Research on target damage evaluation model based on image with single source information

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Abstract. Under the condition of single source information, this paper studies and analyzes the target damage evaluation model based on image information, and proposes an automatic evaluation algorithm based on image change detection based on the analysis of geometric features and texture features before and after the target is hit. The algorithm consists of two parts: image extraction algorithm and image matching algorithm. For the image extraction algorithm, the image gradient, the definition of corner point and the structure feature and the extraction technology of the corner point are introduced in detail. For image matching algorithm, we mainly consider gray-based matching algorithm and feature-based matching algorithm. Under the condition of single information source, the target damage model based on image information is helpful to make up the deficiency of damage evaluation model, which has certain practical significance.

1. Introduction

Under the condition of single source information¹², target damage effect evaluation refers to the analysis and evaluation of the damage status of each target function and the overall damage effect of the target according to the target damage information provided by a single source. It basically evaluates the damage effect of the target³ from various qualitative target damage information.

At present, the main ways to obtain target damage information include reconnaissance satellite, unmanned reconnaissance aircraft, TV floating reconnaissance projectile, position reconnaissance and radar calibration and personnel close-in reconnaissance.

Monophyletic information under the condition of the basic thought of target damage effect assessment¹⁴. According to monophyletic target damage information to determine the target function of each single damage situation, the order of bottom-up is chosen, and according to the target every single function or subroutine damage situation, determine its function indexes on a layer of damaged conditions, final judge target damage effect as a whole.

Among the single source intelligence information, image information is another major damage assessment information source⁵. With the rapid development of satellite remote sensing technology and unmanned aerial vehicle (uav) reconnaissance technology, it is possible to acquire high-resolution target area images quickly and accurately. This method is not only slow, but also subject to the subjective influence of readers, easy to be deceived by the enemy camouflage, and cannot give quantitative evaluation results.
Therefore, it is necessary to use computers to evaluate the impact automatically instead of humans. High resolution satellite remote sensing image or uav aerial photography image of target area are detected by multi-time remote sensing image.

Analysis is an objective and effective method for automatic evaluation of strike effect, which can help to filter out the "impact points" painted by the enemy for camouflage, and improve the accuracy of strike effect evaluation. Based on the analysis of the geometric and texture features before and after the attack, this paper presents an automatic evaluation algorithm of the attack effect based on image change detection.

2. Image extraction algorithm

2.1. Gradient of image

Corner definition and corner extraction algorithm are based on the gradient of image gray scale, which is the most commonly used method in image processing \[^{[6]}\]. Suppose there is an image function \( f(x, y) \), then its gradient at the point \((x, y)\) is defined as a vector, and the magnitude of the vector is equal to:

\[
\|F[f(x, y)]\| = \sqrt{\left(\frac{\partial f}{\partial x}\right)^2 + \left(\frac{\partial f}{\partial y}\right)^2}
\]  

(1)

In computer image processing, the symbol \( F[f(x, y)] \) is commonly used to replace the mode \(\|F[f(x, y)]\|\) of gradient, and the mode of gradient is referred to as image gradient. In addition, difference operations are often used instead of differentiation operations. The difference approximation can be expressed as:

\[
F[f(x, y)] \approx \sqrt{[f(x, y) - f(x + 1, y)]^2 + [f(x, y) - f(x, y + 1)]^2}
\]  

(2)

To reduce the amount of computation, it is further simplified as:

\[
F[f(x, y)] \approx |f(x, y) - f(x + 1, y)| + |f(x, y) - f(x, y + 1)|
\]  

(3)

In addition, there is another cross difference algorithm called Roberts gradient, which is defined as:

\[
F[f(x, y)] \approx \sqrt{[f(x, y) - f(x + 1, y + 1)]^2 + [f(x + 1, y) - f(x, y + 1)]^2}
\]  

(4)

Or further simplified to absolute difference algorithm:

\[
F[f(x, y)] \approx |f(x, y) - f(x + 1, y + 1)| + |f(x + 1, y) - f(x, y + 1)|
\]  

(5)

If it is represented by a graph, equations (3) and (5) are shown in Figure 1 and Figure 2.

\[\text{Figure 1 Difference operations for gradients} \quad \text{Figure 2 Roberts gradient}\]

2.2. Definition and structural characteristics of corner points

In summary, corner points show the position where the grayscale of the image changes dramatically in the two-dimensional space, and are pixels with obvious differences from the neighboring points \[^{[7]}\]. According to the structural characteristics of corner points, corner points can be divided into the
following categories: "Y" corner points, "T" corner points, "V" corner points, "K" corner points, "Arrow" corner points, "X" corner points, etc, as shown in Figure 3.

Figure 3 Classification of corners

2.3. Corner point extraction technology

There are many methods to extract corner points, which can be generally divided into two categories\[8\]: methods based on local gray value of image and methods based on image boundary information. Mokhtarian and Bober is proposed based on Scale Space (Curvature Scale Space CSS) a new angular point extracting technology\[9\]. This algorithm firstly uses Canny detector from original image edge detection, and has the largest absolute cover the point defined as the curvature of edge points, in a very small scale, because there is a lot of noise, so a lot of edge points with maximum absolute curvature, and when the scale increases, the noise is smooth, only corresponding to the maximum value of the real angular point preserved, but the location of the angular point also in change, then the positioning of angular point is very poor. In view of this reason, the algorithm first USES large scale to detect corner points in the image, and then gradually reduces the scale to track and improve corner position at several low scales. Because only candidate corner points need to be calculated in the process of reducing the scale, the calculation amount can be greatly reduced.

In addition, the use of wavelet fast algorithm to extract multi-scale corner points has also been developed rapidly\[10\]. If the Laplacian crossing zero point is detected along the track of the maximum scale variation, the detection result of sub-pixel precision can be obtained. Quddus and Fahmy propose a fast corner extraction algorithm based on wavelet transform\[11\]. They believe that most corner extraction algorithms are based on a single scale space, while most contour curves in actual images are at different scales. For example, an arc on a small scale may be considered an angular point on a large scale; And the angular point of small scale, large scales may be considered just a noise point, so the single scale corner detection on a small scale may be missing small angular point, large scale may be missing more rough feature points, due to their rapid extraction algorithm considering the multi-scale space, so the large Angle can be detected on a large scale, can also be detected in small scale small angular point, and because of the fast algorithm is adopted, so the computational efficiency is high.

3. Image matching algorithm

In the process of machine recognition of things, the spatial calibration of two or more images obtained from the same scene by different sensors at different times and under different imaging conditions, or the search for corresponding patterns on another image according to known patterns, is called image matching\[12\]. The mathematical definition is as follows:

Image matching is the mapping of spatial position and gray intensity between two images. If two images are defined as two-dimensional arrays with known dimensions and expressed as $I_1$ and $I_2$, and $I_1(x, y)$ and $I_2(x, y)$ represent their spatial gray distribution, then the mapping between the two images can be expressed as follows:

$$I_2(x', y') = g(I_1(f(x, y)))$$

(6)

Where, $f$ is the two-dimensional spatial coordinate transformation, which transforms the spatial coordinate $(x, y)$ into the spatial coordinate $(x', y')$, namely: $(x', y') = (x, y)$. And $g$ is a one-dimensional transformation of intensity. The matching problem is to find the optimal spatial domain transform $f$ and intensity transform $g$. According to the different data structures involved in matching operations, matching algorithms can be roughly divided into two categories: grey-level-based algorithms and feature-based algorithms.
3.1. Grey-level-based algorithms

Gray-scale based matching algorithm\[^{[13]}\] matches the original image data after two-dimensional Fourier transform or image data after image correction, edge sharpening and image enhancement, and the image pixel data of the whole region is involved in the matching operation. Research on matching algorithms based on image areas has been relatively mature, such as gray-scale correlation algorithm, phase correlation algorithm and so on. These algorithms are easy to implement and have good matching performance and adaptability to various scenarios without large distortion. However, the computation is large and the speed is slow, and it is easy to be interfered by noise.

3.2. Feature-based algorithms

Feature-based matching\[^{[14]}\] firstly mentions the features that reflect important information of the image, and then uses these features as models for matching. Local feature points, side polygons and complex structure of the image content description. This kind of algorithm for each with different matching primitives, generally, the matching algorithm is based on matching primitives, on the basis of the similarity measure between the similarity measure is called affinity, it is based on matching primitive parameters information of local feature similarity measurement, the measurement method combined with a camera model, can significantly reduce the search space to match.

4. Conclusion

Based on the characteristics of artillery information source and its damage assessment, this paper presents an image-based method of artillery target damage assessment under the condition of single source information. Based on the basic information of image in single information source, the image extraction algorithm and image matching algorithm are analyzed and discussed. For the image extraction algorithm, the image gradient, the definition of corner point and the structure feature and the extraction technology of corner point are introduced in detail. For image matching algorithm, we mainly consider gray-based matching algorithm and feature-based matching algorithm. Under the condition of single information source, the target damage model based on image information is helpful to remedy the defects in practice and has certain practical significance.

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