A target detection algorithm based on gray distribution characteristics

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Abstract. The two-dimensional distribution of gray scale is an important feature of image target, but there is no effective description method for the two-dimensional distribution of gray scale. To solve this problem, a GRD operator is proposed to describe the two-dimensional distribution of gray scale. The design model and calculation steps of GRD operator are discussed. The experimental results of image data show that GRD operator is very effective to describe the features of image target. GRD operator can effectively detect and extract the target, which has a wide range of application value in image target detection, tracking, recognition and so on.

1. Introduction
In target detection and tracking, the description of target features directly affects the effect of detection and tracking. Digital image is a two-dimensional matrix of pixel data, which is the two-dimensional distribution of gray in space. If the gray level of the image is directly used as the target feature for corresponding processing, it is easy to be affected by the rotation, deformation of the target and the change of ambient light. In order to complete the task of intelligent processing better, many methods to describe the two-dimensional distribution of target gray are proposed and applied, such as two-dimensional histogram [1], gray level co-occurrence matrix [2], and local binary patterns [3]. These methods have some limitations. In order to improve the effect of target detection and tracking, a GRD (Gray Relative Distribution) operator is proposed.

2. Methods
The two-dimensional distribution of gray level in space is an important feature of image target. Only gray level image is discussed here, and the corresponding method can be extended to color image.

A good target characterization operator should have the following properties:

1) Anti environmental illumination change
2) Resist the influence of target rotation and deformation
3) Acceptable amount of calculation

GRD (Gray Relative Distribution) operator is designed around the above properties.

1) The relative gray scale is used to reduce the influence of light change
2) In order to improve the adaptability of the algorithm and reduce the amount of calculation, the relative gray level is graded
3) The number of pixels in relative gray level is taken as the core parameter of feature description to resist the influence of target rotation and deformation.

The steps of target detection using GRD operator:

1) Take the gray value of the central pixel of the template as the reference value

2) Calculate the gray difference between each pixel of the template and the central pixel, and grade the gray difference (dg), for example, every 10 gray differences can be one level. How to grade can be comprehensively considered according to the algorithm performance and calculation amount. If each gray difference is one level, the value range of the gray difference (dg) is: $-255 \leq dg \leq 255$, That is to say, there are 511 eigenvalues. If every 10 grayscale differences are one level, there are 51 eigenvalues. The eigenvalues of each level are the number of template pixels of that level.

3) Use GRD operator to extract the feature vector of template image

4) Use GRD operator to extract the feature vector of the search subgraph at the search position of the detection image

5) Use Pearson correlation coefficient formula to calculate the correlation coefficients of two eigenvectors, and the position of the subgraph with the largest correlation coefficient of the eigenvector of the detected image and the template image is determined as the best matching position.

3. Results

In order to verify the performance of GRD operator, the target detection test is carried out. The hardware platform of the test is: 2 CPU with 56 cores (Intel Xeon Gold 6132 CPU @2.6GHz), 256GB RAM, and windows 10 operating system.

Figure 1. Target detection results.

Figure 1 illustrates the result of target detection using GRD operator: It can be seen that the target in the right image has rotation, deformation and illumination change compared with the left image. Using GRD operator can detect the target well.
Figure 2 is a comparison of the GRD correlation detection and the Grayscale correlation detection. The search area is 40x40 pixels, and the template sizes are 20x20, 40x40, 60x60, 80x80, 100x100 respectively. It can be seen that under the same template size, GRD correlation detection takes less time than gray correlation detection. With the increase of template size, the performance advantage of GRD is more obvious.

4. Conclusion
GRD operator is designed to better describe the two-dimensional distribution characteristics of gray scale of image target, which can resist the influence of target rotation, deformation and environmental light change. Under the same template size, GRD correlation detection takes less time than gray correlation detection. GRD operator is a good new algorithm for target detection and tracking.

References
[1] Bruzzone L, Prieto D.F 2002 An Adaptive Semiparametric and context-based approach to unsupervised change detection in multitemporal remote sensing images IEEE Transactions on Geoscience and Remote Sensing
[2] Haralick R M , Shanmugam K , Dinstein I. 1973 Studies in Media and Communication 3(6) 610-21
[3] Ojala T, Valkealahti K, Oja E, et al. 2001 Pattern Recognition 34(3) 727-39