Applied Mechanics and Materials *Online: 2012-12-13*
ISSN: 1662-7482, Vols. 241-244, pp 1733-1736
doi:10.4028/www.scientific.net/AMM.241-244.1733

Research on Automatic identification of airplane targets on infrared images

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Keywords: infrared image, image characteristic, ho's invariant moments, rotation inertia, geometric feature

Abstract. No matter in civil remote sensing or in military investigation, infrared images have an extensive application value. According to the characteristics of the infrared images, in this paper, we build comprehensive feature vectors of airplane identification based on comprehensive consideration of the characteristics of infrared images, including boundary invariant moments , normalized moment of inertia and geometric features. Identifying an air plane by calculating the comparability of feature vector between template image and the image to be identified, the algorithm has been proved by experiments to have a better stability and robustness.

Introduction

Compared with the images obtained from other investigation imaging methods, infrared images have the advantages of working in all weather all day and the ability of reflecting the status information of targets, which has made it one of the significant developing directions of remote sensing, industrial production and military field. Infrared images can be used not only in identifying targets' properties but also in comprehensively analyzing and studying targets' information of status and construction, etc. According to the features of infrared image, identifying airplanes by means of various features fusion has a strong reference value on developing researches on the relative applications.

Characteristics of Infrared Image

Infrared images have very clear characteristics compared with other kinds of images, which can be analyzed through the comparison between the image itself and the gray scale histogram. [1]The following Figures will draw a comparison between a infrared image and its' gray scale histogram and that of a optical image to analyze the characteristics of infrared image histogram, as shown in Figure 1 and Figure 2.

The distribution of infrared image histogram corresponds with the distribution of thermal radiation of context and target. The image catachrestics of targets change relevantly, owing to its unique imaging method, specially showed in aspect of shape, hue and shadow.

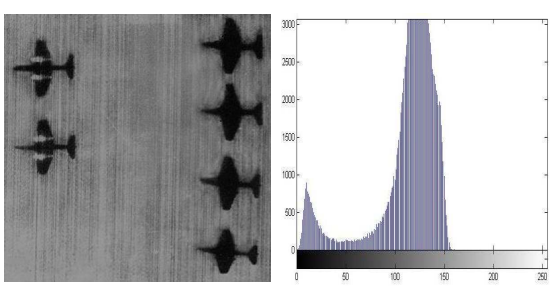

Fig1 Infrared image and its histogram

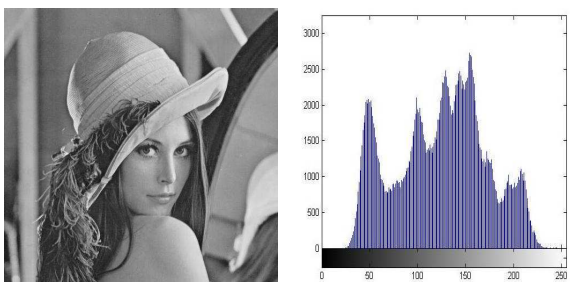

Fig2 Optical image and its histogram

Unlike optical images, infrared images of earthbound objects cannot integrally reflect the shape of targets, which is little changed in optical images. The shape of earthbound objects in an infrared image, owing to the influence of atmospheric scattering, targets' temperature and position relationship between the targets and camera and other factors, generally presents three kinds of situations: one is to reflect the approximate shapes of targets, another is to reflect the actual shapes of targets, and the other is to deform the shapes of targets. Aircraft shapes can remain unchanged on the whole. [2]

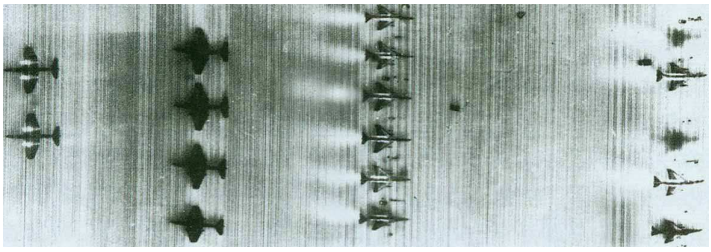

Fig3 Plane on the infrared image

Hue feature is an important basis for analyzing infrared image. Infrared image is a kind of grayscale image, which displays the image with tone of black and white. Except for the function of general hue feature, it can also apply information of status and activities of targets. The detecting ability of infrared detector depends on the difference between target and context. The engine condition and taking-off, landing information of airplane can be reflected by hue feature. We can interpret the properties and the status of targets from figure 3.

Shadow will emerge in infrared images in the circumstance that objects are under heat source radiation and block a part of background. The shadows in infrared image not only have the features and functions of that in optical image, it can also present the outline of the targets, which have left not too long ago. Moreover, the shadows and the targets are similar in shape (Figure 3)

Recognition of Infrared Image

Recognition of infrared image is detecting and classifying targets in the images based on identification features of the known targets. Typical images recognition system is shown in Figure 4.

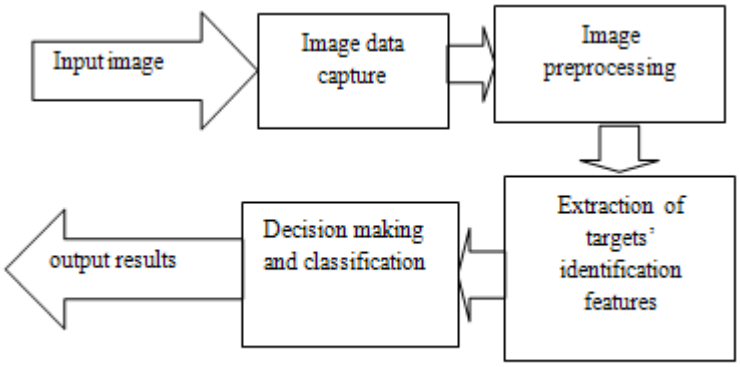

Fig4 plane on the infrared image

The extraction and selection of characteristics is the pivotal issue of image recognition. From the perspective of mathematic, feature extraction is equivalent to the conversion from a physical modal into a random vector. For example, extracting n features of a target, the physical modal can be depicted as a point in an n-dimension space.

The main purpose of feature selection is to obtain the feature vectors which have the characterizations of targets. It makes the targets of same kinds have the highest comparability and the targets of different kinds have the maximum dissimilarity, and at the same time, it improves the results of targets classification and reduces the dimensions of feature vectors. [3]The process of image

recognition is the process of extracting the feature vectors, which is made up with targets' features, and the process of calculating the comparability of the feature vectors between targets and the known template, then classifying the targets with great similarity as a class.

The infrared images generally have the drawbacks of low resolution, low contrast, lacking of gradation, and a bad integrity of image edge, which have lead to the consequence that it is hard to reach a good recognition result with only one feature. This paper combines the features of boundary invariant moments, the normalized moment of inertia and geometry, which have made up a new set of airplane identification features, and then identifies airplane with the method of features matching.

Extraction of airplane identification features

The core of targets identification is the accurate selection and extraction of identification features. Different images in different applications distinguishes a lot in the aspect of interference complexity and the characteristics of target itself, for which reason, it is reasonable to chose different mathematic features, that is to chose appropriate feature vectors, according to different images and different targets' characteristics to get an ideal result. According to characteristics of airplane, this paper abstracts ho's invariant moments, binary edge image, rotation inertia and geometric features of airplane to make up feature vectors of airplane identification

The representation of moment is of great significance in objects classification and recognition because in some image region, moments have some constant features, such as, translation, rotation, and scale, etc. And the most famous of which is ho's moment invariant extracted by American Chinese academic GuiMing Hu. Moments indeed reflect the statistical distribution of gray scale relative to the centroid of objects. For the actual images, there exist the order origin moments and central moments. [4]They can uniquely depict the gray scale distribution and the structure features of images and remain unchanged after translation, rotation, and scaling. Research shows that gray scale features exert a larger effect on images' invariant moments , for which reason, this paperextract the binary edge of image first, and then extract boundary invariant moment features, on the origin base of ho's invariant moment, .to reflect essential characteristics of binary edge image better.

Except for selecting the identification features above, this paper selects the geometric features of airplanes, under the combination of characteristics of airplanes, as the basis for identification. The length-width ration, sphericity, complexity and the features selected in the proceeding paragraphs are chosen to constitute the feature vectors of airplane identifying.

The Identification Algorithms Based on Feature Matching

The target identification based on feature matching is comparing the similarity of the feature values between the targets to be identified and the template. The main method of this process is calculating the comparability of feature vectors with decision function. First, extract the eigenvalue of the targets, establish the samples of identification and extract the eigenvalues of all kinds of targets in order that it can be used in next step. Set a threshold by calculating the comparability of feature vectors between the targets and the sample. And classify the target with the greater similarity than the threshold as a class.

It is an ordinary algorithm to identify target by calculating the comparability between targets and template. On the basis of the extraction of feature vectors of targets and template,the core is the selection of decision function. The main function of decision function is to calculate the comparability between the targets and the feature vectors of the targets. Classify the targets with higher comparability as a class, according to the comparability of the feature vectors between the targets and the template. The first thing to do for the identification system is to determine the categories of targets in calculating the comparability between the input image and the feature template and then classify the targets with the value greater than the threshold as a class by setting a threshold.

In actual calculating, parallel move the template in the original image(binary edge image), regard the original part of the image (binary edge image) relative to the template as the image to be identified. And calculate the comparability of the feature vectors between targets and the template.
Determine the value of T by a large number of experimental data. If the comparability is higher than T, the two belong to the same kind of targets (airplane). If the comparability is lower than T, the two don't belong to the same kind. If there is not a target, the comparability of which is higher than T, there is no airplane in the image.

The features of the same targets are approximately similar in the images get from investigation imaging. Thus, we can intercept a representative target to identify the similar targets in the image. A part of the original image, intercepted in this paper, is treated as the template of testing the identification algorithm. Figure 5(a) is the template image, Figure 5(b) is the image to be identified. According to the identification features selected in last sections, the identification feature vectors of template can be calculated. Parallel move the template on the image to be identified, calculate the feature vectors on the relative image to be recognized and calculate the comparability based on the decision function. Suppose the threshold d=2, the eventual identification result is shown in Figure 5(c) and the number of the airplanes is 6.

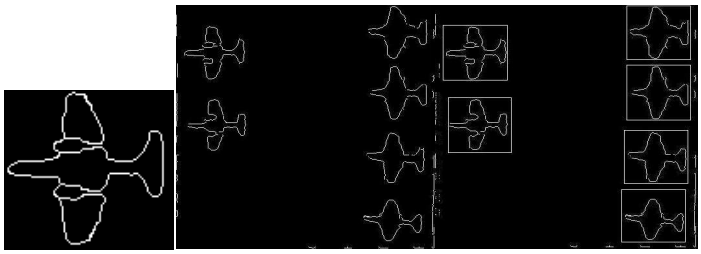

Figure 5 The experiment results of airplane identification

Conclusions

The precise identification of airplane is the foundation of the dynamic monitoring of the airports. The main research contents of this paper is airplane identification on the basis of feature matching. First, the basic principle of image identification and the basic frame of image identification system are introduced. And the identification features, including the basic features and the invariant features, are analysed. In this paper, we build the feature vectors of airplane identification under the combination of the boundary invariant moments, the normalized moment of inertia and the geometric features. Then identify the airplanes by calculating the similarity of feature vectors between the template image and the image to be identified.

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