International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 04 | Apr -2017 www.irjet.net p-ISSN: 2395-0072

An Effective Aircraft Recognition System for High Resolution Optical Satellite Sensing Images Using Bayesian Pursuit Algorithm

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Abstract - *This project describes about the aircraft recognition using Bayesian Pursuit algorithm. This method does not recover the entire shape of aircraft as a precondition before recognition. The direction estimation method is proposed first to align aircraft to a same direction. To estimate the direction angle and magnitudes are determined. After that, the neighbor based images and classification images are calculated using iteration process. Then, a reconstruction based similarity measure is proposed, which transform the type recognition problem into a reconstruction problem. The features matching are done using FAST feature method. Finally, get the aircraft recognized image. The performance of BPA is compared using the parameters such as peak signal to noise ratio and mean square error. The performance of Bayesian Pursuit algorithm is analyzed with the existing method.*

Key Words: Aircraft recognition, SNR, similarity measure, segmentation, features extraction.

1.INTRODUCTION

To recognize the types of airplane is important one. We can get a handle on the action examples of airplane, identify the patterns of airplane and make judgment through the types of aircraft. Airplane recognition with high-resolution spaceborne optical images is a important task. It is still difficult to recognize targets of a few types from the others. The main aim is to recognize the aircraft image from the satellite sensed images. Several methods are proposed to recognize the aircraft. For example Hu moment invariant [3], Hu moment invariant elements are extracted from binary images to naturally distinguish identify six airplane types. In [5] an independent component method is joined with Zernike invariant moments for airplane recognition. In [16] contour tracking is used to eliminate much noise first and after uses moment invariants to recognize the types of the airplane. These methods always use thresholding segmentation for the overall outlines or shape of targets and extract rotation-invariant elements for examples Hu moments, Zernike moments, wavelet moments, and Fourier descriptor for recognition. But these methods has some drawbacks, determining the moment invariants and Fourier descriptor requires perfect extraction of outline or shape of each aircraft as a precondition, which excessively hopeful for focuses with irregular appearance caused by distortion, computation time is high and low SNR in satellite images. Bayesian Pursuit Algorithm improves the PSNR value and reduces the MSE (Mean Square Error) value.

2. PROPOSED METHOD

The proposed method is Bayesian Pursuit algorithm. This technique is mainly used for recognizing aircraft. The haar transform is used for segmentation. The Bayesian Pursuit algorithm is used for extract the features of image from satellite image.

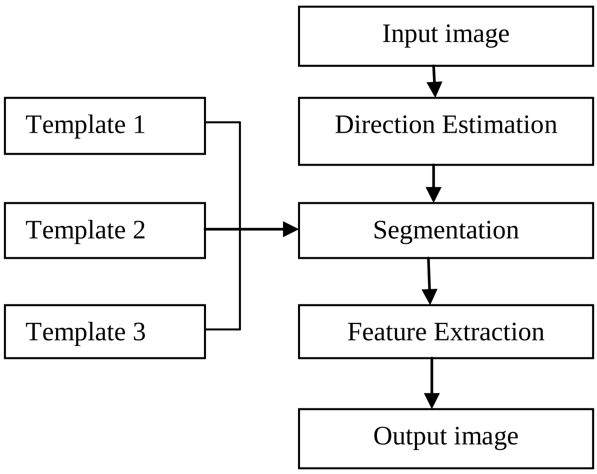

Fig -1: Flow diagram of aircraft recognition

2.1 Input Image

Satellite image as input image. A satellite image is an image of the whole or part of the earth taken using artificial satellites. These images have a variety of uses, including: cartography, military intelligence and meteorology.

2.2 Direction Estimation

Considering the shape characteristics of aircraft such as symmetry and fuselage characteristics, we estimate the directions of aircraft with histograms of oriented gradients for aircraft alignment. The flow of direction estimation is as follows.

Step 1:

The first step is to calculate the gradient of the image to get the contour and texture information and then to weaken the interference caused by image brightness changing.

Step 2:

Get the histograms of oriented gradients. The histograms of oriented gradients are a histogram in nature, such as an image histogram. For an image histogram, the *x*-axis means the range of pixel value, from 0 to 255 for 8-bit images, and the *y*-axis means the votes accumulated into each value in the *x*-axis. For histograms of oriented gradients, the *x*-axis means the range of the orientation of the pixel's gradient, from 0◦ to 180◦. The *y*-axis means the votes accumulated into each orientation bin in the *x*-axis. Along these lines, in these steps, every pixel computes a weighted vote in favor of an edge introduction histogram channel in view of the introduction of the angle component fixated on it, and the votes are collected into introduction canisters. The introduction receptacles are uniformly divided more than 0◦–180.

Step 3:

The line structures of aircraft lie in the fuselages and the wings, and the direction of fuselage indicates the direction of aircraft. The orientation of the fuselage usually corresponds to one of the first three maxima in the gradient direction histogram. Therefore, those first three maxima are selected as potential candidates for aircraft orientation. Obtaining the three candidates of aircraft direction, we align the aircraft upright to three main directions, respectively, for type recognition. It shows the calculation process of the histograms of oriented gradients. In this figure, we divide the range of the orientation of the pixel's gradient (0◦–180◦) into nine bins.

2.3 Histogram of Oriented Gradients

The histogram of oriented gradients (HOG) is a feature descriptor used in computer vision and image processing for the purpose of object detection. The technique counts occurrences of gradient orientation in localized portions of an image. This method is similar to that of edge orientation histograms, scale-invariant feature transform descriptors, and shape contexts, but differs in that it is computed on a dense grid of uniformly spaced cells and uses overlapping local contrast normalization for improved accuracy. The essential thought behind the histogram of oriented gradients descriptor is that local object appearance and shape within an image can be described by the distribution of intensity gradients or edge directions. The image is divided into small connected regions called cells, and for the pixels within each cell, a histogram of gradient directions is compiled. The descriptor is then the concatenation of these histograms. For improved accuracy, the local histograms can be contrast-normalized by calculating a measure of the intensity across a larger region of the image, called a block, and then using this value to normalize all cells within the block. This normalization results in better invariance to changes in illumination and shadowing.

2.4 Segmentation

Image segmentation is a process of portioning an image into non-intersecting regions such that each region is homogenous. Here histogram probability threshold selection is used which overcomes the problem of existing algorithms. It is used to measure the average foreground and background variance to suppress the redundant region to zero's and set one's to desired foreground region. In segmentation purpose harr transform is used. Wavelet transform is a local transformation from time to frequency domain and easily generate a variety of different resolution images. It decomposes the image into different subband images namely LL, LH, HL, HH. In segmentation purpose haar transform is used. A high-frequency subband contains the edge information of input image and LL subband contains the clear information about the image. A data reduction method will be applied to each image for converting multiband to single band images using transfer. Haar transform expression is given by,

$$B_n = H_n A_n H_n^T$$

Where, $A_n = n \times n$ matrix

$H_n =$ n- point harr transform

A high-frequency subband contains the edge information of input image and LL subband contains the clear information about the image.

2.5 Bayesian Pursuit Algorithm

The main task of this algorithm is to determine aircraft features. In some pursuit algorithms (e.g., MP), it is determined by correlation maximization. In some other pursuit algorithms (e.g., StOMP), it is done by comparing the correlations with a threshold. But, here we want to determine it by a Bayesian hypothesis testing from the correlations. For features detection FAST feature method is used. An edge of an object has end points or corners; if we reduce our edge to those corners, we will get enough unique pixels and remove unnecessary information. There are various methods of getting keypoints from an image, many of which extract corners as those keypoints. To get them, we will use the **FAST** (**Features from Accelerated Segment Test**) algorithm. It is really simple and you can easily implement it. Increase the computational efficiency is the most striking feature of fast corner detector. As name stand it is fast and undeniably it is faster than many other feature extraction methods. It uses Bresenham circle of radius 3 to find out whether the selected point is a corner. Each pixel in the circle is given a number from 1 to 16 clockwise. If a set of contiguous pixel inside the circle is brighter or darker than the candidate pixel then it is classified as a corner. FAST is considered as a high quality feature detector. But, still not robust to noise and depend on a threshold. Finally get the aircraft recognized image.

2.6 Target Reconstruction

In this section, we transform the template reconstruction problem to a mathematical problem and propose the method to solve the mathematical problem. Using D = d1…dp ∈map to represent the segments matrix, where each column vector of the matrix di represents the silhouette of a segment obtained by multi scale segmentation. Based on the hypothesis that the shape of target can be pieced together with the segment elements, we can get the following relationship: where α is the coefficient vector, the entries of which are either 0 or 1. The principle in choosing the segments afore mentioned is to use as many coarse scale segments as possible, with the smallest reconstructive error as a precondition, which means that it is better to use as few segments as possible while holding the smallest reconstructive error as a precondition.

3. PARAMETER MEASURES

3.1 Mean Square Error

Mean Square Error is the difference between reconstructed image and original image. If the MSE value is low then the PSNR value will be high.

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}\left[I(i,j) - \hat{I}(i,j)\right]^2$$

Where,

I(i,j) - Reconstructed Image

$\hat{I}(i.j)$ - Original Image

3.2 Peak Signal to Noise Ratio

PSNR value is calculated to measure the quality of reconstructed image. PSNR value is high means the quality of image will be good.

$$PSNR = 10\log_{10}\left(\frac{m*n}{MSE}\right)$$

Where,

m=256 and n=256

4. RESULTS AND DISCUSSION

Grayscale image is used as a input image. Size of input image is 256×256.

Fig -2: Selection of input image

In direction estimation process, the angle and magnitude are calculated.

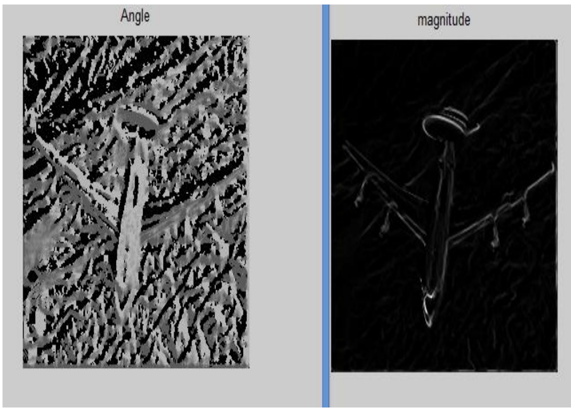

Fig -3: Angle and magnitude of image

After that, Histogram is calculated at each angle.

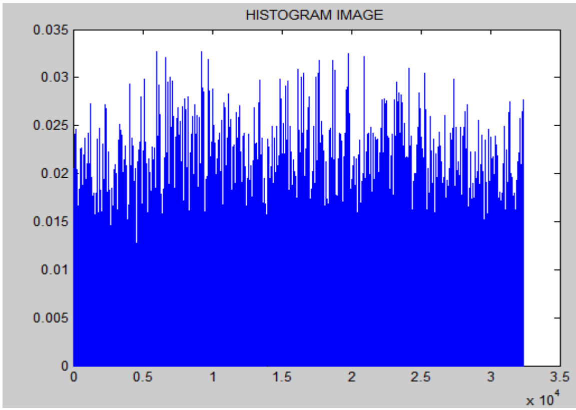

Fig - 4: Histogram of image

Then, the image is segmented using haar transform. The clear image is displayed on LL subband.

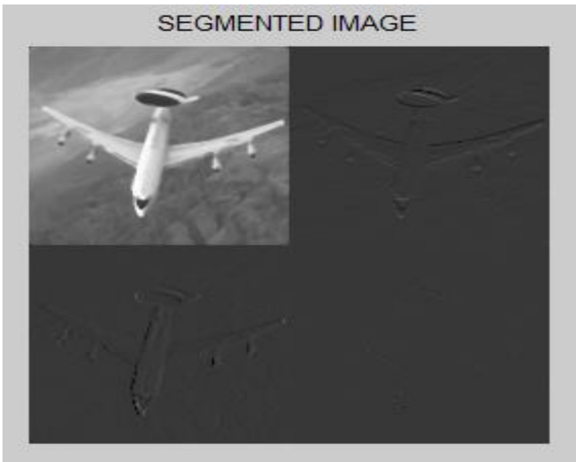

Fig -5: Segmented image

Recognized image is generated by applying Bayesian pursuit algorithm to satellite image. Peak Signal to Noise Ratio for the recognized image is 70.1720 and the Mean Square Error value is 0.0063

Fig -6: Aircraft recognized image

5. PERFORMANCE ANALYSIS

The performance of proposed method is compared with the existing method to analyses the performance.

Table -1: Comparison of PSNR and MSE

S. No	Methodology	PSNR	MSE
1	**Bayesian Pursuit Algorithm**	**70.1720**	**0.0063**
2	Jigsaw Matching Pursuit Algorithm	52.27	0.0184
3	Transform Features & Detect Fuzzy Clustering	51.20	0.0537
4	DSmT and HMM	50.05	0.0348

6. CONCLUSION

In this paper, Bayesian Pursuit algorithm is used to recognized the aircraft image. From the performance measures, it is concluded that Bayesian Pursuit algorithm is having high Peak Signal to Noise Ratio and low Mean Square Error.

ACKNOWLEDGMENT

The author would like to thank my guide Y.R. Packia Dhas, Associate Professor, Department of ECE, PET Engineering College.

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