared small target detection method based on super complex amplitude spectrum

In reality, human vision often exhibits efficient, fast, and accurate detection of targets, and it benefits from the unique visual attention mechanism in the human visual system. Therefore, more in-depth exploration and research on the principle of human vision can bring important inspiration

to the infrared target detection in the automatic target recognition system, and play an important guiding role. At present, more and more automatic vision detection methods based on biological vision have been proposed, indicating that this field is being highly valued by more and more researchers, and it will also provide new opportunities for the development of automatic target recognition system algorithms to break through traditional bottlenecks. Ideas. Cognitive psychology shows that the visual attention mechanism can effectively distinguish the significant patterns in the scene that differ greatly from the general background patterns. This process can be realized by visual saliency calculation. In the remote infrared thermal imaging system, the small target is affected by the optical point diffusion effect and exhibits an approximately isotropic Gaussian shape, while the background clutter texture usually has local directionality, which can be regarded as the target and background texture mode. difference.

This paper constructs a saliency detection model based on super complex amplitude spectrum. We call it Hypercomplex Fourier Transform Using the Directional Features (HFTDF), which effectively uses the information of the image amplitude spectrum. It is applied to the detection of small infrared targets. This model solves the problem of small target detection from two angles. First, the saliency detection of infrared small targets is converted into the problem of frequency domain analysis of images. Second, the concept of non-significant is cited, by compressing the repeated non-symbols. Significant areas to achieve the goal of enhancing the area of significance. This chapter will also prove that the convolution of the amplitude spectrum of the image with the low-pass Gaussian kernel of the appropriate scale can suppress the non-significant region enhancement significance region, which is equivalent to the frequency domain significance detection operator. Of course, in the specific implementation process, the original image is not directly used (the experimental effect is not ideal), but the original 2D image is reconstructed by constructing its super complex matrix form. Therefore, the feature composition of the super complex matrix is also the key of this chapter. Since the small targets are subjected to the optically diffusing effect and exhibit the approximate isotropic Gaussian shape, and those background non-significant regions, the clutter texture and the like usually have local directionality, so we consider the directional characteristics when reconstructing the image to optimize Test results. Through a large number of experimental results analysis, we constructed super complex feature coefficients for infrared images, which are the second-order derivative fusion features of two vertical intersections of images 0 and 90, and the second-order derivative fusion of two perpendicular intersections of 45 and 135. Features and grayscale features after image smoothing. The amplitude spectrum contains a lot of information about the scene. Filtering the amplitude spectrum by selecting a suitable scale by Gaussian low-pass filter can suppress the non-significant region and obtain a significant small target region. Through a large number of analysis, evaluation, and comparison of several classic small target detection algorithms, the experiment demonstrates that our small target saliency method is outstanding in both qualitative visual analysis and quantitative data analysis.

5. Conclusion

In the past decade, with the development of science and technology and the richness of research methods, the exploration of human visual attention mechanism has attracted a lot of interest from many researchers including neurobiology and computer vision. On the one hand, the human visual system has recognized unparalleled ability to understand the scene. Its principle lays an important foundation for the computer's bionic intelligent information processing and data analysis, and further helps people understand and improve the knowledge of the brain's visual system structure. On the other hand, the mastery of visual attention mechanisms can effectively promote and promote the development of fields including computer science and artificial intelligence science. Among them, as one of the core elements of the visual attention mechanism, the visual saliency calculation simulates the observation and analysis mode of the human eye on the scene, quickly and accurately locates important information in the scene, and suppresses or ignores the background redundant information. This efficient information processing method provides a new solution to the detection

problem in the traditional infrared small target detection system. In theory, it can not only improve the processing efficiency of the algorithm, but also reduce the false alarm more effectively and improve the accuracy of detection. However, until now, whether it is the construction of the visual saliency model or the research on the target detection method based on the visual attention mechanism, it is still in the exploration stage, and its development is not mature. In view of this, this paper focuses on visual saliency calculation, focusing on infrared small target detection based on spectral residual and super complex transformation.

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