A Remote Sensing Image Target Recognition Method Based on SIFT Algorithm

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Abstract. Aerial camera could obtain the ground target image information, and the target recognition could be carried through the image preprocessing and interpretation. In the process of image interpretation, under the precondition of massive images, if the interpretation member recognition was used only, the interpretation process will be complicated, time-consuming and the man-made errors will also be increased gradually. Based on this situation the SIFT method was used in the paper and the target in image received from aerial camera were got feature extraction, the feature points were obtained and it were contrast to the target feature points of standard target in the library which were set up in advance, so the accurate interpretation of aviation image target could achieved, so a kind of effective interpretation identification method for correct aviation image target recognition was proposed.

Introduction

Aviation remote sensing image has been widely used in resource exploration, disaster monitoring, urban planning, military reconnaissance and other fields. Especially in the process of military reconnaissance, the use of reconnaissance satellites or air vehicle carrying all kinds of optical sensors can work for military intelligence gathering on peacetime or wartime; it was also one of the main methods of intelligence information in nowadays. The aviation remote sensing image processing, classification, extraction and target recognition is the main task of the military image processing. Due to the huge amount of data that aviation remote sensing image contained, if the simple interpretation member recognition were used, the interpretation process will be very complex, and human error will gradually increased, so as to the recognition speed and accuracy were out of the quasi real-time requirements, so the computer image automatic identification technology research were started, and it have been the hotspot of content. This paper adopted a scale invariant feature transform (SIFT) algorithm to take the feature extraction of interest target of remote sensing image, and then the comparing computation with the pre-established targets of standard library were made, the link between the two targets is obtained according to the feature point correlation, so as to achieve accurate recognition [1].

Target Identification Strategy

Target recognition is actually related to the image area of mode decision process, the general strategy is to extract the corresponding area of the image, and the recognition for the content of regional information were contrasted, the presence of interest targets were determined. Usually the judgment method is based on the known samples, under the premise of the known target standard in advance to get interested in samples, establish the corresponding standard target model library or database. By using the method of building the known target sample library is very likely to be one kind of area target into the corresponding sample library, then based on the remote sensing image classification and pretreatment, treat interpretation area target using SIFT algorithm to extract the sample characteristics, and the comparison calculations were taken to that of the most likely one or several target sample feature points of the samples in the library. The specific process was shown in Fig.1.

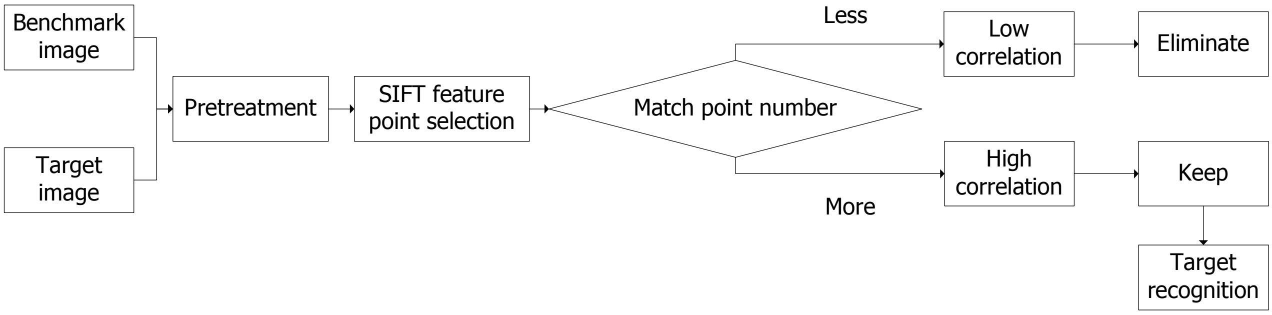

Fig.1 The specific process of the comparison calculations

SIFT Algorithm

SIFT algorithm was proposed in 1999 and made a perfect and summary in 2004 by D G Lowe [1, 2]. It based on image local feature description. The key points of SIFT maintain invariance for image scaling and rotation and the probability of noise jamming were reduced due to the localized of the frequency spatial. The calculation of the main process can be represented by the following steps.

The Generation of the Scale Space. The first stage of calculation is searching all scale and image position, it can detect the potential feature point effectively using the Gauss differential formula, and these key points were invariant for scaling and rotation. Scale space theory is designed to simulate the multi-scale characteristics of image data. Gauss convolution kernel is the only linear kernel to realize the scale transform. A two-dimensional image scale space is defined as:

$$L(x,y,\sigma) = G(x,y\sigma) * I(x,y) \tag{1}$$

$$G(x,y,\sigma) = \frac{1}{2\pi\sigma^2} e^{-(x^2+y^2)} / 2\sigma^2 \tag{2}$$

Where, $G(x,y,\sigma)$ are Gauss function of variant scale. (x, y) are space coordinate, σ is scale coordinate. In order to detect the stable key points in the scale space effectively, the DOG scale-space was proposed, it was generated by Gauss difference kernel with different scales and image convolution. The DOG operator is simple and it is the approximation of LOG operator with normalized scale [1].

$$D(x,y,\sigma) = (G(x,y,k\sigma) - G(x,y,\sigma)) * I(x,y) = L(x,y,k\sigma) - L(x,y,\sigma) \tag{3}$$

Image Pyramid was constructed, there are O group together, and S layer in every group, the next set of images were gained from a set down sampling of the last set image. Two octaves of a Gaussian scale-space image pyramid with s=2 intervals. The differences of two adjacent intervals in the Gaussian scale-space pyramid create an interval in the difference-of-Gaussian pyramid. σ is scale space coordinate, O is octave coordinate, and S are sub-level coordinate. The relationship is:

$$\sigma(o,s) = \sigma_0 2^{o+s/S} \tag{4}$$

Where $o \in o_{min} + [0,...,O\text{-}1]$, $s \in [0,...,S\text{-}1]$, and σ_0 is norm layer scale [2].

The detection of space extreme point. In order to find the extreme points of scale space, each sampling point should be compared to all of its adjacent point to make sure if it is bigger or smaller in image domain and scale domain. So it can be sure that the extreme points could be detected in the scale space and 2-dimension image space [3]. We can confirm the location and scale for each candidate and identify their direction. Each point is assigned a direction, all the data operation to image could be converted to the operation of feature point direction, scale and location, thus ensuring the s invariance of change.

The extreme points position and direction distribution confirmation. Due to the strong edge response of the DOG operator, it could remove the key points of low contrast and the unstable edge response points to enhance the matching stability and improve the ability of resist noise simultaneous. The extreme points are very important. There are a large main curvature in the edge across and a small main curvature in the vertical edge if the extremum of Gauss difference operators were not well defined [4].. The principal curvature can be calculated by a 2x2 Hessian H matrix:

$$H = \begin{bmatrix} D_{xx} & D_{xy} \\ D_{xy} & D_{yy} \end{bmatrix} \tag{5}$$

Derivative was estimated from adjacent difference of sampling points. Make the principal curvature of D and the Eigen value of H proportional， α is the largest Eigen value, and β is the smallest Eigen value, then:ake

$$Tr(H) = D_{xx} + D_{yy} = \alpha + \beta \tag{6}$$

$$Det(H) = D_{xx}D_{yy} - (D_{xy})^2 = \alpha\beta \tag{7}$$

Where α=γβ :

$$\frac{Tr(H)^2}{Det(H)} = \frac{(\alpha+\beta)^2}{\alpha\beta} = \frac{(\alpha\beta+\beta)^2}{\alpha\beta^2} = \frac{(r+1)^2}{r} \tag{8}$$

The value of item (r+1)2/r is least when the two Eigen value are equal. And its value will bigger along with the value of r. So, it is only to detect if Eq. 9 is come into existence:

$$\frac{Tr(H)^2}{Det(H)} < \frac{(r+1)^2}{r} \tag{9}$$

Using the neighborhood pixel gradient direction distribution characteristics of key point as specify direction parameter of each key point, so the operator with rotation invariance.

$$m(x,y) = \sqrt{(L(x+1,y) - L(x-1,y))^2 + (L(x,y+1) - L(x,y-1))^2} \tag{10}$$

$$\theta(x,y) = \alpha \tan 2\left(\frac{L(x,y+1) - L(x,y-1)}{L(x+1,y) - L(x-1,y)}\right) \tag{11}$$

The formulas are gradient modulus value and direction formulation of (x, y), where the L's scale are the respective scale of key points. In actual calculation, the samplings of neighborhood windows were carried out with the key points as the center, and the gradient direction of neighborhood pixel were made by histogram statistic. Histogram peak is the neighborhood gradient direction of the key points, as key point's direction. In the gradient direction histogram, when there is another peak that is equivalent to 80% energy of the main peak, it can be considered as assist direction of the key point. A key point may be specified with multiple directions, so the matching robustness could be enhanced [5]. So far, the image detection of the key point is finished, and there are 3 information of each key point: location, scale, direction. They can determine a SIFT feature region expressed with elliptic or arrow.

The description creation of key points. The axis should be rotated as key point direction to ensure that the rotation invariance. Then take a window with the key point as the center. The gradient direction information of that near the critical point of the pixel is more contribution. Then the gradient direction histogram of the directions of each piece could be calculated, and the accumulated value of each gradient direction could be rendered, a seed point was formed, it is the key point descriptor [6].

The Algorithm Simulation Results and Analysis

In order to verify the effectiveness of proposed method, a set of experimental data and images were taken as the object, and the SIFT algorithm program were simulated in MATLAB. The same typical targets identification of two images was taken and the result is shown in Fig.2. The left image is a radar positions scene captured from the remote sensing image, if artificial interpretation were used, it have to rely on experience in interpretation of mass screening and interpretation to judge what is the radar type, the final effect is not ideal. And if the method of computer automatic identification were adopted, so that it can directly compare with the target repository model. The right image is the target sample figure which was stored in the target library, the solid line connection between the two figures indicated the correlation between the target feature points, the more lines were shown that the correlation between the two goals were more likely the same target.

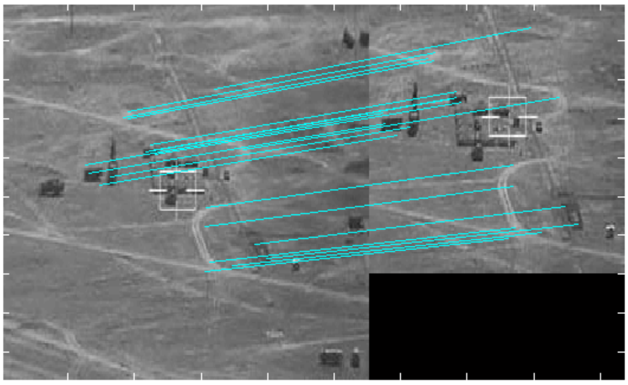

Fig.2 The correlation between the target feature points

Conclusions

A target recognition method based on SIFT algorithm and the characteristics of remote sensing image target was put forward in this paper, the method can stay interpretation according to the characteristics of the target area, and the extraction of target feature points and feature vector were taken automatically. The SIFT feature points matching and identification calculation analysis were made with the standard target in the library, as a result the image of higher feature point matching rate was retained finally, which can automatically recognize the type of the target models. The theory analysis and simulation results were shown that the correct recognition rate of the feature point matching results was higher, the recognition time of matching greatly better than that of artificial interpretation.

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