и прекращения трудовых отношений, основания увольнения, виды трудовых договоров и иные виды условий труда работника указанные в договоре;

– используемая система: (компьютер, планшет, смартфон);

– операционная система: Windows, Mac OS, Linux/Unix, Android, IOS;

– веб-приложение разработано в фреймворке Django, на языке программирования Python.

Создание цифровой системы информации о трудовой деятельности граждан позволяет модернизировать учетную политику и предназначено для государственного управления системой обеспечения трудовыми ресурсами.

Создание цифровых баз трудовой деятельности граждан дает возможность проанализировать вопросы, которые могут возникнуть в связи с переходом к цифровой экономике.

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AN INFRARED DIM OBJECT DETECTION ALGORITHM BASED ON FEATURE REFINEMENT PERCEPTION

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To protect structure texture of theinfrared dim target, this paper puts forward aninfrared dim target detection algorithm based on feature refinement perception.The feature refinement perception operation is used to rich structure texture information.The proposed algorithm can not only effectively suppress background clutter, and realize the precise separation of the target and the background.

Keywords: infrared dim target detection, feature refinementperception.

Introduction. Infrared detection technology is widely used in the military field of such as aviation, navigation surveillance and flight guidance, due to its advantages of strong penetration capability, anti-jamming capability and all-weather detection [1]. Infrared target scene usually has the characteristics of far target distance, small target size, complex target imaging background and lack of texture information, which makes the infrared small target detection task more difficult.

Infrared dim target detection can be divided into filtering-based methods, local contrast-based methods, low-rank sparse recovery methods, and deep learning-based methods. [2] proposed an improved local contrast algorithm, which uses the gray mean value of the central window as the suppression factor to reduce the contrast value of high brightness point noise and reduce the false alarm rate of the algorithm [3] extended the infrared patch-image to 3D, constructed the patch-tensor model, and realized the detection of targets by recovering the low-rank components and sparse components in the patch-tensor model. The rapid development of target detection methods based on deep learning has brought the infrared small target identification method to a new stage [4] proposed an infrared target detection algorithm for attention-guided context feature pyramid network, which not only uses the local correlation of feature maps, but also integrates the feature information of deep and shallow layers of the image to efficiently extract target features. The performance of deep learning-based detection method mainly depends on the discrimination of training samples to extract features. In some specific scenarios, it has stronger adaptability than traditional methods.

Based on the method of low-rank sparse recovery, this paper proposes feature refinement perception combined with infrared small target detection of mask patch-tensor model. It enriches the target features through feature fine perception operation, and the patch-tensor is built on the basis of mask map to effectively suppress the background clutter and realize the accurate detection of targets.

Feature refinement perception. The exponential form of the local derivative is introduced in the MLV (Mean Local Variance) filter, and the local derivative can clearly reflect the image texture through the change of the exponential. The EMLV (Exponentially Mean Local Variance) filter [5] is as follows:

$$f_{EMLV}(O) = f_{MLV}^{\gamma}(O) = \left| \frac{1}{|\Omega|} \sum_{\Omega} \nabla O \right|^{\gamma}, \tag{1}$$

where, Ω is the local patch around each pixel of image O; $|\Omega|$ is the number of elements of Ω; γ is gradient sensitivity index of O.

Light exposure and reflectivity can capture the structure and texture information of the objects in the scene, respectively. The structural texture perception approach is to extract the illumination and reflection components of the scene using the Retinex module. In this paper, the weighted matrix based on structure and texture information is set, and acts on the illumination and reflection components to enhance the low light image. Weighting matrix based on EMLV filter:

$$S_0 = \frac{1}{\left(\left| \frac{1}{|\Omega|} \sum_{\Omega} \nabla I_0 \right|^{\gamma_s} + \varepsilon \right)}, \; T_0 = \frac{1}{\left(\left| \frac{1}{|\Omega|} \sum_{\Omega} \nabla R_0 \right|^{\gamma_t} + \varepsilon \right)}, \tag{2}$$

where, γ_s and γ_t are two exponent parameters to adjust the structure and texture awareness for illumination and reflectance decomposition. $\varepsilon = 10^{-8}$.

The illumination and reflection components were estimated simultaneously using the Retinexmodel [6], and the TV-norm standard illumination and reflection components. The model is as follows:

$$\min_{I,R} \|O - I\text{O}R\|_F^2 + \alpha \|S_0 \text{O} \nabla I\|_F^2 + \beta \|T_0 \text{O} \nabla R\|_F^2, \tag{3}$$

where, S_0 and T_0 are two weighting matrices, which represent the structure map of illumination and the texture map of reflectivity respectively.

In order to better extract the detailed features of the weak target, enrich the structure texture information of the target, and preprocess the infrared image, the proposed algorithm senses the structure texture of the infrared image through EMLV filter, and uses Retinex model to enhance the infrared image, so as to realize the fine processing of the infrared target features. In this paper, DOG(Difference of Gaussian) bandpass filter is used to suppress background clutter and noise. On the generated binary mask map, the whole map is traversed by sliding window to obtain patch-image, which are stacked into a 3D cube to construct a mask patch-tensor model.

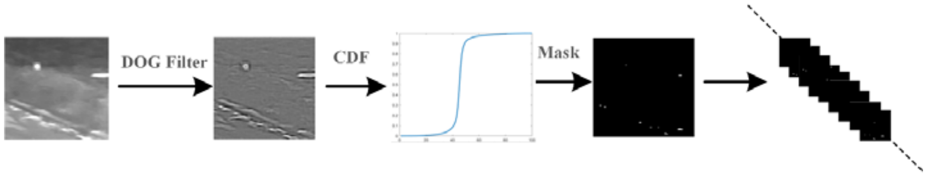

Fig. 1. Mask block tensor generation graph

The application of the mask graph guarantees the low rank of the background image, and transforms the background separation into a convex optimization function based on the patch-tensor:

$$\min_{B,\mathrm{T}} \|B\|_* + \lambda \|\mathrm{T}\|_{1,} \ \mathrm{s.t.} \|F - B - T\|_F \le \delta, \tag{4}$$

where, $\|\cdot\|_*$ is the nuclear number of matrix B; $\|\cdot\|_1$ is ℓ_1 – norm; λ is a weighted parameter.

In this paper, three infrared images of 128 × 128 were selected to construct the mask map, containing candidate targets and residual weak noise noise. The red rectangular box marks the true target to be detected. By contrast with the source image, the mask map suppresses the strong trunk edge of the first frame image, the strong cloud light edge in the second to four frames, and the complex thick clouds. The masked map was verified to suppress clutter by comparing the masked map with the corresponding global 3D display map. According to the experimental detection results, the proposed algorithm overcomes the interference of complex background and clutter, and realizes the accurate detection of infrared targets.

Conclusion. In this paper, the feature refinement sensing operation is used to compensate for the details of small targets and effectively mine the target features. The application of masked graph not only inhibits background clutter, but also ensures the low rank of background. By using the method based on low rank sparse recovery to transform the infrared small target detection problem into a convex optimization function solution problem based on masked patch-tensor model, so as to achieve the precise separation of target and background.

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